Expert Opinion on Drainage Issues

Amendment C228 to the Casey Planning Scheme

Report Author: Warwick Bishop

Report Prepared for: The Minta Group

Instructed by: Norton Rose Fulbright

Report Date: 6 April 2018

1. REPORT AUTHOR

Warwick Bishop

Senior Principal Engineer, Director
Water Technology Pty Ltd
15 Business Park Drive
Notting Hill, VIC 3168

Qualifications:

- B.E. (Hons), University of Melbourne, 1993
- MEngSci, Monash University, 2000

Affiliations:

- Chartered Member, Institution of Engineers, Australia
- Member, Engineers Australia, Victorian Water Panel Committee
- Member, International Association for Hydraulic Research
- Member, Australian Water Association
- Member, River Basin Management Society
- Member, Stormwater Victoria

Experience

I am a Director of Water Technology and have 25 years' experience in hydrologic and hydraulic investigations, specialising in the development and application of rural and urban hydrodynamic models and their application to flooding, drainage, water quality, sediment transport and environmental values. I also have extensive experience in coastal and estuary modelling including wave, current, oil spill and coastal vulnerability investigations. I have worked extensively in the Murray Darling Basin, principally on environmental hydraulic investigations for the Living Murray Program. I was recently involved in the revision of Australian Rainfall and Runoff, with particular focus on the application of 2D hydraulic models to flooding in urban and rural areas. In 2011 I worked in the Flood Intelligence Unit of SES during the January floods and have provided advice to Catchment Management Authorities over the subsequent period.

2. STATEMENT OF EXPERTISE

With my qualifications and experience, I believe that I am well qualified to provide an expert opinion regarding drainage issues related to Amendment C228 to the Casey Planning Scheme.

3. SCOPE OF THIS REPORT

In relation to Amendment C228 to the Casey Planning Scheme, I have been requested to:

1. Provide an overview of the drainage of the PSP area
2. Background to the development of a drainage strategy for the eastern part of the land
3. An opinion on which of the scenarios is preferable and why
4. Any outstanding drainage issues (and whether they need to be dealt with now or would be dealt with later)
5. Anything else that should be taken into account from a stormwater management perspective

4. BASIS OF THIS REPORT

This report is based on:

- Information provided to me by Norton Rose Fulbright, including:

  Letter from Biosis to Alluvium regarding biodiversity habitat values - Input into the Minta Farm Drainage Strategy, biosis, 20 November 2017

  3 Stormwater Management Scenario layout figures and corresponding assessment tables by Alluvium, March 2018

  Amendment C228 - Minta Farm PSP 11- Submission summary (working draft), March 2018

- Melbourne Water (2007), Principles for Provision of Waterway and Drainage Services for Urban Growth
- Minta Farm Berwick - Cardinia Creek Catchment - Stormwater Management Strategy, Water Technology, July 2016.
- Supporting information to Amendment C228 downloaded from the VPA website, including:
  - Minta Farm Draft Precinct Structure Plan - Background Report (VPA), October 2017
  - Biodiversity Assessment Report, C21 Business Park, PSP Area 11 (Practical Ecology), 30 November 2011
  - Minta Farm PSP Surface Water Management Strategy (Engeny) - October 2017
  - Minta Farm Precinct Structure Plan (VPA), October 2017.
  - Section 96A Application – Minta Farm, Urbis June 2017.
- Background knowledge of the site and surrounding area from previous studies, including inspection of the site.

My report has been prepared in accordance with Planning Panels Victoria's "Guide to Expert Evidence".

5. INTRODUCTION

Amendment C228 to the Casey Planning Scheme has been prepared by the Victorian Planning Authority (VPA) in collaboration with the City of Casey. The subject site covers an area of 286 hectares of rural land known as 'Minta Farm', which corresponds to the Minta Farm PSP. The subject site is bounded by Soldiers Road to the west, Grices Road to the south, Cardinia Creek to the east and the Princes Freeway to the north.

The VPA has worked extensively with Council, developers, land owners and State agencies to resolve issues arising from submissions. This process has specifically involved Melbourne Water in relation to drainage issues, and DELWP in relation to ecological issues associated with the Cardinia Creek corridor.

I understand the stormwater management strategy is currently being reviewed by Melbourne Water and that three options have been developed for consideration. These are discussed later in this report.

Drainage designs for greenfield development are generally produced in accordance with the "Principles for Provision of Waterway and Drainage Services for Urban Growth", published by Melbourne Water in 2007. This document describes 16 principles that govern the way in which drainage services are provided for broad-scale development, typically through a Development Services Scheme (DSS). In some circumstances a DSS may not be required by Melbourne Water, for example when there is a small number of land-owners and it is more efficient for the developers to directly deliver the drainage strategy. Although there is no DSS covering the site and no decision has been made as to whether a Melbourne Water-administered DSS for this area will be put in place, these principles are relevant to the determination of an appropriate stormwater management strategy for the site along with a range of local, state and federal policies, regulations and legislation.

