Victorian Planning Authority

Minta Farm PSP Surface Water Management Strategy

Report




October 2017

V5000_001

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1. INTRODUCTION

The Victorian Planning Authority has engaged Engeny Water Management (Engeny) to undertake a Surface Water Management Strategy for the Minta Farm Precinct Structure Plan (PSP 11).

The Victorian Planning Authority (VPA) develops Precinct Structure Plans (PSP) to guide future urban development. At present, VPA is preparing a draft urban structure plan for the Minta Farm Precinct Structure Plan (PSP 11) in preparation for the future urbanisation of this parcel of land.

The Minta Farm land is located approximately 46 km south-east of Melbourne in Berwick. The site is bounded by existing residential development and the Pakenham Bypass to the north, Soldiers Road to the west, Grices Road to the south and Cardinia Creek to the east. The site is illustrated in Figure 1-1.

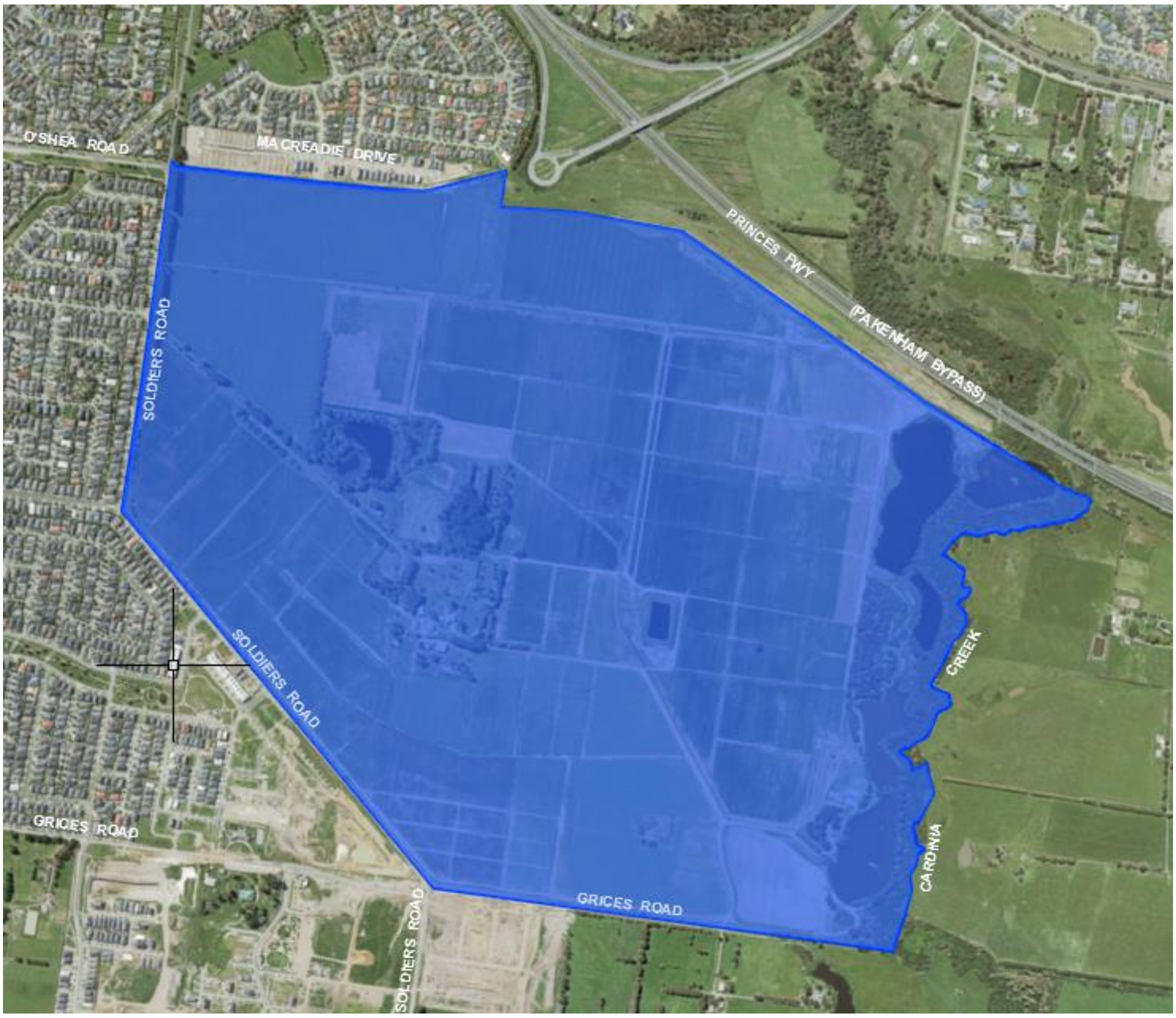

Figure 1-1 Minta Farm Land

In defining the urban structure, it is critical that land-take for drainage purposes is determined early. 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 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 has been achieved through incorporation of best planning practices for stormwater management during the development of the urban structure.

This Surface Water Management Strategy (SWMS) for the Minta Farm PSP 11 identifies the assets required to manage the increased surface water runoff from urbanisation, ensures that the assets will function in accordance with their intent and indicates the land-take required for the safe operation and maintenance of these assets. The surface water management for Minta Farm has been optimised and has been designed to achieve multiple benefits for the community and the environment.

Revision 1 of the surface water management strategy was produced in August 2015. Revision 2 was prepared in late 2016 and was subject to review and provision of comments by VPA, Melbourne Water, City of Casey and the Department of Environment Land Water and Planning (DELWP) following a meeting on 2 February 2017. Revisions 3, 4 and 5 were adjustments of the earlier work following review by the VPA and other stakeholders including redesign of the Future Urban Structure (FUS) of the Minta Farm PSP. Revision 6 of this report has involved replacement of previous versions of the FUS with a plan provided to Engeny on 6 October 2017. No changes to Engeny's modelling have been undertaken for Revision 6.

This strategy has taken into account a number of requirements and has produced a design with numerous benefits and innovative features. Details of these outcomes are provided in the conclusions section of this report.

2. CATCHMENT CHARACTERISTICS

The Minta Farm site is located at the eastern end of Grices Road in Berwick and is approximately 282 ha in size. It is bounded by Cardinia Creek to the east. The average annual rainfall for the region is between 800 mm and 900 mm. The site is currently used for agricultural purposes and has had significant modification to the pre-European catchment form. What was originally floodplain abutting Cardinia Creek was modified many years ago to form three sizable and distinct ponds adjacent to the creek.

In its current state, the site has two distinct catchments, the Ti Tree Creek catchment and the Cardinia Creek catchment. Figure 2.1 depicts the catchment delineation. The external catchments upstream of Minta Farm are part of the wider Cardinia Creek catchment.

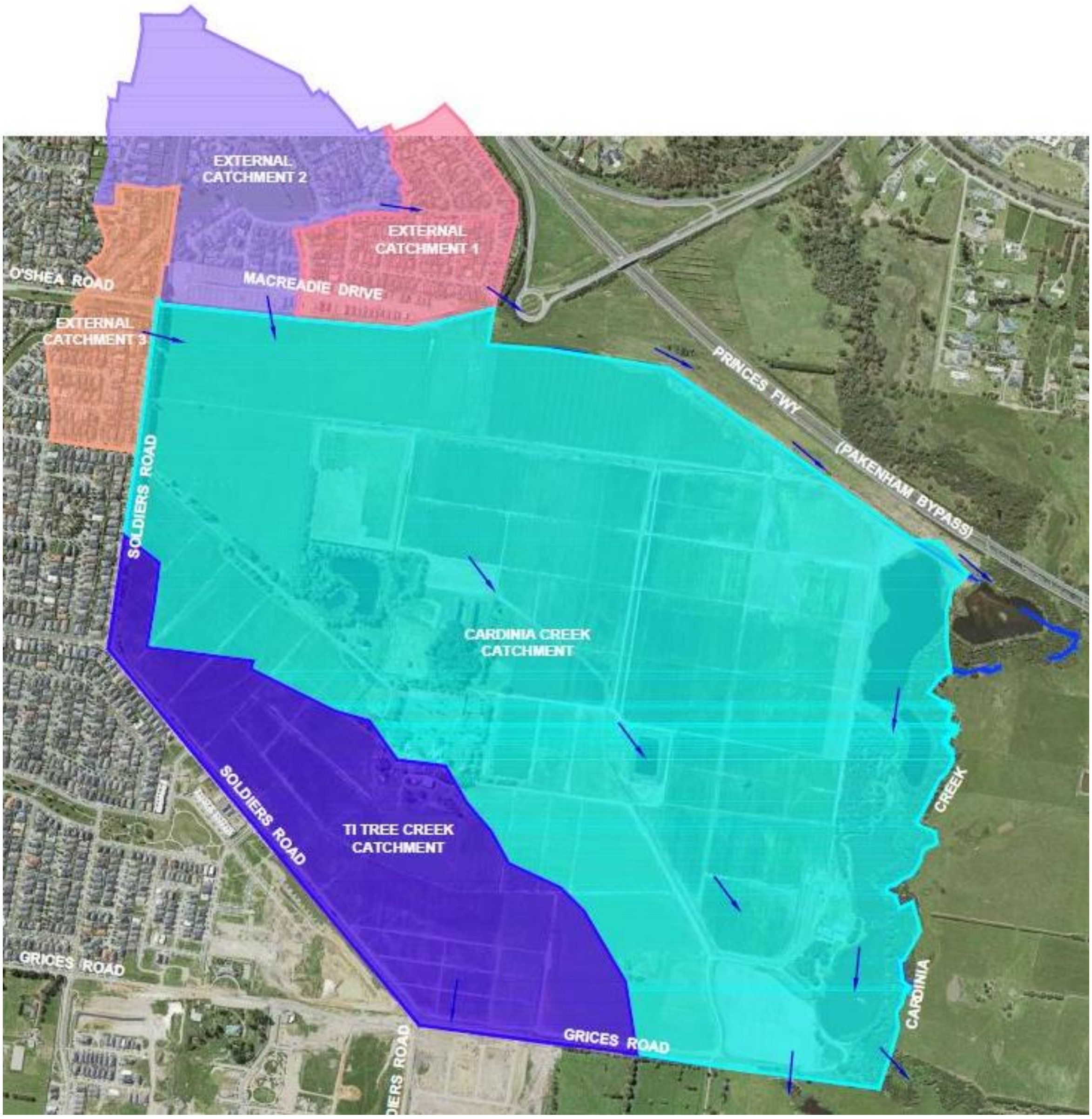

Figure 2-1 **Catchment delineation**

The Ti Tree Creek catchment is approximately 51 ha and drains to the south west corner of the property. The topography has some grade ranging from RL57 m AHD at the crest of the catchment to RL32 m AHD in the south west corner. Surface grades are generally in the range of 1 % to 8 %. This catchment drains into Melbourne Water's existing Ti Tree Creek Development Services Scheme and will form part of this scheme. The Ti Tree Creek Scheme allows for runoff from Minta Farm, including retardation and stormwater treatment of runoff from Minta Farm.

The Cardinia Creek catchment is approximately 292 ha including Minta Farm and three external catchments and drains towards Cardinia Creek. This catchment can be separated into several components. External Catchment 1 is approximately 18 ha and is currently diverted across the northern boundary of Minta Farm connecting to Cardinia Creek via a Council 1350 mm pipe with an approximate capacity of 4.2 m^3/s. It is possible that overland flow from External Catchment 1 could enter Minta Farm near the Freeway access roundabout and this will be catered for in the design (and has been included in the RORB model). External Catchment 2 is approximately 31 ha. The minor drainage for this catchment is conveyed with External Catchment 1 to Cardinia Creek, whilst the gap flows in excess of the pipe capacity will flow overland and enter Minta Farm. External Catchment 3 is approximately 12 ha and is conveyed through Minta Farm from the north-west. There is approximately 10 ha of the Cardinia Creek catchment in the south-east corner of the Minta Farm site that drains across Grices Road to connect into a cut drain south of Grices Road, before draining south and then eventually to Cardinia Creek. This 10 ha part of the Cardinia Creek catchment drains into Melbourne Water's Clyde North Development Services Scheme and will form part of this scheme. The Clyde North Scheme allows for runoff from Minta Farm, including retardation and stormwater treatment of runoff from Minta Farm.

The overall Cardinia Creek catchment has an average grade of approximately 2 % with existing levels ranging from approximately RL45.5 at the northern site boundary to approximately RL34.60 at the southern existing pond immediately upstream of Grices Road. The Cardinia Creek catchment discharges directly into Cardinia Creek and will form its own Drainage Strategy.

2.1 Existing Minta Farm Ponds

The Cardinia Creek catchment has three existing ponds (see Figure 2.2) that were created by the land owners of the Minta Farm area some 50 years ago. The ponds are located in what was the Cardinia Creek flood plain by creating a levee in between the creek and the property. These ponds have been used for water supply purposes for agriculture. They have also become a significant habitat for amphibians and migratory birds.

The existing land owner has advised that Pond 1 fills from a diverted catchment via a shallow open drain, and then discharges into Pond 2. Once Pond 2 is full, it connects directly to Cardinia Creek. Pond 3 fills from a diversion of the watercourse within the property prior to discharging to Cardinia Creek. Table 2.1 summarises the size of the ponds based on LiDAR data.

Table 2-1 Minta Farm Cardinia Creek Ponds

Parameter	Pond 1	Pond 2	Pond 3
Surface Area (m^2)	42,570	8,630	41,880
Approximate Volume (m^3)*	85,140	17,260	83,760
Assumed NWL (m)	38.2	35.6	36.4
Assumed Weir Level (m)	39.5	34.6	35.7

*Based on discussion with the land owner indicating the ponds are at least 2 m deep

Due to the habitat values and the 100 m offset recommended from Cardinia Creek top of bank, it is proposed to maintain but utilise these ponds as follows:

- Pond 1 (northern pond). This pond can be developed for stormwater treatment purposes as advised by DELWP
- Ponds 2 and 3 (central and southern ponds). These ponds need to be retained in their current form to provide habitat. The stormwater strategy aims to continue to provide flow to these ponds and to treat stormwater prior to it flowing into the ponds to reduce the risk of algal blooms in these ponds and maximise the environmental values of ponds 2 and 3. Ponds 2 and 3 are proposed to be within Conservation Area 36 as advised by VPA and DELWP.

Minta Farm has another existing dam located in the centre of the property. It is a turkey nest dam with no existing habitat values and due to the height of the dam is problematic to maintain water circulation without pumping. This dam is not expected to have any benefits in the context of the future urbanisation of the area. Therefore it has been decided that this dam should be removed with the urbanisation of the property.

The property also contains an existing lake not far from the original homestead. Whilst this lake is aesthetically pleasant, it is not well positioned to provide any benefit for stormwater management and holds little ecological value. This lake is not expected to have any benefits in the context of the future urbanisation of the area and therefore this lake may be removed for development.

Figure 2-2 **Minta Farm Land Existing Water Bodies**

3. PROPOSED MINTA FARM DEVELOPMENT

Minta Farm is proposed to be developed into an urban area with a range of proposed land uses. A number of iterations of the development plan for the Minta Farm PSP have been developed by the VPA with input from a number of stakeholders, including the City of Casey, Melbourne Water and DELWP. Engeny has assisted VPA in sizing the surface water elements of the proposed development.

Engeny has been provided with what we understand to be the latest iteration of the proposed Minta Farm Future Urban Structure (FUS). A copy of the plan supplied to Engeny by the VPA (on 5/04/2017) that shows the latest version of the Minta Farm FUS is included in **Appendix A**.

4. PROCESS

The primary objective of this analysis is to determine the change in hydrologic response of the catchment due to the urbanisation of the land, and determine how to manage the change. In doing so the analysis is based on the following process:

- Establish a RORB model of the catchment
- Calibrate and / or validate the model and derive parameters for the catchment models
- Determine peak discharges from the catchment under pre development conditions
- Determine peak discharge from the site for post-development conditions
- Determine the need for peak flow mitigation
- Establish methods of conveyance for the major (100 year ARI) post development design flows
- Identify significant trunk drainage and waterway infrastructure required to convey design flows
- Treat the stormwater runoff generated from the urbanisation to best practice
- Determine the treatment required to meet the SEPP Schedule F8 pollutant reduction targets for the Cardinia Creek catchment
- Determine the required land-take for management of the stormwater related to the change in the hydrologic response of the catchment and the urbanisation of the catchment.

5. HYDROLOGIC ANALYSIS

The intent of the hydrologic analysis is to determine the magnitude of flows to be conveyed through and around Minta Farm, and the retardation requirements of the flows prior to discharge to receiving systems.

The Clyde North Precinct Structure Plan Surface Water Management Aspects (Craigie 2009) states that no retardation is required for the portion of the Baillieu property that is discharging to Ti Tree Creek. The proposed infrastructure in the downstream Kilora Estate has made allowance for this urbanised catchment.

The Clyde North Precinct Structure Plan Surface Water Management Aspects (Craigie 2009) also states that the 100 year ARI design flow crossing Grices Road and discharging to the south must be limited to 3 m^3/s but that the majority of the runoff generated from the Cardinia Creek catchment of this site will discharge into the existing ponds and then into Cardinia Creek.

The Assessment of Drainage Strategy for PSP 53 and the Overall Cardinia Creek Catchment (Stormy Water Solutions et al, 2012) recommends that flows are not retarded prior to discharging into Cardinia Creek. Instead the report recommends undertaking some flood mitigation works at the confluence of the creek from the Baillieu property (Minta Farm) and Cardinia Creek to ensure no increase in flood levels in the Koo Wee Rup Flood Protection District, and an upgrade of the Cardinia Creek Outfall. The intent is to capture contributions from development within the overall Cardinia Creek catchment and utilise the contributions to fund these works. In accordance with the intent of this strategy, retardation of this catchment will only be provided by:

- the existing ponds (one (1) of which will be converted into Wetland 1)
- Two (2) further proposed wetlands that are required for stormwater treatment, but that will also provide some incidental retardation of peak flows within the catchment.

5.1 RORB Model

5.1.1 Methodology

The industry accepted runoff routing software package, RORB was adopted as the design runoff routing model for generation of flows and simulation of storages throughout the catchment. RORB generates catchment runoff based on the selection of local rainfall intensity frequency duration data and appropriate loss models.

The catchment boundary, sub-areas and waterway network were established using a combination of LiDAR data, aerial photogrammetry and land-use planning. The RORB catchment plan is contained in **Appendix B**.

Special storages have been used in the RORB model for wetland 2 and wetland 3. These wetlands are located at nodes Q1 and AD1 respectively.

Calibration of the model parameters is ideally carried out by using available storm events for which both runoff hydrographs and catchment rainfall data are available. The model can be tested with other storm events to check agreement between calculated and recorded results. The model is then used with design rainfall data and the adopted parameters to obtain runoff estimates for various return periods and storm durations.

However this catchment does not have systematic stream flow and/or water level gauging stations. Consequently parameter values were derived using accepted regional equations and validated through comparison with flow estimates based on the probabilistic rational method.

5.1.2 RORB Parameters

Discussion regarding the selection of the RORB parameters is included in **Appendix C**. Rainfall parameters used in the RORB modelling are provided in **Appendix D**. Table 5.1 summaries the parameters adopted to run the RORB model.

Table 5-1 RORB Parameters Adopted

RORB Parameter	Cardinia Creek Catchment	Ti Tree Creek Catchment
Kc	2.8	1.58
M	0.8	0.8
IL	10 mm	10 mm
C	0.6	0.6

5.1.3 RORB reach types

RORB reach types were discussed between Engeny and Melbourne Water. The aim was to choose reach types that would best represent the actual routing of flows through the catchment for 100 year ARI storms. The reach types were agreed as follows:

- The uppermost urban reaches for each sub catchment were modelled as reach type 3 (pipes). This was chosen to represent that most of the relatively small flows in the very upper end of the catchment is in pipes and / or narrow smooth gutters
- Other urban reaches were modelled as reach type 2 (excavated unlined channels). This was agreed as it represents that the peak 100 year ARI flow along roads only reaches the end of the reach when the overland flow along the road reaches the end of the reach
- Constructed waterways were also modelled as reach types 2 as agreed.

5.1.4 Peak 100 Year Average Recurrence Interval Design Flows

The peak flows from Minta Farm are negligible in the overall Cardinia Creek catchment and the timing of peak flows from this catchment do not coincide with the timing of peak flows in Cardinia Creek. Therefore it has been elected to not provide any further retardation to this catchment, in accordance with the Cardinia Creek Strategy (Craigie 2009), although some incidental retardation will be provided by flood storage within the proposed wetlands as described below.

As the discharge of 9.7 m^3/s from the Ti Tree Creek catchment from our RORB model is less than the 100 year ARI design flow of 10.4 m^3/s at Grices Road that has been allowed for in the Melbourne Water Ti Tree Creek scheme, no retardation will be provided for this catchment. The downstream system has a 900 mm diameter low flow pipe and a grassed open channel. The combined capacity of this system is 10.4 m^3/s. Once the flow from upstream exceeds the capacity of this pipe, it will surcharge into the open channel downstream of Grices Road.

Table 5.2 lists the 100 year ARI design flow at key locations within the Minta Farm land.

Table 5-2 100 year ARI Design Flows

Location	Flow (m^3/s)
Peak flow into WL2 from the north	5.4
Peak flow into WL2 from the west	8.2
Inflow to Wetland 2	15
Outflow from Wetland 2 into upstream end of waterway	8.1
Inflow to Wetland 3	5.7
Outflow from Wetland 3	1.8
Flow in downstream end of waterway, into pond 3	9.4
AF1 (flow into Ti Tree Creek catchment)	9.7

5.1.5 Wetland 2 and 3 details for flood management

It can be seen in Table 5-2 that there is significant attenuation of peak flows in the 100 year ARI event due to Wetland 2 and Wetland 3. This occurs due to the proposed configuration of each of these wetlands. It should be noted that to be conservative and to comply with Melbourne Water requirements the wetlands have been assumed to be full to EDD at the start of the 100 year ARI storm.

Note that wetland 1 has not been designed to provide retardation and does not discharge into the proposed constructed waterway through Minta Farm. Therefore wetland 1 has not been included in the RORB model.

For wetland 2 and wetland 3 the depths have been set as follows:

- The Normal Water Level (NWL) is the controlled water level in the wetland during dry weather

- Extended Detention Depth (EDD) has been set as 350 mm above (NWL) in accordance with Melbourne Water Guidelines

- A further 550 mm of depth has been provided above EDD to the 100 year ARI Top Water Level in the wetland. This allows sufficient depth for weir flow from the wetland to enter a pit for discharge via a pipe to the waterway. The large weir pit can be designed to minimise the risk of blockage as per usual design practice for Melbourne Water outlet structures

- A further 600 mm of freeboard to adjacent lots has been provided from the 100 year ARI Top Water Level

- Engeny set the 100 year ARI Top Water Levels for wetlands 2 and 3 to be at or below natural surface. This ensures that there is no embankment required that would trigger the need for an ANCOLD assessment. The natural ground level at the lowest point for wetland 2 is at the 100 year ARI Top Water Level at the south east corner of the site. This would allow a spillway to be set at this level and for any flow in excess of the 100 year ARI storm to safely discharge across natural ground and then into the downstream waterway. Wetland 3 is also designed to be fully in cut. A spillway from wetland 3 could be cut into the natural surface and be designed to spill into the proposed adjacent waterway

- The outlet for WL2 will consist of a low flow orifice as per the MUSIC modelling results and then a large weir pit with capacity for the 100 year ARI peak outflow to be able to discharge into the pit. Downstream of the large weir pit will require a culvert that will be approximately 200 metres long, as shown on the layout plan in Appendix H. To convey the 8.1 m^3/s outflow from WL2 in a 100 year ARI storm will require a 2250 mm diameter culvert at a velocity of 2 m/s, or (more likely) an equivalent capacity box culvert

- The outlet for WL3 will consist of a low flow orifice as per the MUSIC modelling results and then a weir with capacity for the 100 year ARI peak outflow to be able to discharge into the immediately adjacent constructed waterway as shown on the layout plan in Appendix H. To convey the 1.8 m^3/s outflow from WL3 in a 100 year ARI storm will require a 4.5 metre wide weir

- 100 year ARI flows downstream of WL2 and WL3 discharge directly into the proposed waterway which is proposed to have capacity to contain the 100 year ARI flow, with 600 mm of freeboard. WL1 will discharge into the ponds in the conservation area. There will therefore not be any overland flow into urban lots or streets downstream of any of the proposed wetlands

- In large flow events it is necessary to consider the impact on the sediment pond and wetland of high flows and the option of diverting high flows around these features. Engeny checked the wetland 2 and 3 concept designs against Melbourne Water criteria for velocities for the sediment ponds and wetlands. The proposed Engeny configurations for wetland 2 and 3 comply with Melbourne Water velocity limits for high flow events and therefore high flow bypass pipes or channels within the wetlands are not required.