6. EXISTING DRAINAGE CHARACTERISTICS

6.1 Site Topography

The site topography is shown in Figure 6-1. This figure is based on LIDAR aerial survey, which is the most accurate broad-scale ground level information available and is widely utilised for flood mapping and waterway assessment purposes. The LIDAR survey typically has a vertical accuracy of around +/- 150 mm and is appropriate for the delineation of catchment boundaries and interpretation of existing surface water characteristics. Figure 6-1 illustrates the broad topographical features of the area. Some points to note are:

- Cardinia Creek waterway runs along the eastern boundary of the site (flowing from north to south).
- There is an internal watercourse, referred to as Baillieu Creek in PSP reports, although historically this is an un-named waterway.
- There is a ridge line that runs diagonally in a SE direction through the southern part of the site.
- To the south of the ridge-line flows pass into the Ti Tree Creek catchment.
- The topography of the site generally slopes from north to south with the highest elevation being around 68 m AHD in the north-west corner. The lowest elevations are around 32 m AHD along the southern boundary of the PSP area. Slopes vary from generally flat through the middle and east of the site (around 1 in 200), to much steeper along the west side with slopes of around 1:25.

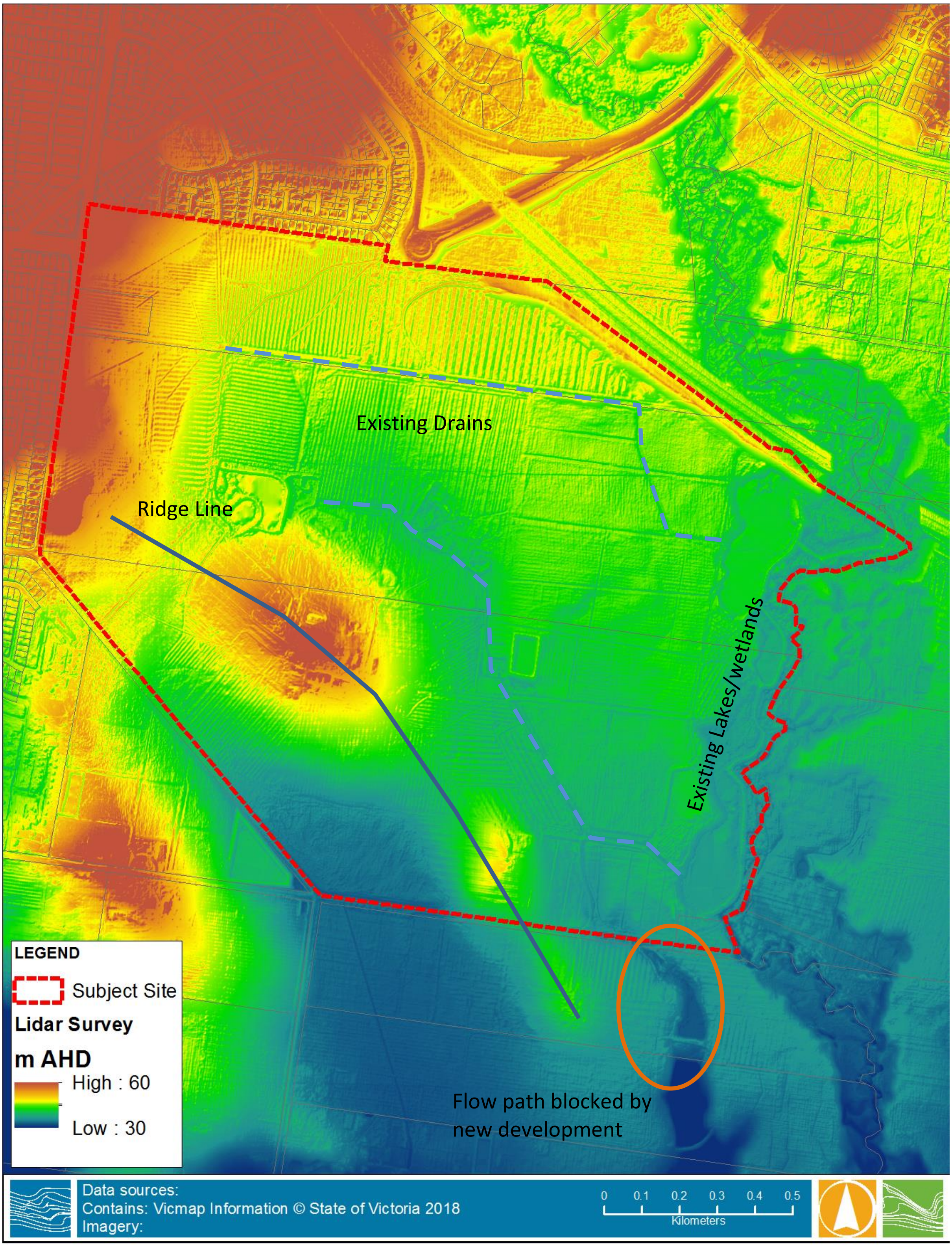

Figure 6-1 Lidar based topography of the site (Source: DELWP)

6.2 Cardinia Creek Catchment

Cardinia Creek is a significant waterway with high environmental values that flows from the Dandenong Ranges to the north, past the site and through the Koo Wee Rup Swamp before entering Western Port east of Tooradin.