The Wetland Normal Water Level typically needs to be at least 1.5 metres below adjacent lots to enable drains to connect into the wetland and to enable sufficient head above the high flow outlet.

Table 5.3 below provides the proposed levels and other details used in the RORB modelling.

Table 5-3 Wetland parameters / results from RORB

Location	Area at NWL (ha)	NWL (m AHD)	EDD (m AHD)	100 year ARI TWL (m AHD)	Adjacent Minimum Lot Level (m AHD)
Wetland 2	2.25	36.5	36.85	37.40	38.0
Wetland 3	1.53	34.5	34.85	35.40	36.0

Engeny's concept design plans for wetland 2 and wetland 3 are provided in **Appendix E**. These plans show the proposed wetland / sediment pond footprints, batter slopes and proposed land budget areas. The concept designs have been undertaken using the sediment pond and wetland areas from the MUSIC modelling, plus battering up from Normal Water Level to natural surface at 1 in 6, plus allowance for a 4 metre wide access track all around the wetland, plus allowance for a sediment drying area adjacent to the sediment pond. The Charlton Degg concept design for wetland 1 is also included in **Appendix E**.

6. HYDRAULIC ANALYSIS

A hydraulic analysis was undertaken to determine the sizing of the key stormwater infrastructure required to convey the design flows through the development.

The intent of the hydraulic analysis was to determine where in the catchment the capacity of the road reserves is insufficient to convey the overland flows and a constructed waterway is required. The constructed waterway will need to convey the 100 year ARI flows, as well as provide environmental, open space, linear path and aesthetic benefits as required by Melbourne Water's Waterway Corridor Guidelines (October 2013).

The waterway corridor has been sized based on these requirements and sizes for main road culvert crossings have been provided to convey the 100 year ARI peak flows.

It is also important to ensure that the stormwater will be able to freely drain into the proposed wetlands and waterway and discharge from the site. This has been considered in allocated levels to constructed wetlands and constructed waterway depths.

The roads will need to convey the gap flows. Gap flows are the difference between the 100 year ARI design flows and the capacity of the pipe drainage network. Pipe drainage infrastructure will be provided to convey the 5 year ARI design flow for the residential areas and the 10 year ARI design flow for the Office and Technology precinct, the retail zones and the Town Centre.

For an initial sizing of pipe infrastructure, it was assumed that the 5 year ARI design flow is 40 % of the 100 year ARI design flow and the 10 year ARI design flow is 50 % of the 100 year ARI design flow.

The majority of the major connector roads and main streets proposed within this precinct structure plan are located on high points of the land form; therefore the majority of overland flow conveyed by road reserves will be done so via access streets.

Table 6.1 lists the capacity of an access street with a 16 m road reserve with a typical profile to convey the following gap flows at various grades, meet safety criteria and comply with VPA's Engineering Guidelines.

The road layout and pipe sizes from the external catchments to the upstream end of Wetland 2 will need to be designed to convey 100 year ARI flows with a combination of underground pipes and overland flow paths along roads. The conveyance of these flows has been discussed with VPA and Melbourne Water and the details can be determined during detailed design. Engeny's RORB modelling provides information to assist with planning for overland flow in roads and potential pipe sizing as detailed in Table 5-2.

The proposed Urban Structure has allowed for an overland flow path through the proposed commercial development north of Wetland 2. There is also a local valley that approaches wetland 2 from the west. During detailed design the overland flow path cross sections and pipe sizes will need to be confirmed to safely convey these flows without inundating buildings or exceeding safe limits. This will be determined during detailed design.

Table 6-1 Overland Flow capacity of a 16 m Road Reserve

Grade %	Flow (m^3/s)
0.5	2.5
1	3.5
2	4.0
3	4.0
4	3.5
5	3.5
8	3.0

A constructed waterway, WW1, will be required from the 100 year ARI culvert outlet from WL2 to the existing Pond 3. The waterway has been sized to safely convey the 100 year ARI design flow from WL2 to Pond 3.

The alignment of the culvert outlet from Wetland 2 to the upstream end of the proposed waterway was considered. The shortest culvert option would be for the culvert to be constructed from the wetland outlet near the South East corner of the wetland in an easterly direction across the proposed road at a right angle. This alignment was considered, including a detailed review of the position of the existing open drain / waterway and the LiDAR terrain data. It was found that the existing open drain/ waterway follows the proposed culvert alignment and that the land on the east side of the proposed road adjacent to wetland 2 is substantially higher than the proposed outlet from wetland 2.

To construct the culvert on this angle would have required either:

- Raising WL2 and the proposed upstream end of the waterway. This would then require an embankment on wetland 2. An embankment would require an ANCOLD assessment and potentially a very expensive spillway to manage the risk of embankment failure. This would also involve a substantial land take for the upstream end of the waterway and a second culvert under the east-west collector road.

  OR

- Extensive excavation for the upstream end of the waterway, substantial land take for the upstream end of the waterway and a second culvert under the east-west collector road.

Therefore a slightly longer outlet culvert is proposed from wetland 2 that follows the existing drainage alignment and valley.

Engeny has sized an open waterway from Wetland 2 to pond 3 to comply with the requirements outlined by Melbourne Water's Waterways Corridors in Greenfield Developments Guidelines (2014).

The required capacity of this waterway is 8.1 to 9.4 m^3/s from the RORB results for the 100 year ARI flow, as detailed in Table 5.2.

We have used Melbourne Water's DSS spreadsheet to model the required pilot channel and floodway capacity. The cross section of the waterway has been determined to have a 10.6 m wide, 0.60 m deep pilot channel with a floodway with a further 500 to 600 mm of depth to convey the 100 year ARI flow. Adding 600 mm of freeboard to adjacent lots will give a total depth from waterway invert up to adjacent lot level of 1.80 m. These levels and depths have been adopted to allow the waterway to drain wetlands 2 and 3 and to enter pond 3 at its normal water level, while requiring minimal fill to adjacent lots. The concept design is based on proposed waterway invert levels as follows:

- Upstream end of waterway at pipe outlet from Wetland 2 – invert = 36.0 m AHD
- Downstream end of waterway into existing pond 3 – invert = 34.4 m AHD.

Based on the required hydraulic width and the requirements for access tracks and riparian zones, it is recommended that a 45 m wide waterway corridor is allocated. This is in accordance with Melbourne Water's Waterway Corridor Guidelines (October 2013) with active edges on both sides of the waterway. A cross section for the proposed waterway is provided in Figure 6-1 below.

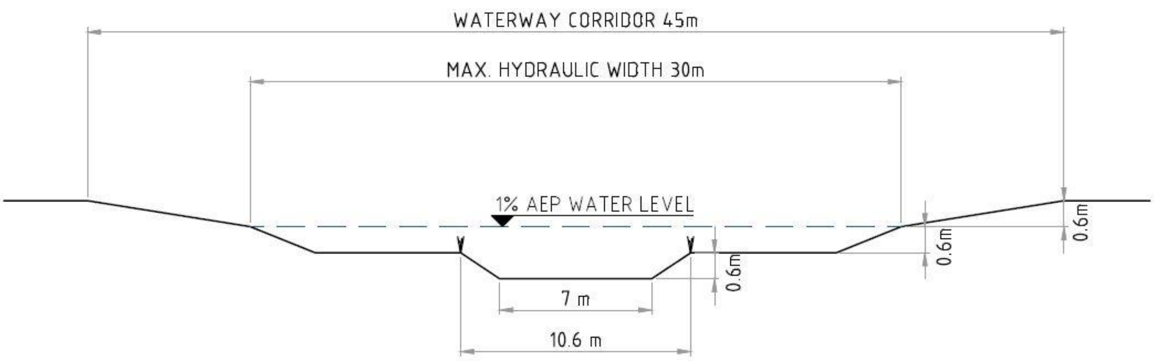

Figure 6-1 Waterway Cross Section

The maximum hydraulic width for the waterway is 30 metres calculated using the Melbourne Water DSS spreadsheet. With reference to Table 3 in the Melbourne Water Waterways Corridors in Greenfield Developments Guidelines (2014) the required waterway corridor width is 45 metres, allowing for "active edges" along the waterway corridor.

7. STORMWATER QUALITY ASSESSMENT

7.1 Best Practice Pollutant Reduction Targets

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 7-1 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 water quality treatment train considers the Minta Farm property discharges to two receiving waterbodies. The 51 ha Ti Tree Creek catchment ultimately drains to Port Phillip Bay and the remaining catchment that discharges to Cardinia Creek ultimately drains to Western Port Bay. The objective is to meet the overall pollutant reduction targets prior to discharge from the site. This holistic approach provides the mechanism to "over-treat" in one sub-area within the development to compensate for a lower treatment level achieved in another sub-area. The Best Practice Guidelines indicate that only land that will be developed within Minta Farm must meet the reduction targets, not the external catchment conveyed through the site.

The Best Practice Pollutant Reduction targets apply for all residential developments in Victoria in accordance with clause 56.07 of the Victorian Planning Provisions. Engeny has also been advised that there is an additional requirement for the catchments draining to Western Port. Western Port has a RAMSAR listed sea grass area that is susceptible to sediments. The Western Port catchment is in segment F8 of the State Environment Protection Policy (Waters of Victoria). An additional requirement for F8 is therefore for increased treatment with Engeny having been advised that the latest revised F8 targets are the same as the targets in Table 7-1 above, except for TSS which is required to have increased removal of 85 %[1].

A MUSIC (Model for Urban Stormwater Improvement Conceptualisation) modelling approach has been used to establish the proposed treatment train strategy. The model estimates the amount of pollutants the catchment produces, the performance of treatment measures and the pollutant load generated once the catchment is treated.

[1] The 85 % TSS, 45 % TN and 45 % TP removal targets were advised by Melbourne Water.

The proposed urban layout is not conducive to distributed treatment located in streetscapes as the majority of the proposed major road infrastructure is located along crests of the catchment. Therefore a regional approach to treatment has been adopted with wetlands strategically positioned throughout the development to ensure they have a reasonable contributing catchment but have not reached the point of saturation from a pollutant loading perspective. The locations are also mindful to minimise the land-take but positioned for maximum aesthetic value and to provide stormwater treatment upstream of the main proposed constructed waterways within the catchment as well as to protect the receiving waterways.

The layout of the MUSIC model with the names of every sub catchment used in MUSIC is shown on the plan in **Appendix F.** The plan in **Appendix H** illustrates the proposed positioning of the wetlands and sediment basins within the catchment.

The wetlands have been sized to achieve best practice pollutant reduction targets and the revised F8 targets overall for the Minta Farm land within the Western Port catchment.

For the Ti Tree Creek catchment the targets will be achieved via treatment within the Melbourne Water Ti Tree Creek DSS. No stormwater treatment assets and no land budget for stormwater treatment is required for the approximate 51 ha of Minta Farm that drains to the Ti Tree Creek catchment. DSS contributions will be required to be paid to Melbourne Water. The runoff from this catchment will meet Best Practice targets due to works in the Melbourne Water DSS.