6.3 Internal Drainage Catchments

As shown in the topography figure above there are two internal drainage catchments either side of the ridge. The southern catchment is part of the Ti Tree Creek Drainage Scheme, which has an agreed set of water management measures that are well established.

The northern part of the site flows via a series of farm drains towards the east and is directed primarily into the existing lakes system. The overflow from the lake passes overland towards Cardinia Creek from the most southerly lake. There are also some existing small culvert connections directly to Cardinia Creek from the lakes.

A former high-flow drainage path to the south, over Grices Road (circled in orange), is now blocked by development to the south of Grices Road.

7. DEVELOPMENT OF DRAINAGE STRATEGIES FOR MINTA FARM

7.1 Overview

The following sections outline my understanding of the development of drainage management optiosn for Minta Farm that have been undertaken on behalf of the VPA, The Minta Group and Melbourne Water.

7.2 Engeny Surface Water Management Strategy

In 2015 Engeny were engaged to develop a Surface Water Management Strategy for the Minta Farm PSP. This strategy was developed over approximately a 2 year period, incorporating feedback from various stakeholders, with the final version (Revision 6) dated October 2017. Figure 7-1 shows the final Engeny drainage strategy layout plan.

The strategy comprises:

- Three constructed wetlands (one within the existing northern lake)
- One sediment basin
- A constructed waterway directed into the southern lake

It appears that Engeny have adopted the concept design for Wetland 1 from the Charlton Degg/Water Technology report, which is discussed below (a copy of the Charlton Degg report is provided in Appendix A). No further calculations or detailed descriptions of this wetland are provided. It is flagged that runoff from external catchments to the north-west of the site may be diverted into Wetland 1 as it is oversized for Engeny's assumed inflow catchment area.

Issues in relation to the Engeny design are:

- The waterway flows diagonally through the southwest part of the subject site. This is not idea from a residential development layout perspective, creating a barrier and some awkwardly shaped parcels of land.
- There may not be sufficient flow to sustain the northern-most wetland. In order to improve efficiency of Wetland 1 it is proposed to divert water from external catchments. However, this may have the result that the development will pay for a wetland to treat flows from outside the catchment while additional take land and construction costs will be borne by the

development to create additional internal wetlands to treat internal catchment flows. This is not in keeping with the principal of finding the most cost effective solution.

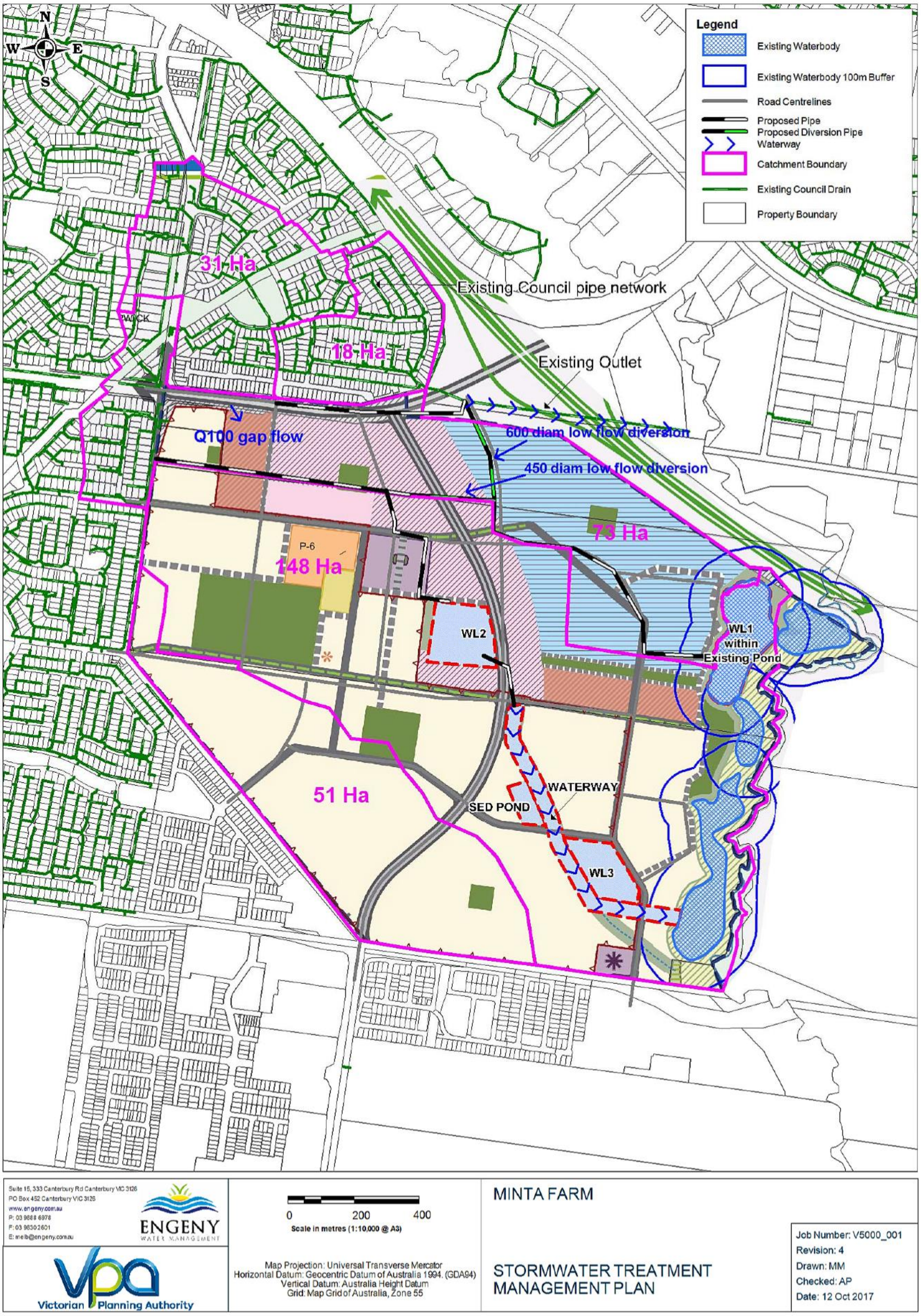

Figure 7-1 Engeny Stormwater Management Strategy Layout

7.3 Charlton Degg / Water Technology Stormwater Management Strategy

Towards the end of 2015, Water Technology were approached by Charlton Degg to assist with the development of a stormwater management plan for Minta Farm. This was at the request of the owners as they wished to investigate ways in which the existing lakes could be incorporated into the drainage plan. My understanding is that, at that time, none of the existing lakes were incorporated into the drainage strategy. I believe the proposal at that stage was to direct all the site runoff to the constructed waterway flowing south through the site, towards Grices Road. There was a concern that the existing assets were not being utilised and that without significant inflows from the site, their health and/or amenity may deteriorate significantly.

A drainage strategy was then developed that utilised an east-west waterway to convey the main flows from the site to the northern lake, via a treatment wetland. Flow would then cascade through the lake system and outfall to Cardinia Creek at the south-west corner of the site. The Charlton Degg/Water Technology strategy is shown in Figure 7-2.

The final strategy report was produced in July 2016 following extensive consultation with Melbourne Water, including several meetings to discuss and refine the approach. The main concerns of Melbourne Water at the time was that water quality in the lakes would be maintained and that EPA SEPP 8 conditions would be met.