It is proposed to discharge the 10 ha south east corner of Minta Farm south of the proposed constructed waterway via a pipe crossing under Grices Road and discharge this runoff into the Clyde North DSS. The Clyde North DSS has been planned to treat runoff from the small catchment area of Minta Farm that drains across Grices Road. No stormwater treatment assets and no land budget for stormwater treatment is required for the area of Minta Farm that drains to the Clyde North DSS catchment. DSS contributions will be required to be paid to Melbourne Water. The runoff from this catchment will meet Best Practice targets due to works in the Melbourne Water DSS.

For the Cardinia Creek catchment that drains to pond 3 there are three treatment assets proposed. The details of these proposed assets are provided in Table 7-2 below.

Table 7-2 Stormwater treatment system sizes

Asset	Area at Normal Water Level (ha)	Total Land Budget for PSP (ha)
Wetland 2	2.25	3.6
Sediment Pond	0.30	0.88
Wetland 3	1.53	2.63

Plans have been provided in **Appendix E** showing the Engeny concept design layouts for wetland 2 and wetland 3. We have also included. The concept design plan for wetland 1 was produced by Charlton Degg.

For the northern part of the Minta Farm development the drainage is proposed to be discharged to a new wetland on the footprint of the existing pond 1. A concept design of wetland 1 has been prepared by Charlton Degg, a copy of the concept design plan for wetland 1 in **Appendix E)**. The cost of wetland 1 is minimised by adopting the footprint of the existing pond 1. To create a smaller wetland would require more filling of pond 1 and therefore more cost. The proposed wetland 1 has the capacity to treat more flow than just the flow from its natural catchment, due to the size of pond 1. This therefore creates the opportunity for additional environmental benefits to be achieved at little additional cost. Diversions are proposed to increase the effectiveness of wetland 1. The diversions should be constructed if the benefits of the diversions outweigh their cost.

The plan in **Appendix H** shows the sizes and alignments of the key features of the surface water management system, including:

- Diversion pipes to maximise the flow to wetland 1
- Wetlands 1, 2 and 3
- The waterway from wetland 2 to pond 3
- The sediment pond adjacent to the waterway.

The MUSIC model includes a number of non-standard features to enable the system to be assessed from a number of points of interest to various stakeholders, including:

1. Inclusion of diversions from existing urban areas to provide a cost effective increase in TSS and TN removal for the Western Port catchment, without any further land take or cost to construct the treatment asset (wetland 1).
2. Inclusion of receiving ponds 2 and 3 in the model to enable the pond turnover to be easily assessed.
3. Consideration of pollutant loads and removal rates just from the runoff from the proposed Minta Farm development to demonstrate compliance with BPEMG and revised F8 targets.
4. Consideration of pollutant loads and treatment rates from all catchments draining to ponds 2 and 3 (including existing urban areas) to demonstrate that high quality water will be discharged to ponds 2 and 3.
5. Calculation of the additional pollutant removal over and above that required for the Minta Farm development to the benefit of Cardinia Creek and Western Port and how the value of this additional pollutant removal exceeds the cost of works required to achieve the additional pollutant removal.

The results from the MUSIC modelling have been provided in a number of different forms to address all of the points listed above. Details of the pollutant loads from every sub catchment and the pollutant removal for all scenarios are provided in sheet 1 in **Appendix G**.

Some key results are summarised in the body of the report as follows, with details of results in **Appendix G**.

For the catchment area draining to pond 1 the treatment has included diversion of flows from existing external development into the proposed wetland 1. This will assist in:

- exceeding Best Practice treatment for the runoff from Minta Farm
- treating existing external areas that currently drain directly to Cardinia Creek without any treatment
- contributing to exceeding F8 sediment targets for Minta Farm for the discharges to Western Port Bay
- protecting the water quality for ponds 2 and 3
- ensure that there is more than sufficient turnover for ponds 2 and 3 to reduce the existing risk of algal blooms and to ensure that these ponds are within parameters set by Melbourne Water to manage the risk of algal blooms.

The size of the sediment pond and wetland modelled in MUSIC on the footprint of pond 1 are a sediment pond with an area of 4,000 m^2 at Normal Water Level and a wetland with an area 40,000 m^2 at Normal Water level. This will allow sufficient area for sediment drying and access without requiring any developable land budget to be set aside in the PSP.

In relation to the need for the runoff from the Cardinia Creek catchment part of Minta Farm to achieve its required targets Table 7-3 below summarises how the system achieves these targets. Interrogation of the results showed that the critical pollutants were sediment and Nitrogen. Therefore results have been provided for TSS and TN.

Table 7-3 summarises the overall treatment to ponds 2 and 3 and includes only the pollutant loads from the Minta Farm development within the Cardinia Creek catchment, while allowing for all of the pollutant removal from the system. See **Appendix G** for full details of the MUSIC analysis. Sheet 4 in **Appendix G** provides the calculations used in Table 7-3.

Table 7-3 Treatment Performance for Cardinia Creek catchment – including flow from Minta Farm only

	TSS (kg/year)	TN (kg/year)3
TOTAL loads from Minta Farm only draining to ponds 2 and 3 (receiving waters)	208,343	2,998
Total loads removed by treatment system prior to discharge to ponds 2 and 3	220,331	1,921
Removal as a percentage of the loads from Minta Farm	105.8 %[2]	64.1 %
BPEMG removal target	80 %	45 %
Achievement of BPEMG target	Yes	Yes
Revised F8 removal target	85 %	45 %
Achievement of Revised F8 target	Yes	Yes
Amount of pollutant required to just achieve revised F8 target (85 % of TSS load from Minta Farm)	177,092	1,349
Amount of pollutants removed in excess of revised F8 requirement	43,239	572

As can be seen from the results in Table 7-3 the system exceeds Best Practice and revised F8 targets in relation to Minta Farm's obligations, which are to achieve Best Practice targets from their runoff.

The proposed Minta Farm system includes extra treatment mainly by diverting flows from existing urban catchments into wetland 1 as detailed above. The benefits of these diversions include:

- Removal of pollutants discharging into ponds 2 and 3 in the conservation area to ensure that overall the water in these ponds meets revised SEPP F8 requirements to protect the habitat in these ponds
- Provision of additional flow into ponds 2 and 3 to increase turnover and reduce the risk of algal blooms
- Removal of additional sediment from Cardinia Creek and Western Port Bay, which will contribute to reducing the impact on the RAMSAR listed sea grass beds in Western Port
- Removal of additional TN from Cardinia Creek and Western Port. The additional TN removed is 572 kg of TN / annum as detailed in Table 7-3.

[2] Note that this result is in excess of 100 %. This is because the results in Table 7-3 relate to how the overall system removes pollutant loads from those generated only by Minta Farm. The system treats runoff from Minta Farm, but also treats runoff from the existing catchment to the north. For example if Minta Farm generated 100 kg of pollutant, the external catchment generated another 20 kg of pollutant and the treatment system removed 105 kg, then the treatment removal for Minta Farm would be 1055/100 = 105 %. The overall treatment removal would be 105/120 = 87.5 %. See Table 7-4 for the overall treatment removal results.

The treatment of flows to ponds 2 and 3 has been assessed in relation to the health of ponds 2 and 3 to ensure that the water that flows into these ponds meets Best Practice and Revised F8 targets in total to protect the environment of the ponds in Conservation Area 36. Table 7-4 below summarises the results for water quality to ponds 2 and 3. Further details of this analysis are contained in **Appendix G**, including Sheet 5. **Appendix G** also contains sheets that detail how the diversions work and how much flow and pollutants are diverted into the proposed Minta Farm system.

Table 7-4 Treatment Performance for flow into ponds 2 and 3, including diversion flows

	TSS (kg/year)	TN (kg/year)3
TOTAL loads from Minta Farm AND from existing urban areas being diverted to ponds 2 and 3 (receiving waters)	253,401	3,668
Total loads removed by treatment system prior to discharge to ponds 2 and 3	220,331	1,921
Removal as a percentage of the loads from Minta Farm	86.9%	52.4%
BPEMG removal target	80 %	45 %
Achievement of BPEMG target	Yes	Yes
Revised F8 removal target	85 %	45 %
Achievement of Revised F8 target	Yes	Yes

The MUSIC model has been provided to the VPA and Melbourne Water.

7.1.1 Stormwater Reuse

Stormwater harvesting removes runoff and its associated pollutant wash-off. This is an excellent system of achieving pollutant reduction targets and contributes significantly to achieving a water sensitive city, through a supplement to water supply. Numerous demands can be identified for harvested stormwater in the precinct, such as irrigation of the sporting fields, irrigation of vegetation along the waterway corridors or wash-down in the retail zone.

The most suitable locations from which stormwater could be harvested would be from the wetlands proposed within Minta Farm (wetlands 1, 2 and 3). The amount that can typically be harvested from urban drainage catchments needs to ensure that there is no deleterious effect on receiving waters. Typically this would require consideration of:

- Continuing to allow at least the rural rates and volumes of runoff to continue to flow to the receiving waters
- No adverse impact on the environment of the receiving waters.

Often there is a benefit to receiving waters of stormwater harvesting from urban areas as urban areas increase flow peaks and volumes as well as pollutant loads and stormwater harvesting removes some of the flow and pollutants. To ensure that rural rates and volumes of runoff continue to be discharged it could be permitted to harvest between 50 % and 75 % of the total runoff volumes from Minta Farm. However it would also be necessary to ensure that there was adequate turnover in ponds 2 and 3 (which are the receiving waters for the Cardinia Creek catchment of Minta Farm. It is therefore proposed that the maximum volumes of stormwater that could be harvested from the Cardinia Creek catchment of Minta Farm would be as follows:

- 50 % of the flow into wetland 1
- 30 % of the flow into wetland 2 and wetland 3.

These limits would ensure that the turnover of ponds 2 and 3 is less than 30 days to minimise the risk of algal blooms and would allow for some stormwater harvesting that would have the benefits of reducing the demand for water in the area as well as reducing the pollutant load and excess water being discharged from Minta Farm.

The amounts that could be harvested would be:

- Wetland 1 – 283 Ml/annum
- Wetland 2 – 121 Ml/annum
- Wetland 3 – 73 Ml/annum.

These amounts are calculated from the mean annual flows for each wetland as calculated from the MUSIC model.

However the region is mandated for a third pipeline to supply recycled water for non-potable water uses. Therefore it is understood that stormwater harvesting will only be undertaken if the water retailer deems it financially viable to harvest and combine with the other water sources used to supply non-potable water.

7.2 Water Quality in Ponds 2 and 3 in Conservation Area

Ponds 2 and 3 are planned to be contained within proposed Conservation Area 36.

The conservation area is being created to provide a number of environmental benefits including an ongoing high quality aquatic habitat for migratory birds. DELWP has therefore requested information on how the surface water strategy for Minta Farm will maximise the environmental values of ponds 2 and 3. The surface water system for Minta Farm has a number of features and outcomes that have been designed to maximise the environmental conditions in ponds 2 and 3. Factors that have been taken into account include:

- Minimising nutrient loads being deposited in ponds 2 and 3 and ensuring sufficient lake turnover to minimise the risk of algal blooms

- Treating runoff and discharging high quality water into ponds 2 and 3 to provide high quality water as a habitat for the conservation area.

MUSIC modelling has been undertaken to address these requirements. As detailed in Table 7-4 above the water being discharged into ponds 2 and 3 will meet the revised F8 pollutant removal targets and will therefore provide high quality water into the ponds that achieves SEPP requirements for receiving waters in the Western Port catchment.

The pond turnover has been analysed and the 90 percentile turnover time for the ponds have been determined as:

- 9 days for pond 2

- 19.6 days for pond 3.

Both of these results comply with the Melbourne Water guidelines target of less than 30 days to provide sufficient turnover and minimise the risk of algal blooms. Diversion of flows proposed from external catchments by Engeny in this strategy has a significant benefit in reducing turnover times and reducing the risk of algal blooms.

Given the risk for algal blooms is low our opinion is that no mitigation measures are required to further lower the risk of algal blooms.

8. LAND-TAKE FOR DRAINAGE PURPOSES

A critical component of the development of the Minta Farm Precinct is to ensure sufficient land is allocated for drainage purposes. As this catchment requires no retardation except for that which is achieved from the existing ponds, the land required for drainage purposes is due to treatment and conveyance.

Table 8-1 outlines the waterway sizes, treatment sizes, and recommended drainage reserve sizes. The recommended drainage reserve sizes for treatment have considered the footprint size of the treatment, the batters to the surface, allowance for maintenance tracks and provision for sedimentation dry out area, in accordance with Melbourne Water's Draft Constructed Wetlands Guidelines (2014). The corridor widths for the constructed waterways are in accordance with Melbourne Water's Waterway Corridor Guidelines (October 2013) Table 3 based on active edges abutting both sides of the waterway. The locations and sizes of the land areas required have been discussed and agreed with VPA to fit in with existing title boundaries and the proposed Future Urban Structure. Engeny has provided VPA with digital shapes of the proposed land areas for the waterway, wetlands and sediment pond.

Table 8-1 Drainage Reserve Areas for Minta Farm

<table>
<tr><th>Asset</th><th>Catchment Location</th><th>Asset Identifier</th><th>Asset Size</th><th>Drainage Reserve Size</th></tr>
<tr><td>Constructed Waterway</td><td>Wetland 2 to Pond 3</td><td>WW1</td><td>45 m wide waterway reserve</td><td>4.31 ha</td></tr>
<tr><td rowspan="6">Stormwater Treatment</td><td rowspan="4">Cardinia Creek</td><td>WL1</td><td>WL: 40,000 m^2 (at NWL)
SB: 4,000 m^2 (at NWL)</td><td>Within existing footprint of Pond 1</td></tr>
<tr><td>WL2</td><td>WL: 20,500 m^2 (at NWL)
SB: 2,000 m^2 (at NWL)</td><td>3.6 ha</td></tr>
<tr><td>WL3</td><td>WL: 14,500 m^2 (at NWL)
SB: 800 m^2 (at NWL)</td><td>2.63 ha</td></tr>
<tr><td>Sediment Pond</td><td>3,000 m^2 (at NWL)</td><td>0.88 ha</td></tr>
<tr><td>Cardinia Creek catchment draining across Grices Road</td><td>Nil</td><td>To be provided in Melbourne Water's DSS</td><td>Nil</td></tr>
<tr><td>Ti Tree Creek</td><td>Nil</td><td>To be provided in Melbourne Water's DSS</td><td>Nil</td></tr>
</table>

The overall layout of the proposed surface water system is shown on the plan in **Appendix H**. Engeny provided land take polygons to VPA in October 2016 for each of the surface water elements. Since October 2016 there is a slight change required to accommodate wetland 2 within the latest supplied FUS (April 2017), due to minor changes to road alignments. The plans in **Appendix H** and **Appendix E** show the required dimensions of wetland 2 to accommodate this change.

9. MANAGEMENT OF THE SURFACE WATER SYSTEM

Management of the design, construction, ownership and maintenance of the surface water system within Minta Farm has been discussed between the responsible authorities:

- Melbourne Water
- DELWP
- City of Casey.

It is recommended that agreement is sought early regarding the asset ownership of the proposed wetlands, proposed constructed waterways and the existing ponds. These issues have been discussed between Melbourne Water, City of Casey and DELWP and will be finalised at the appropriate time. Applying usual arrangements and based on the initial discussions Engeny would expect that:

- Melbourne Water will oversee the implementation of the Surface Water Management Strategy
- DELWP will be responsible for ponds 2 and 3 and other aspects of Conservation Area 36
- Melbourne Water will be responsible for the proposed constructed waterway, as it will be designed in accordance with Melbourne Water requirements and has a catchment in excess of 60 hectares
- Stormwater treatment assets with a catchment greater than 60 hectares are expected to be Melbourne Water assets
- Drainage and stormwater treatment assets with catchments less than 60 hectares are likely to be Council assets.

10. CONCLUSIONS

The Surface Water Management Strategy for Minta Farm is documented in this report. Key outcomes and conclusions form the preparation of this strategy are:

1. This Surface Water Management Strategy (SWMS) for the Minta Farm PSP 11 identifies the assets required to manage the increased surface water runoff from urbanisation, ensures that the assets will function in accordance with their intent and indicates the land-take required for the safe operation and maintenance of these assets.

2. The surface water management for Minta Farm has been optimised and has been designed to achieve multiple benefits for the community and the environment.

3. A plan showing the proposed surface water management system for Minta Farm is provided in **Appendix H** of this report. The total land take for stormwater treatment has been significantly reduced by this latest strategy due to the following factors:

   - Treatment for wetland 1 is to be located within the existing pond 1, eliminating the need for potential developable land to be set aside for this wetland
   - The waterway and associated treatment assets that were proposed in the PSP in the Office and Technology precinct for Engeny's 2015 report are no longer part of the proposed PSP. These features were found to not be an optimal design due to the limited catchment area and effectiveness of these assets compared with the land take and cost
   - Reduction in the length of the waterway through the Cardinia Creek catchment through positioning of wetland 2 and its outlet
   - No stormwater treatment or retardation within Minta Farm is required for the Ti Tree Creek catchment as Melbourne Water's Ti Tree Creek DSS has allowed for regional stormwater treatment assets to cost effectively remove pollutants from the Minta Farm area draining into this scheme
   - No stormwater treatment or retardation within Minta Farm is required for the south east corner of the property as Melbourne Water's Clyde North DSS has allowed for regional stormwater treatment assets to cost effectively remove pollutants from the Minta Farm area draining into this scheme

4. The strategy includes treatment of runoff from existing urban areas north of Minta Farm. Treating this existing urban area has a number of benefits, including:

   - Removal of additional sediment from Cardinia Creek and Western Port Bay, which will contribute to reducing the impact on the RAMSAR listed sea grass beds in Western Port
   - Removal of additional TN from Cardinia Creek and Western Port over and above the amount that is required to be removed from the Minta Farm

development. The additional TN removed is 572 kg of TN / annum as detailed in Table 7-3

- Provision of additional flow into ponds 2 and 3 to increase turnover and reduce the risk of algal blooms.

5. The strategy optimises the water quality conditions for ponds 2 and 3 within Conservation Area 36, providing water quality and water turnover conditions to provide water quality that meets revised SEPP F8 water quality requirements and maximises pond turnover to minimise the risk of algal blooms.

11. RECOMMENDATIONS

The Surface Water Management Strategy has outlined the required land-take for best practice conveyance and treatment of the increased stormwater runoff generated due to the urbanisation of the Minta Farm property. The treatment and waterway assets have been sized in accordance with Melbourne Water guidelines. This Surface Water Management Strategy will be used to inform Melbourne Water's Drainage Strategy for the site.

It is recommended that VPA, DELWP, Melbourne Water, City of Casey and the property owner consider this Surface Water Management Strategy in planning the development of Minta Farm.

12. 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.

13. REFERENCES

CSIRO, 2006, Urban Stormwater: Best Practice Environmental Management Guidelines.

Melbourne Water Corporation, 2014, DRAFT Constructed Wetlands Guidelines.

Melbourne Water Corporation, 2013, Waterway Corridors.

Melbourne Water Corporation, 2005, WSUD Engineering Procedures.

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Metropolitan Planning Authority, Minta Farm Draft Future Urban Structure.

Monash University, 2010, RORB Version 6 Runoff Routing Program User Manual.

Neil M Craigie, 2009, Clyde North Precinct Structure Plan Surface Water Management Aspects (Version 4 Final).

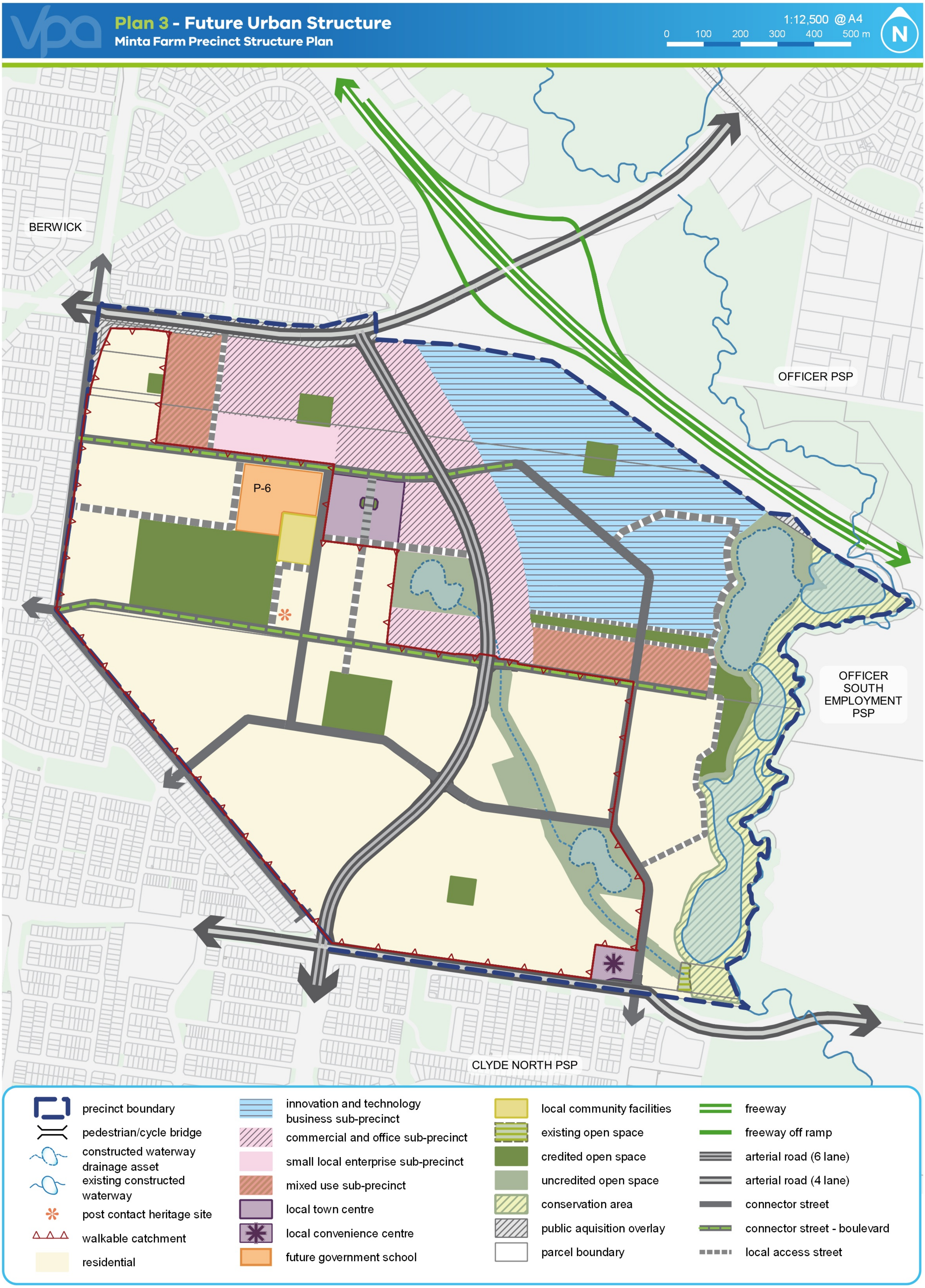
Stormy Water Solutions, Neil M Craigie and Pat Condina and Associates, 24 September 2012, Assessment of the Drainage Strategy for PSP 53 and the Overall Cardinia Creek Catchment.