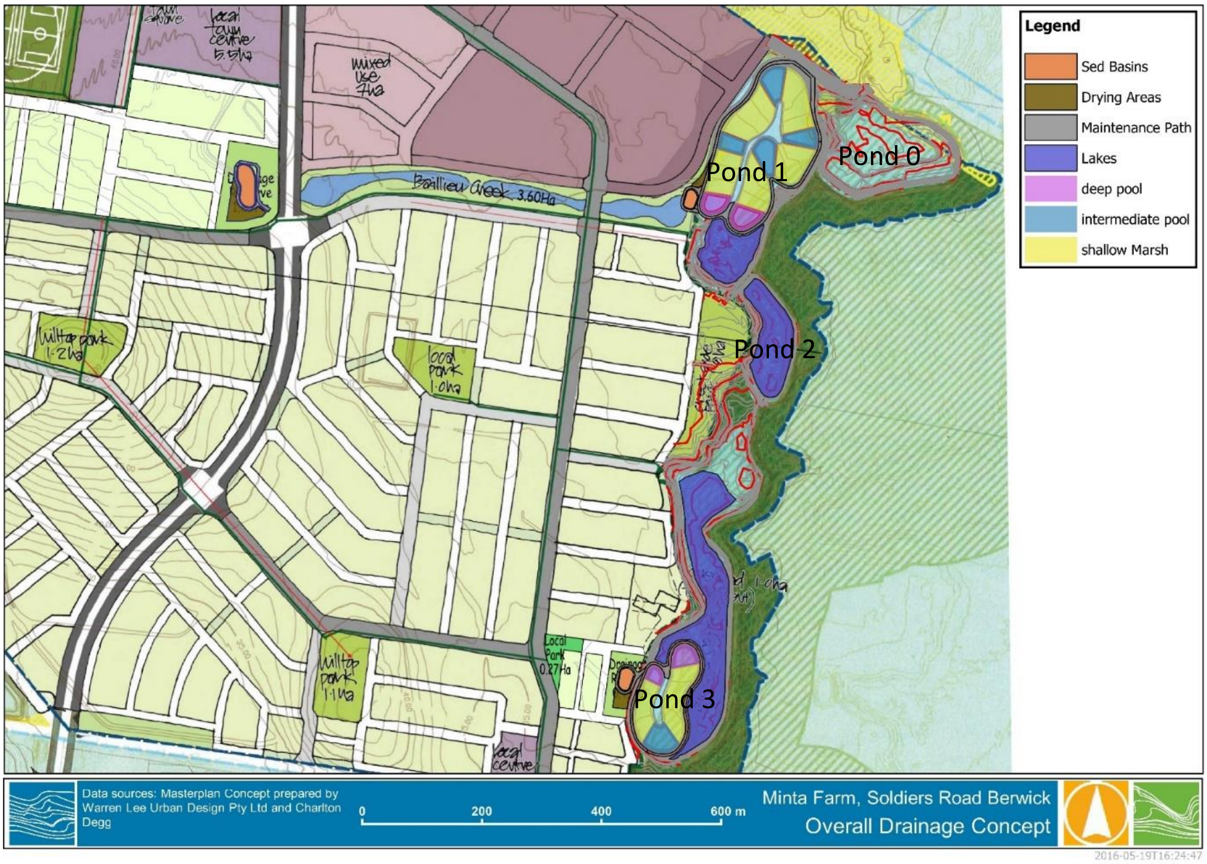

Figure 7-2 Charlton Degg/Water Technology Stormwater Strategy Layout

It is noted that no detailed assessment or review of the ecological values along the Cardinia Creek corridor, including the lakes, was undertaken as part of this report. However, the environmental overlay did inform the location and arrangement of potential constructed wetland sites. Care was taken to ensure water quality was maintained within the lakes system and lake turnover was optimised to reduce algal bloom risk, in response to feedback from Melbourne Water.

7.4 Alluvium Drainage Management Options

Alluvium have been engaged by Melbourne Water to review the stormwater management strategies and have developed 3 scenarios as shown in Figure 7-3, Figure 7-4 and Figure 7-5. These scenarios have been assessed against environmental criteria related to the Cardinia Creek corridor, as well as standard DSS principles.

The environmental criteria have been informed by a review of biodiversity habitat values by Biosis (2017). This comprises a desktop review of the 2011 Biodiversity Assessment Report by Practical Ecology for the GAA. This work recommends that:

- The hydrologic regimes of Pond 0 (as labelled in Figure 7-2) and Pond 3 should be maintained to protect the ecological values identified.
- Seek to provide Growling Grass Frog habitat in some of the constructed wetland areas.
- Minimise disturbance to areas of high ecological value during construction.

Scenario 1 is similar in concept to the Charlton Degg/Water Technology design with an east-west waterway corridor directing flow towards the lakes. There is a sediment basin proposed at the western end of the waterway corridor as in the CD/WT plan. The main difference is that Alluvium have located Wetland 3 outside of the current Pond 3 footprint, where the CD/WT plan had this wetland incorporated inside the pond footprint. This change is sensitive to the need to preserve the high-value pond 3 habitat and is a logical approach.

Scenarios 2a and 2b are considered to be similar to the Engeny design, with a constructed waterway flowing towards the south-west carrying the majority of runoff from the site. The main difference compared to the Engeny design is the location and configuration of Wetland 3, which is aligned next to pond 3, rather than alongside the constructed waterway.