Appendix A

Minta Farm Future Urban Structure Plan

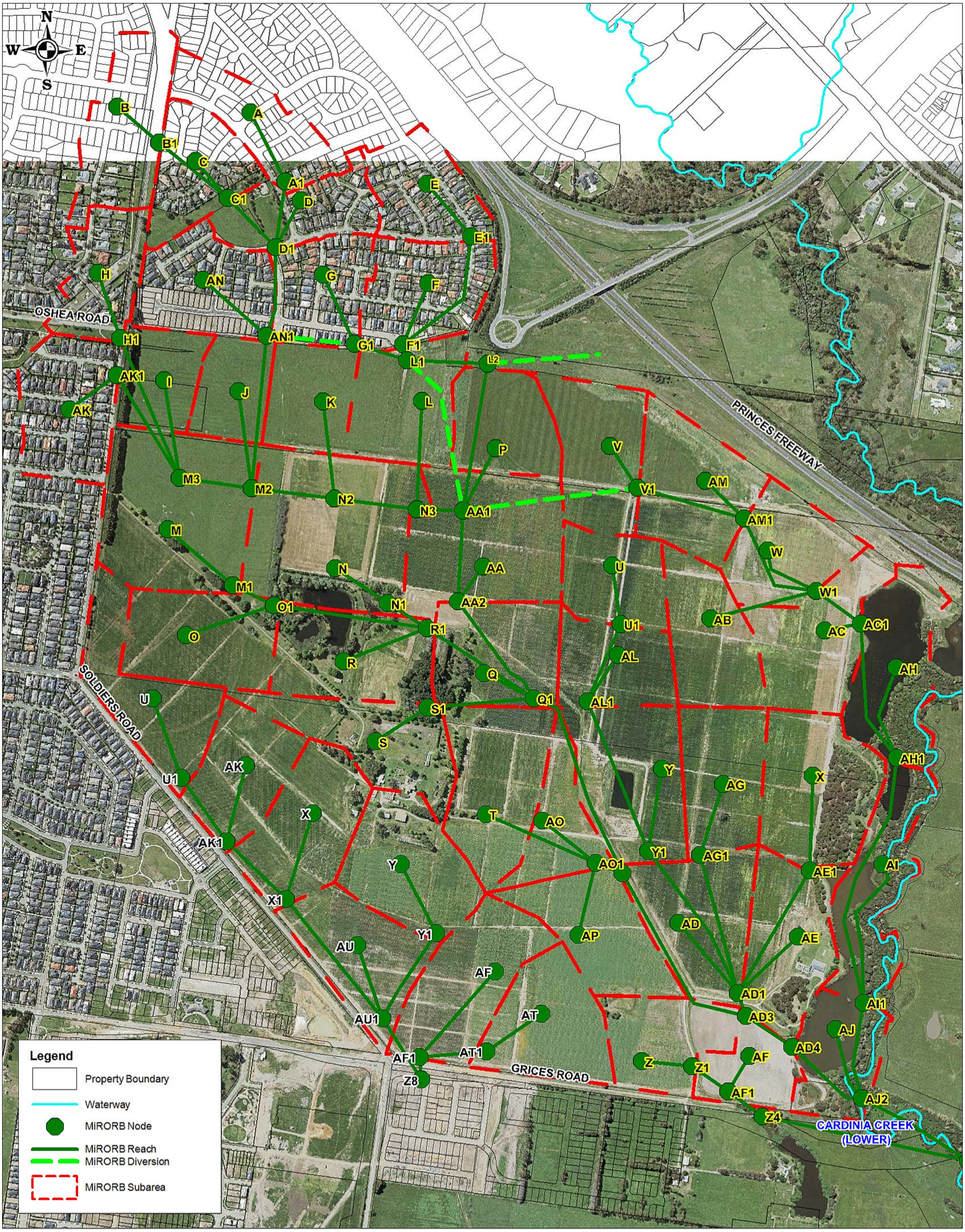
Plan 3 - Future Urban Structure

Minta Farm Precinct Structure Plan



Appendix B

RORB Catchment Plan



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ENGENY WATER MANAGEMENT

Victorian Planning Authority

0 160 320

Scale in metres (1:8,000 @ A3)

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

MINTA FARM

RORB CATCHMENT LAYOUT PLAN

Job Number: V5000_001
Revision: 0
Drawn: MM
Checked: AP
Date: 28 Sep 2017

Appendix C

RORB Parameters

Design Rainfall

Intensity Frequency Duration (IFD) information for Minta Farm was obtained from the Bureau of Meteorology. The data requirements consist of basic rainfall intensities (maps 1 to 6), one skewness value (map 7) and two geographical short duration factors F2 and F50 (maps 8 and 9) which are all sourced from the Australian Rainfall and Runoff (AR&R) Volume 2.

Table C-1 Minta Farm IFD Data

IFD Data	Value
${}^{2}I_{1}$	17.68 mm/hr
${}^{2}I_{12}$	3.94 mm/hr
${}^{2}I_{72}$	1.15 mm/hr
${}^{50}I_{1}$	34.02 mm/hr
${}^{50}I_{12}$	7.59 mm/hr
${}^{50}I_{72}$	2.20 mm/hr
skew	0.38
F2	4.27
F50	14.98

The Minta Farm catchment is located within zone 1. Design rainfall intensities are tabulated versus duration and Average Recurrence Interval (ARI) in Appendix D.

Filtered AR&R temporal patterns were used to ensure internal consistency of the ARI storm intensities of shorter durations within the temporal pattern. That is, no short period within a storm has a greater intensity than the AR&R IFD intensity for that duration and the same ARI. This filtering process is consistent with methods in Melbourne Water Technical Guidelines.

Rainfall Design Losses

The initial loss / runoff coefficient model has been adopted for design as the catchment will be predominantly urbanised.

Values of 10 mm initial loss and a volumetric runoff coefficient of 0.6 accord with those recommended in the AR&R and have been adopted for this study for the 100 year ARI's. Appropriate volumetric runoff coefficients have been adopted for lower ARI events.

Derivation of RORB Parameters

RORB is based on the storage discharge relationship:

$S = 3600kQ^m$ where $k = kc*kr$

The exponent m in the storage equation is a measure of the catchment's non-linearity. A value of m=0.8 is adopted for non-gauged catchments. The kc value is an empirical coefficient applicable to the catchment. There are a range of possible formulae that can be used to estimate a kc value. Table C-2 summarises the formulae and estimated kc values for the Cardinia Creek catchment based on a total catchment area of 2.92 km^2.

Table C-2 Cardinia Creek Catchment kc Values

Source of formula	kc Formula	kc Value
RORB equation	$Kc = 2.2A^{0.5}$	3.76
AR&R equation (MAR>800 mm)	$Kc = 2.57A^{0.65}$	5.16
MWC Regional Parameter	$Kc = 1.53A^{0.55}$	2.76

The Cardinia Creek RORB model was run varying the kc value until a value that resulted in a hydrograph for the 100 year ARI design storm which reconciled to the flow determined using the rational method. The kc value of 2.8 produced the following results.

Table C-3 Rational Method flows compared to RORB flows for Cardinia Creek Catchment

3	RORB Q_{100} (m^3/s)	Rational Method Q_{100} (m^3/s)
AK1	28.61	28.13
AK2 (Cardinia Creek)	33.07	34.12

Table C-4 RORB Parameters Adopted for Cardinia Creek Catchment

3	Value
kc	2.8
m	0.8
IL	10 mm
C (100 year ARI)	0.6

Table C-5 summarises the formulae and estimated kc values for the Ti Tree Creek catchment based on a total catchment area of 0.513 km^2.

Table C-5 Ti Tree Creek Catchment kc Values

Source of formula	kc Formula	kc Value
RORB equation	$Kc = 2.2A^{0.5}$	1.58
AR&R equation (MAR>800 mm)	$Kc = 2.57A^{0.65}$	1.90
MWC Regional Parameter	$Kc = 1.53A^{0.55}$	1.06

The Ti Tree Creek RORB model was run varying the kc value until a value that resulted in a hydrograph for the 100 year ARI design storm which reconciled to the flow determined using the rational method. The kc value of 1.58 produced the following results.

Table C-6 Rational Method flows compared to RORB flows for Ti Tree Creek Catchment

Location	RORB Q_{100} (m^3/s)	Rational Method Q_{100} (m^3/s)
AF1 (Discharge under Grices Road)	9.65	9.49

Table C-7 RORB Parameters Adopted for Ti Tree Creek Catchment

RORB Parameter	Value
kc	1.58
m	0.8
IL	10 mm
C (100 year ARI)	0.6

APPENDIX D

Minta Farm IFD Table

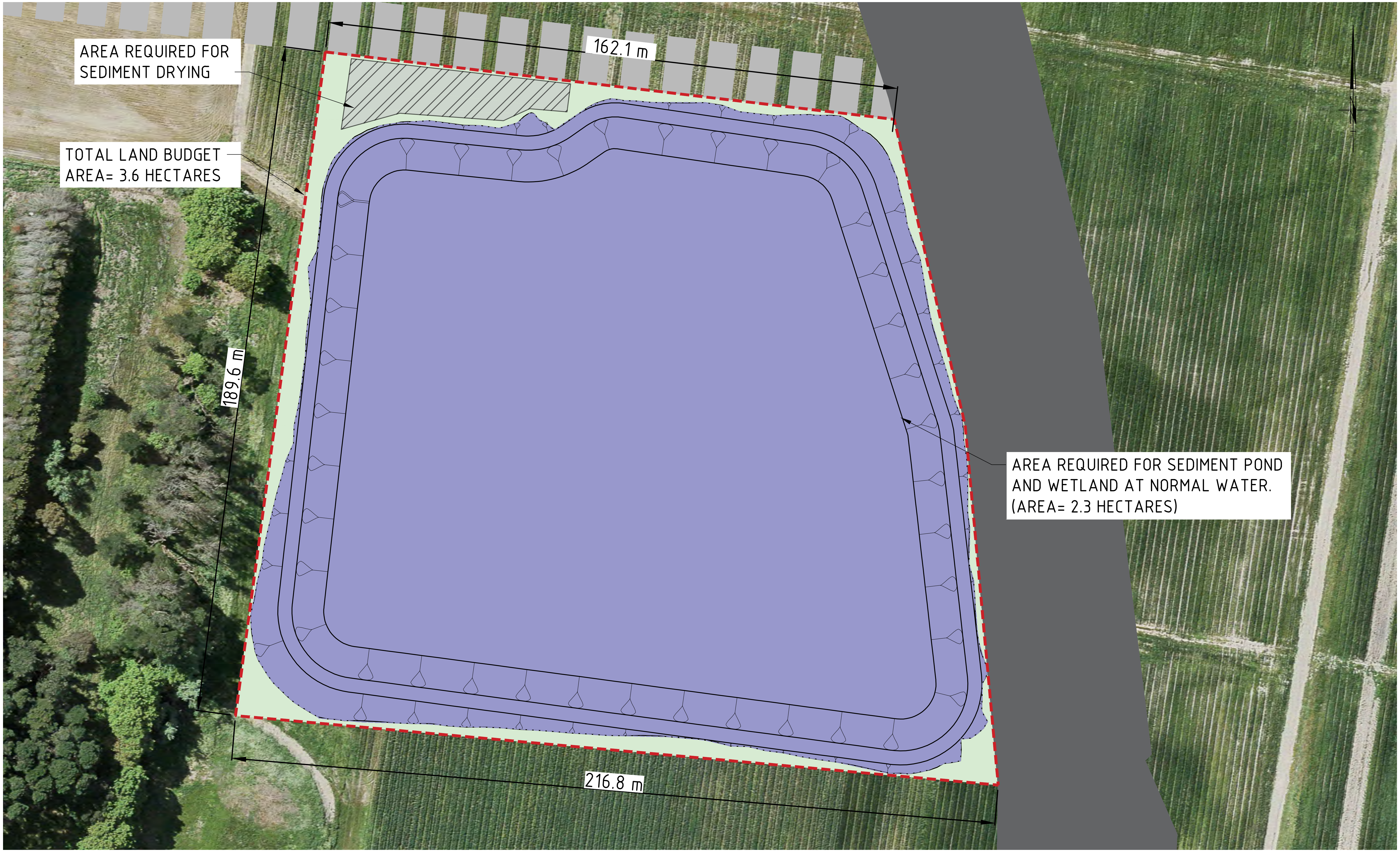
Minta Farm Rainfall Intensities (mm/hour)

Duration	Average Storm Recurrence Interval (Years)						
	1	2	5	10	20	50	100
5 min	44.09	58.87	80.97	96.31	116.66	146.30	171.07
6	41.25	55.05	75.60	89.85	108.81	136.32	159.32
7	38.89	51.86	71.06	84.33	102.03	127.65	149.06
8	36.88	49.12	67.15	79.57	96.15	120.10	140.11
9	35.14	46.74	63.74	75.41	91.00	113.49	132.26
10	33.60	44.65	60.74	71.74	86.46	107.66	125.34
11	32.23	42.78	58.07	68.48	82.42	102.48	119.20
12	31.00	41.11	55.67	65.56	78.81	97.86	113.71
13	29.89	39.60	53.51	62.93	75.56	93.70	108.78
14	28.88	38.23	51.55	60.55	72.62	89.94	104.33
15	27.95	36.97	49.76	58.38	69.94	86.53	100.29
16	27.10	35.81	48.11	56.39	67.50	83.41	96.61
17	26.31	34.75	46.60	54.56	65.25	80.55	93.23
18	25.58	33.76	45.20	52.87	63.18	77.92	90.13
19	24.90	32.84	43.90	51.31	61.27	75.49	87.27
20	24.27	31.98	42.70	49.86	59.49	73.24	84.61
21	23.67	31.18	41.57	48.50	57.83	71.15	82.15
22	23.11	30.43	40.52	47.24	56.29	69.20	79.86
23	22.59	29.73	39.53	46.05	54.84	67.37	77.71
24	22.09	29.06	38.60	44.94	53.49	65.67	75.71
25	21.62	28.43	37.72	43.89	52.21	64.06	73.83
26	21.18	27.84	36.89	42.90	51.01	62.55	72.06
27	20.76	27.27	36.11	41.97	49.88	61.13	70.39
28	20.36	26.74	35.36	41.09	48.80	59.78	68.81
29	19.98	26.23	34.66	40.25	47.79	58.51	67.32
30	19.61	25.74	33.99	39.45	46.82	57.30	65.91
35	18.02	23.62	31.07	36.00	42.65	52.09	59.83
40	16.73	21.90	28.72	33.22	39.31	47.93	54.99
45	15.65	20.47	26.78	30.94	36.57	44.54	51.05
50	14.73	19.25	25.15	29.02	34.28	41.70	47.76
55	13.94	18.21	23.75	27.38	32.32	39.28	44.97
60	13.25	17.30	22.53	25.97	30.63	37.20	42.56
75	11.62	15.16	19.69	22.65	26.69	32.37	36.99
90 min	10.42	13.59	17.62	20.26	23.85	28.90	33.01
2 hours	8.77	11.43	14.80	17.00	20.00	24.21	27.63
3	6.86	8.94	11.57	13.29	15.63	18.92	21.59
4.5	5.36	6.99	9.06	10.40	12.24	14.82	16.92
6	4.50	5.87	7.62	8.75	10.29	12.47	14.24
9	3.51	4.58	5.95	6.84	8.05	9.75	11.15
12	2.94	3.83	4.98	5.73	6.74	8.17	9.34
18	2.27	2.97	3.85	4.43	5.21	6.32	7.22
24	1.89	2.46	3.19	3.67	4.32	5.23	5.97
36	1.43	1.87	2.42	2.78	3.27	3.95	4.51
48	1.17	1.52	1.97	2.26	2.66	3.22	3.66
72 hours	0.86	1.12	1.45	1.67	1.97	2.38	2.71

Appendix E

Wetland Concept Design Plans

Figure 11-1 North Wetland Plan



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SCALE BEFORE REDUCTION

NOT FOR CONSTRUCTION

CAD REF:V:\PROJECTS\V5000 MPA\V5000_001 MINTA FARM PSP 11\05 DESIGN\AUTOCAD\DRAWINGS\CONCEPT FIGURES.DWG

LAST MODIFIED:4/6/2017 12:41 PM

This drawing is confidential and shall only be used by Engeny's Client for which it was prepared.

No.	BY	DATE	REVISION	APPD

DOC. NUMBER	DOCUMENT TITLE
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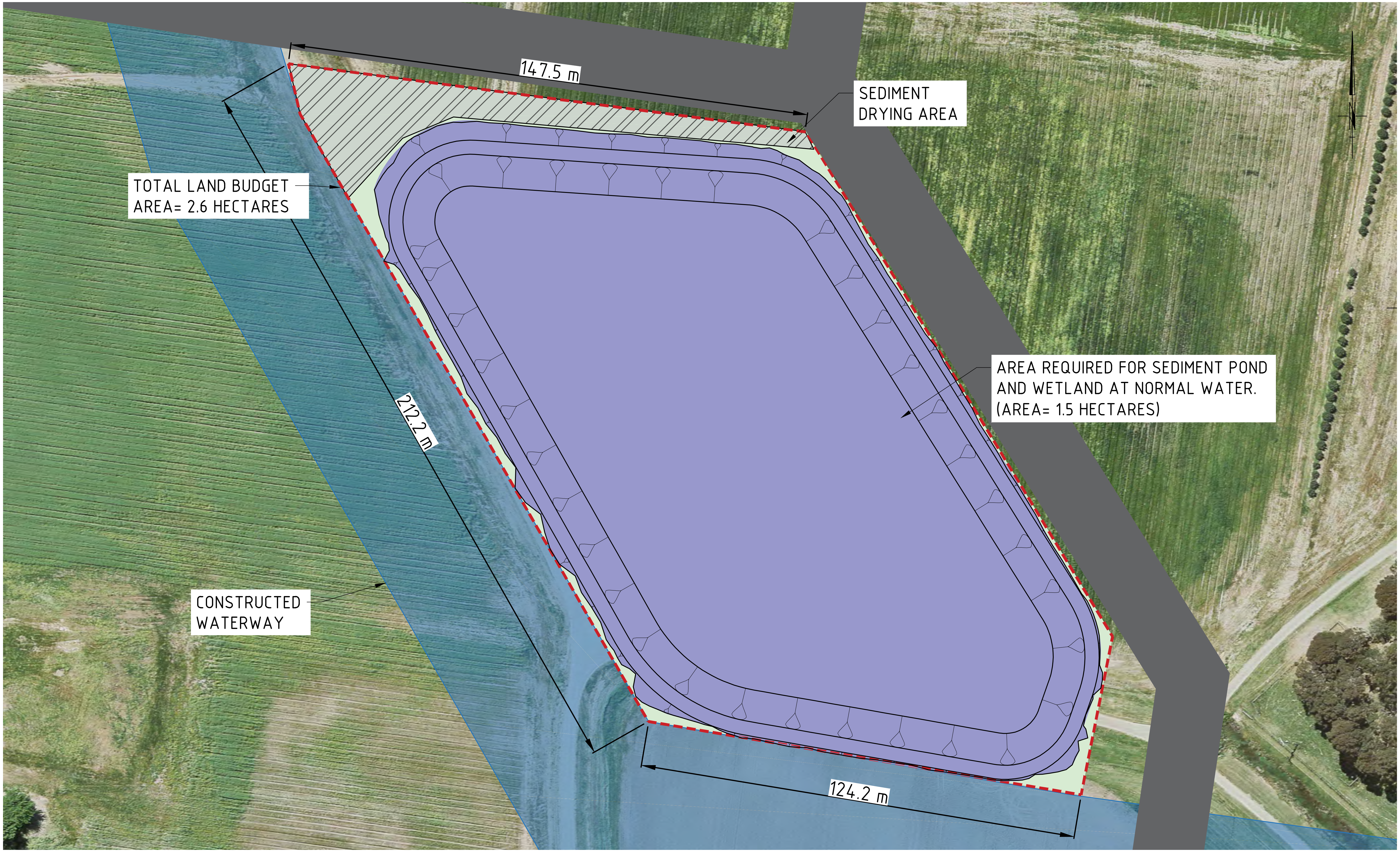
Status

DESIGNED		CHECKED	
DRAWN		CHECKED	
APPROVED		DATE	06.04.17
RPEQ		RPEQ No.	

MINTA FARM
WETLAND 2- CONCEPT DESIGN PLAN

Original Size	Drg No.	Rev.
A1	V5000-001-C100	

Plot Date: 4 April 2017 - 5:00 PM Plotted by: ---- Cad File No: V:\Projects\V5000 MPA\V5000_001 Minta Farm PSP 11\05 Design\AutoCAD\Drawings\Concept Figures.dwg



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SCALE BEFORE REDUCTION

NOT FOR CONSTRUCTION

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No.	BY	DATE	REVISION	APPD

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DESIGNED		CHECKED	
DRAWN		CHECKED	
APPROVED		DATE	06.04.17
RPEQ		RPEQ No.	

MINTA FARM
WETLAND 3- CONCEPT DESIGN PLAN

Original Size	Drg No.	Rev.
A1	V5000-001-C101	

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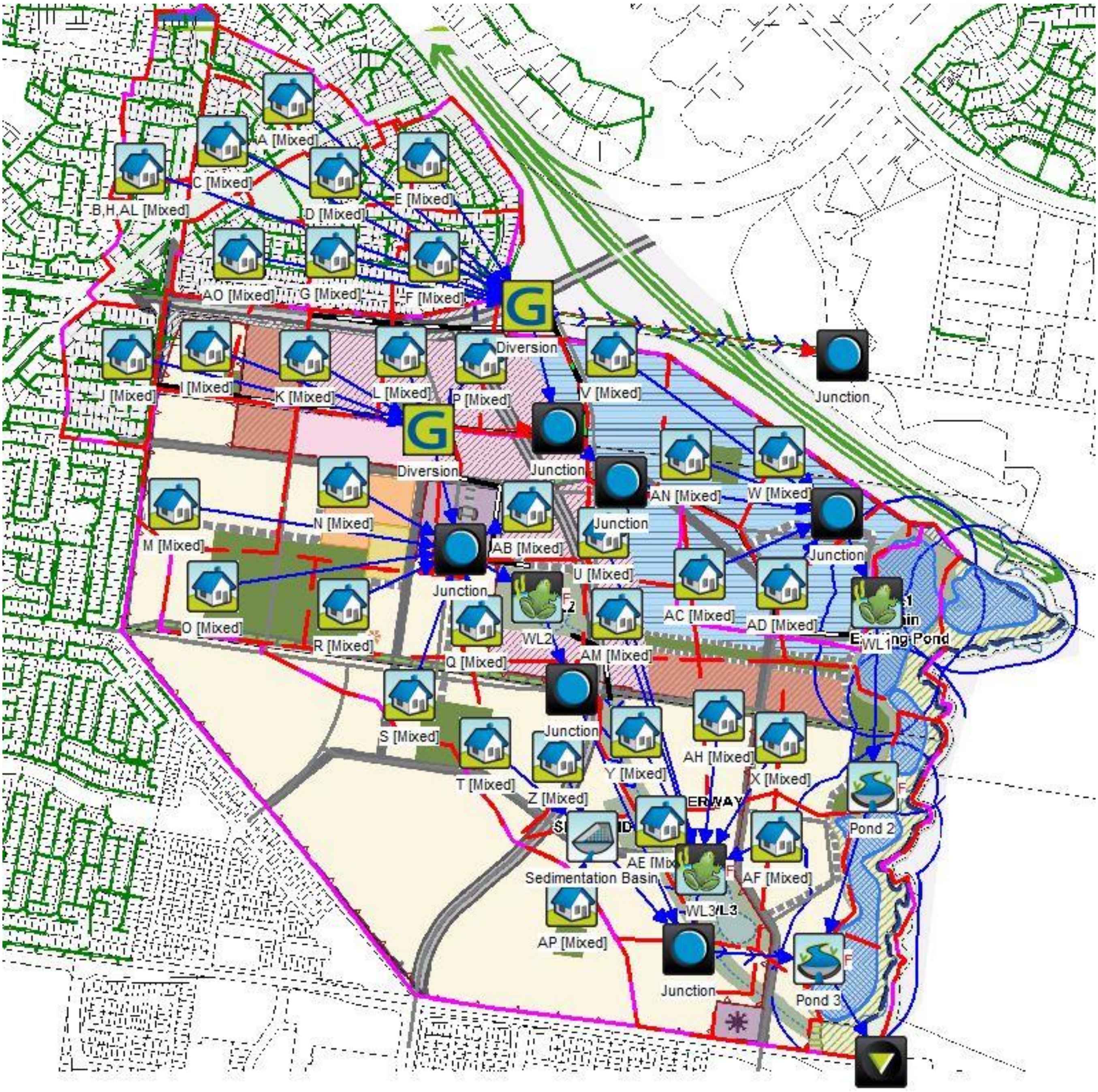
LAST MODIFIED:4/6/2017 12:41 PM