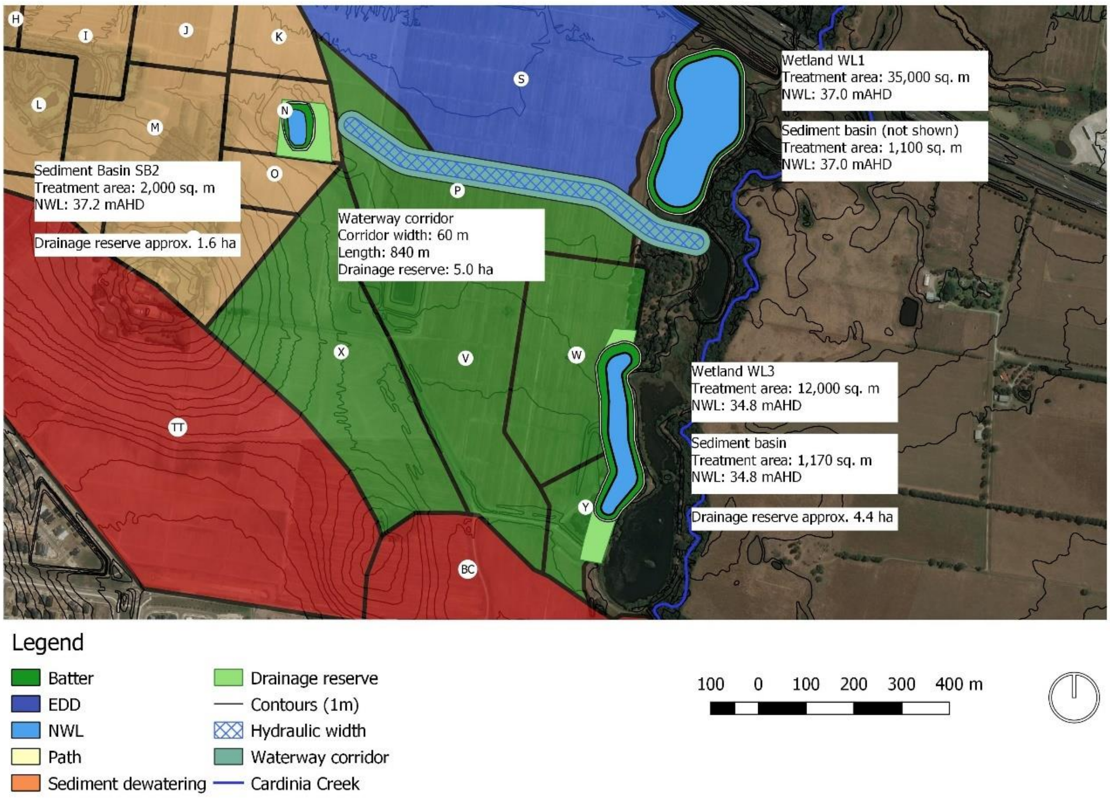

Figure 7-3 Alluvium Water Management Scenario 1 Layout

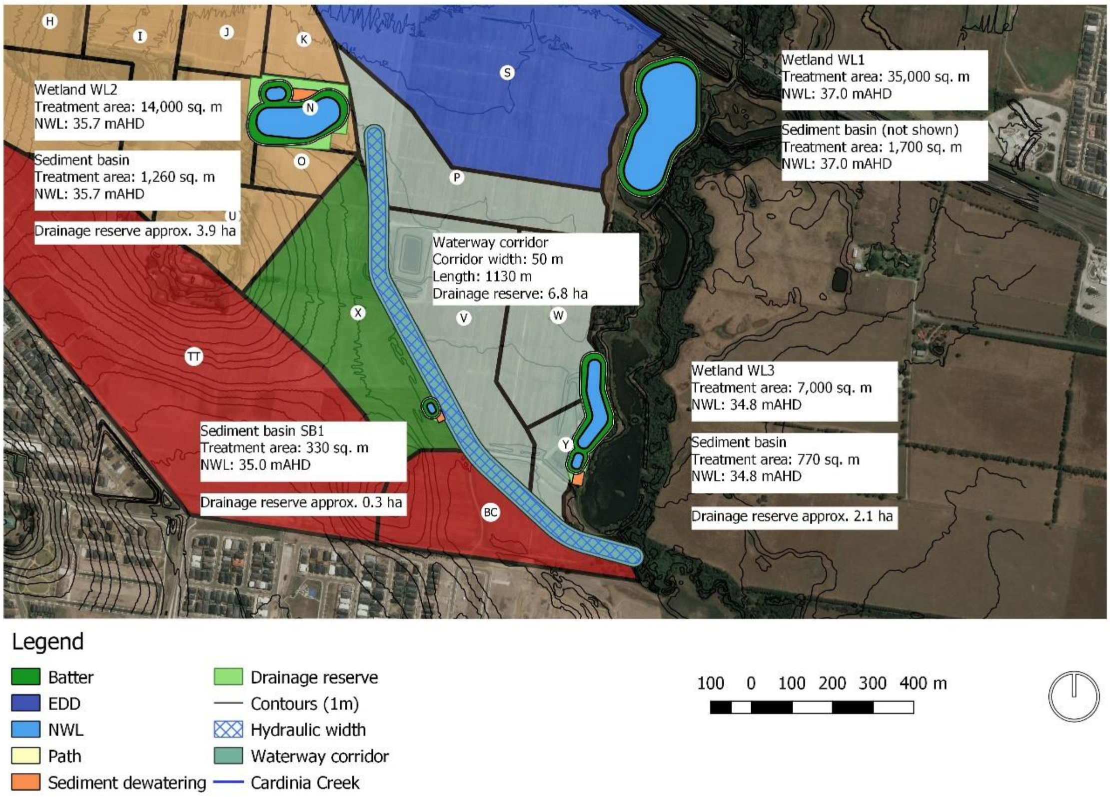

Figure 7-4 Alluvium Water Management Scenario 2 Layout

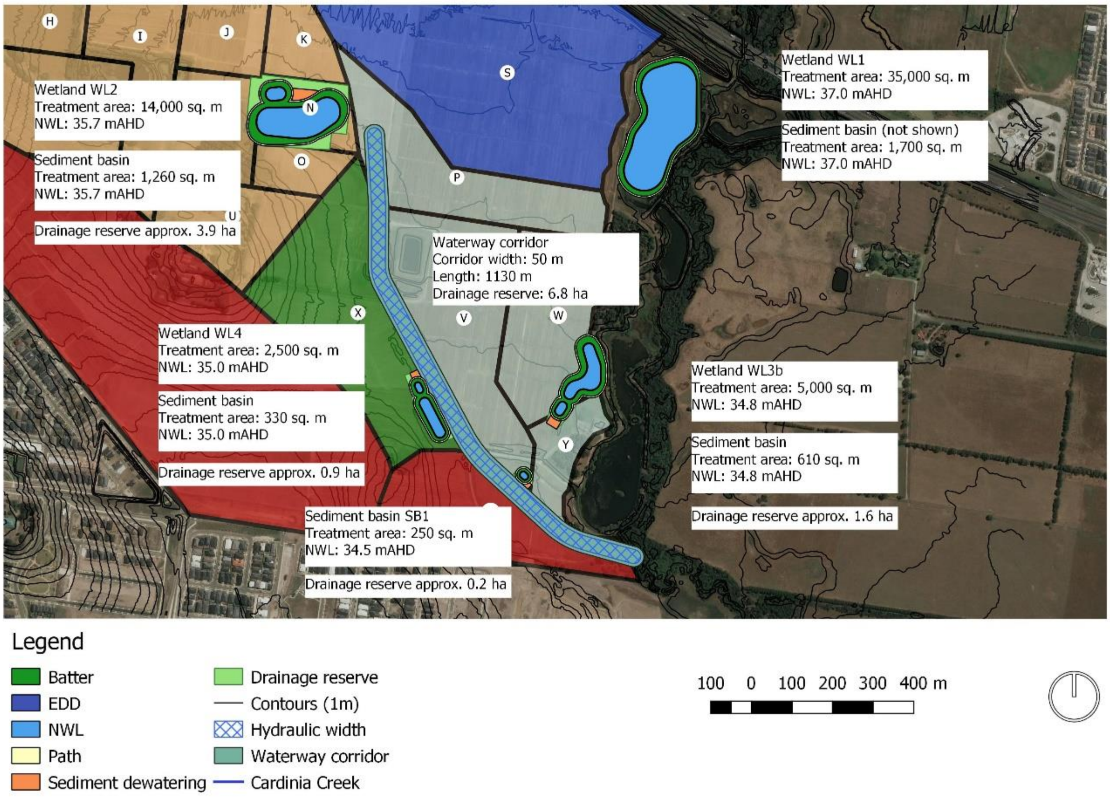

Figure 7-5 Alluvium Water Management Scenario 2b Layout

7.5 Preferred Drainage Management Scenario

Having reviewed the various design proposals I consider that Scenario 1 is the preferable design approach for management of stormwater from Minta Farm and preservation of ecological biodiversity values. The following points are relevant to this assessment:

- Scenario 1 takes greater advantage of the existing pond assets, reducing land take and cost of constructing additional treatment wetlands.
- The east-west waterway corridor can provide an enhanced buffer between the residential development to the south and the commercial development to the north. This buffer already exists and could be enhanced with a constructed waterway with limited additional land required.
- Scenario 1 provides more flexibility in the management of the hydrologic regime of the sensitive water-dependent ecosystems along the Cardinia Creek corridor. This is because water can be either directed into the ponds or diverted to flow directly into Cardinia Creek. This will allow the appropriate sequences of wetting and drying the pond/wetland areas for improved ecological habitat. A large portion of the flow is also directed away from Pond 3 which has particularly high ecological value and would be potentially degraded by excessive inflows.
- Scenario 1 allows for a more flexible development layout, freeing the southern part of the site from the constraint of the waterway corridor.
- Siting Wetland 3 adjacent to Pond 3 complements the already significant habitat at that location that has been identified in the ecology reports.

7.6 Outstanding Drainage Issues

A primary issue for the design will be to define the optimal hydrologic regime for each pond and ensure that this is achieved through the subsequent detailed design phase. This level of detail can be conditioned and final design will be subject to Melbourne Water approval in the normal way.

8. CONCLUSIONS

With respect to drainage issues related to Amendment C228 to the Casey Planning Scheme, the following conclusions can be made:

- The PSP reflects the latest design from Engeny.