Plot Date: 4 April 2017 - 5:00 PM Plotted by: ---- Cad File No: V:\Projects\V5000 MPA\V5000_001 Minta Farm PSP 11\05 Design\AutoCAD\Drawings\Concept Figures.dwg

Appendix F

MUSIC Model Layout Plan



Minta Farm MUSIC model layout

Appendix G

Music Model Results

Minta Farm **MUSIC Model Results - Sheet 1**

V5000_001 **Sediment and TN loads from every sub-catchment**

Sub catchment	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
AN	8,050	117
AD	7,660	111
AE	5,110	84
U	6,440	94
P	6,660	94
AB	12,800	180
N	14,100	206
I	4,290	65
J	3,300	51
K	5,110	75
L	7,730	112
M	11,500	175
O	6,870	104
R	7,300	109
T	6,430	95
Q	7,810	118
S	3,940	68
AH	5,180	80
Z	3,990	60
AF	6,090	96
AC	7,350	106
Y	8,350	123
X	1,430	44
W	6,640	97
V	7,600	110
AM	4,990	74
F	5,420	84
G	4,440	69
E	4,510	70
AO	6,610	98
B_H_AL	16,900	260
A	4,570	70
C	3,610	60
D	4,400	68
AP	6,420	96

Minta Farm **MUSIC Results - Sheet 2**

V5000_001

Wetland 1 catchment MUSIC results

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
AN	8,050	117
AD	7,660	111
AE	5,110	84.1
U	6,440	94
P	6,660	93.8
AB	12,800	180
N	14,100	206
I	4,290	64.6
J	3,300	50.5
K	5,110	75
L	7,730	112
M	11,500	175
O	6,870	104
R	7,300	109
T	6,430	94.6
Q	7,810	118
S	3,940	68.4
AH	5,180	80.3
Z	3,990	59.8
AF	6,090	95.9
AC	7,350	106
Y	8,350	123
X	1,430	44.2
W	6,640	96.7
V	7,600	110
AM	4,990	74.4
F	5,420	83.7
G	4,440	68.8
E	4,510	70
AO	6,610	97.5
B_H_AL	16,900	260
A	4,570	70.1
C	3,610	60.3
D	4,400	67.6
AP	6,420	96.2

Pollutant loads from urban area that drains across freeway

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
AO	6,610	98
F	5,420	84
G	4,440	69
E	4,510	70
B_H_AL	16,900	260
A	4,570	70
C	3,610	60
D	4,400	68
TOTALS	50,460	778
Amount diverted to WL1	45,058	670.0

Diversion capacity 0.5 m3/s

Pollutant loads from existing urban area that drains into Minta Farm and to 450 mm diversion

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
J	3,300	50.5

Pollutant loads from Minta Farm to 450mm diversion

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
P	6,660	93.8
I	4,290	64.6
K	5,110	75
L	7,730	112

TOTALS to 450 diversion (J, P, I, K, L)	27,090	395.9
Amounts diverted to WL1	24,443	344.5
Diversion capacity	0.3 m3/s	

Pollutant loads from Minta Farm Catchments draining directly to WL1

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
AN	8,050	117
AD	7,660	111
AC	7,350	106
W	6,640	96.7
V	7,600	110

WL1 total loads and treatment - including loads from existing urban areas

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS to WL1 (directly connected plus 450 and 600 diversions)	106,801	1,555
Removal by WL1	100,500	919
% removal by WL1	94.1%	59.1%

WL1 Minta Farm only loads and treatment

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
Minta Farm only loads to WL1 (directly connected plus 450 diversion without area J)	61,743	885
Removal by WL1	100,500	919
% removal by WL1	162.8%	103.8%

Minta Farm **MUSIC Results - Sheet 3**

V5000_001

Results for catchments draining to Pond 3

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
AN	8,050	117
AD	7,660	111
AE	5,110	84.1
U	6,440	94
P	6,660	93.8
AB	12,800	180
N	14,100	206
I	4,290	64.6
J	3,300	50.5
K	5,110	75
L	7,730	112
M	11,500	175
O	6,870	104
R	7,300	109
T	6,430	94.6
Q	7,810	118
S	3,940	68.4
AH	5,180	80.3
Z	3,990	59.8
AF	6,090	95.9
AC	7,350	106
Y	8,350	123
X	1,430	44.2
W	6,640	96.7
V	7,600	110
AM	4,990	74.4
F	5,420	83.7
G	4,440	68.8
E	4,510	70
AO	6,610	97.5
B_H_AL	16,900	260
A	4,570	70.1
C	3,610	60.3
D	4,400	67.6
AP	6,420	96.2

Catchments from Minta Farm draining directly to WL2

AB
N
M
O
R
Q
S

Treatment by WL2

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS to WL2	80,500	1,146
Removal by WL2	64,896	553
% removal by WL2	80.6%	48.2%

Catchments from Minta Farm draining to WL3

AE
U
AH
AF
Y
X
AM

Treatment by WL3

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS to WL3	46,500	688
Removal by WL3	38,389	347
% removal by WL3	82.6%	50.5%

Catchments from Minta Farm draining to Sediment Basin

T
Z
AP

Treatment by Sediment Basin

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS to Sediment Basin	19,600	279
Removal by Sediment Basin	16,546	102
% removal by Sediment Basin	84.4%	36.7%

Overall treatment prior to discharge to pond 3

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS loads from catchment draining to pond 3	146,600	2,113
Total removal by WL2, WL3 and sediment pond in pond 3 catchment	119,831	1,002
% removal by WL1	81.7%	47.4%

Minta Farm **MUSIC Results - Sheet 4**

V5000_001 **Treatment of Minta Farm Flows to Conservation Area Ponds**

Results show how the overall treatment system treats the pollutant loads from the proposed Minta Farm development.
Results include total loads from Minta Farm and the benefits of treating both Minta Farm Runoff and external catchments.

WL1 Minta Farm only loads and treatment discharge to pond 2

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
Minta Farm only loads to WL1 (directly connected plus 450 diversion without area J)	61,743	885
Removal by WL1	100,500	919
% removal by WL1	162.8%	103.8%

Overall treatment of catchment draining to waterway prior to discharge to pond 3

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS loads from catchment draining to pond 3	146,600	2,113
Total removal by WL2, WL3 and sediment pond in pond 3 catchment	119,831	1,002
% removal by WL1	81.7%	47.4%

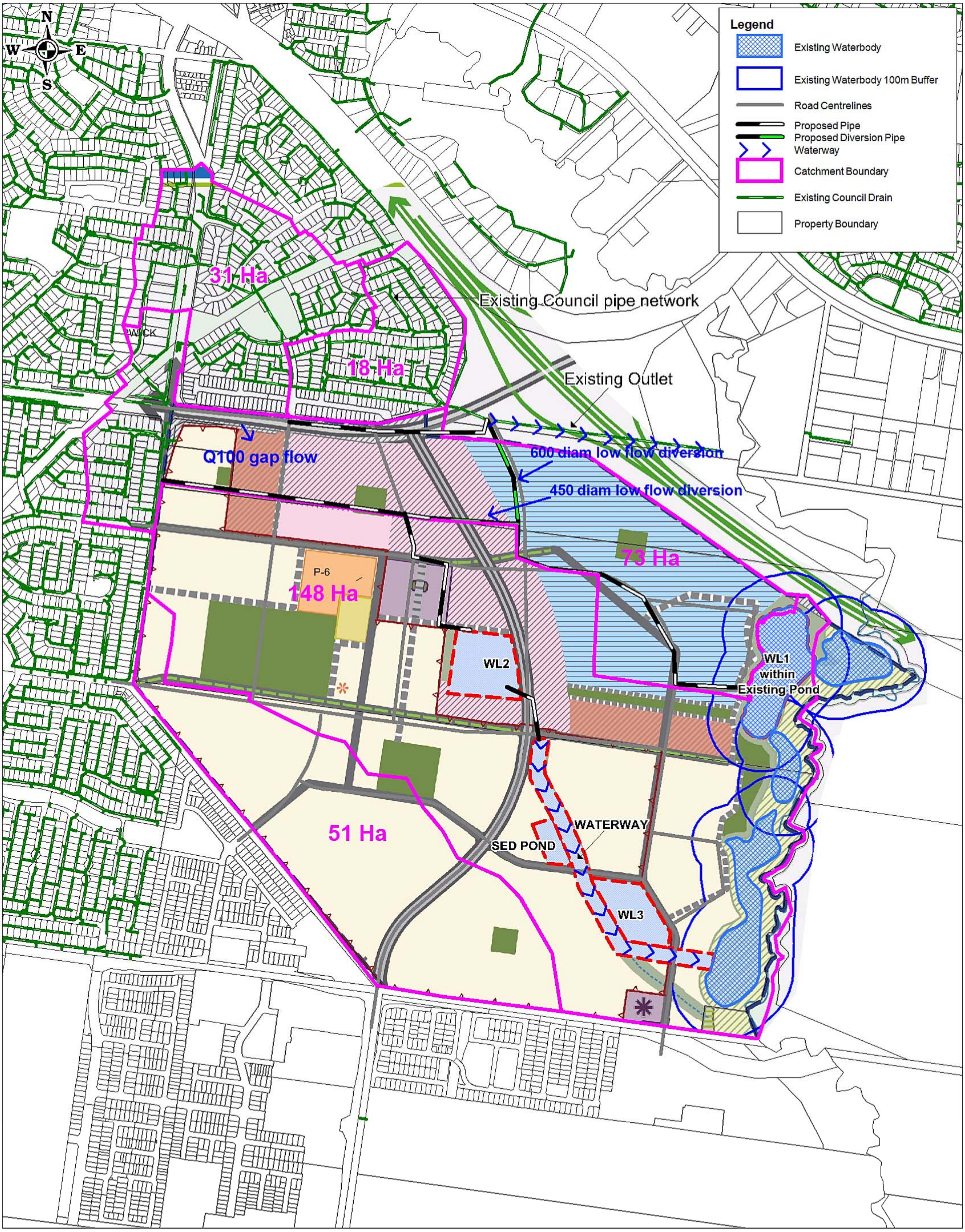
Overall treatment to Ponds 2 and 3

Loads that need to be treated are from Minta Farm only
Treatment results include benefits of diversions from existing urban areas

	TSS load from sub catchment (kg/year)	TN load from sub catchment (kg/year)
TOTALS loads from Minta Farm draining to ponds 2 and 3 (receiving waters)	208,343	2,998
Total removal by WL1, WL2, WL3 and sediment pond (includes removal from flows diverted from existing urban areas)	220,331	1,921
% removal of Minta Farm only load	105.8%	64.1%
BPEMG removal target	80%	45%
Achievement of BPEMG target	Yes	Yes
Revised F8 removal target	85%	45%
Achievement of Revised F8 target	Yes	Yes
Quantity of pollutant removal required to just achieve Revised F8 target for pollutants from Minta Farm (kg/year)	177,092	1,349.3
Removal of pollutant in excess of Revised F8 target due to diversion from existing urban area north of Minta Farm (kg/year)	**43,239**	**571.99**

Appendix H

Layout Plan for Proposed Surface Water System



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ENGENY WATER MANAGEMENT

Victorian Planning Authority

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

MINTA FARM

STORMWATER TREATMENT MANAGEMENT PLAN

Job Number: V5000_001
Revision: 4
Drawn: MM
Checked: AP
Date: 12 Oct 2017