- Charlton Degg/Water technology and Alluvium have put forward alternative design options for stormwater management at the site.
- It is practical and most efficient from an overall scheme perspective to direct the majority of Minta Farm catchment flows along an east-west waterway towards Cardinia Creek.
- Placing the waterway corridor between the residential and commercial precincts will enhance the separation and environmental buffer for these areas.
- Scenario 1 makes best use of the existing water assets whilst enabling protection of the high-value habitat along the Cardinia Creek corridor.

9. DECLARATION

I declare that I have made all the enquiries that I believe are desirable and appropriate and that no matters of significance which I regard as relevant have to my knowledge been withheld from the Panel.

Warwick A Bishop

B.E. (Hons), MEngSci

6 April 2018

APPENDIX A – CHARLTON DEGG/WATER TECHNOLOGY DRAINAGE STRATEGY REPORT

Minta Farm, Berwick
Cardinia Creek Catchment
Stormwater Management Strategy

July 2016

DOCUMENT STATUS

Version	Doc type	Reviewed by	Approved by	Distributed to	Date issued
v01	Report	Warwick Bishop	Warwick Bishop	Adam Charlton	20/05/2016
v02	Report	Warwick Bishop	Warwick Bishop	Adam Charlton	01/06/2016
v03	Report	Warwick Bishop	Warwick Bishop	Adam Charlton	14/06/2016
v04	Report	Warwick Bishop	Warwick Bishop	Adam Charlton	14/07/2016
v05	Report	Warwick Bishop	Warwick Bishop	Adam Charlton	20/07/2016

PROJECT DETAILS

Project Name	Minta Farm Stormwater Management Strategy
Client	Mutual Trust
Client Project Manager	Adam Charlton
Water Technology Project Manager	Thomas Cousland
Report Authors	Thomas Cousland, Adam Charlton
Job Number	4167-02
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Document Name	4167-02_R03v05a_Overal Drainage Strategy.docx

15 Business Park Drive
Notting Hill VIC 3168

Telephone (03) 8526 0800
Fax (03) 9558 9365

ACN No. 093 377 283
ABN No. 60 093 377 283

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EXECUTIVE SUMMARY

On the 24th August 2015 the land owner met with Melbourne Water to gain an understanding of the process to develop a Stormwater Management Strategy for Minta Farm (the subject land). Of particular interest was the catchment discharging to Cardinia Creek (Westernport Catchment) which is the subject of a new Drainage Services Scheme.

The Cardinia Creek catchment within the subject land is approximately 216 ha. An additional developed external catchment of approximately 62 ha lies to the north and west. Of the developed external catchment, approximately 14 ha is to be piped through the subject land. The balance of the external catchment is piped directly to Cardinia Creek with gap flows discharging into the subject land.

The subject land incorporates the Cardinia Creek watercourse and approximately 15 ha of existing lakes (water surface area, April 2016). The lakes are contained within a corridor immediately west of Cardinia Creek, ranging in width between 100 metres and 200 metres. The width of the lakes corridor is generally consistent with the setbacks for development along the Cardinia Creek corridor north of the subject land. It is also consistent with the Cardinia Creek Masterplan incorporated into the Clyde North Precinct Structure Plan immediately south of the subject land. (Significantly, the Cardinia Creek Masterplan proposes a series of wetlands within the proposed 'Cardinia Creek Conservation Corridor' with a width typically between 100 metres and 150 metres).

The lakes have existed for many decades and form an integral part of the rural drainage system. They have functioned with minimal maintenance receiving runoff from the farm and upstream catchment via a series of east-west channels directing stormwater to the north lake which in turn discharges south to the middle lake and then to the southern lake before overflowing to Cardinia Creek.

Over time the lakes have developed into an important part of the ecosystem and are a feature of the property.

It was the strong view of the land owners that any proposed urban drainage scheme should integrate these unique assets as far as practicable.

The key outcomes of the initial discussions with Melbourne Water were:

- The proposed Cardinia Creek Catchment area is to be the subject of a new Drainage Services Scheme (DSS).
- Hydraulic and Water Quality requirements would be met on site as part of the cost of any future development with no DSS charges applying.
- The State Environmental Planning Policy (SEPP - F8) requirements would apply to sediment targets for the Cardinia Creek catchment.
- Runoff from the developed catchment was not required to be retarded prior to discharging to Cardinia Creek.
- Levee works are required downstream, within the greater Cardinia Creek Catchment Area. These works will be delivered by MW and will attract a special DSS contribution to contributing catchments.
- Melbourne Water was supportive of a drainage strategy that incorporated the existing lake system into the stormwater treatment train.
- Any drainage asset, including the existing lakes, with a contributing catchment of greater than 60 ha would be maintained by Melbourne Water.

As a consequence of the initial discussions, a Concept Masterplan and Preliminary Drainage Strategy (October 2015) were developed for the site in consultation with the Metropolitan Planning Authority (MPA) and Melbourne Water. The Masterplan and Preliminary Drainage Strategy was developed taking into consideration the existing flow of stormwater across the land and the viability of the existing lake system in any future development of the land.

The lakes were incorporated into the treatment train, being a primary objective of all stakeholders. Flows from the north-west were diverted to the north lake to provide a viable stormwater supply not dissimilar to previous farm practices on the subject land. A preliminary MUSIC model was prepared to demonstrate that the combination of three proposed sediment basins and utilisation of the existing lakes system in the stormwater treatment train could exceed current best practice targets for pollutant removal.

Over the course of the last 7 months the Drainage Strategy has evolved following continuous input from Melbourne Water and other stakeholders. Subsequent submissions have included the following key documents.

- Detailed level and feature survey of the existing lake beds, water levels and survey of the proposed Baillieu Creek alignment.
- 100 year ARI Stormwater Strategy Catchment Plan (Refer Appendix G).
- Subdivision major overland flow path analysis including typical road cross-sections, flows, flow depth and velocity analysis. (Refer Appendix H)
- 5 year ARI Stormwater Strategy Catchment Plan and Computations (Refer Appendix I).
- Concept Design of the three key sediment basins.
- Existing and proposed flow control structures between the lakes.
- Lake Turnover Analysis.
- Associated calculations and proposed lake system longitudinal sections and cross-sections.

This work demonstrated the high level viability of a proposed drainage strategy which incorporated the existing lakes into the treatment train for a future developed catchment. In summary, the stormwater drainage strategy included the following key features.

- Three key sediment basins located strategically to fully utilise the capacity of the surrounding road system and minimise the number of basins.
- A constructed waterway (Baillieu Creek) which conveys stormwater flows from the Baillieu Creek Sediment Basin to the North Lake.
- Modified lakes to drop normal water levels to allow the diversion of flows from the north west of the subject land.

On the 4th February and the 22nd February 2016 Melbourne Water responded to the submissions providing its in-principal support for the drainage strategy. Following consultation with its internal departments Melbourne Water required modifications to the existing lake system such that the treatment areas comply with Melbourne Water's guidelines for constructed wetlands. In particular Melbourne Water suggested that the northern lake be retrofitted with a wetland. In addition, Melbourne Water requested that the following matters be addressed in a final, consolidated report:

- A brief summary of the opportunities and constraints.
- A revised MUSIC model that incorporates the changes to the treatment train.
- A revised lake turnover analysis that considers the changes to the treatment train.
- Indicative concept layout and cross sections for the proposed wetlands including high flow bypass arrangement.

- Preliminary ANCOLD 'Hazard Assessment'.

This report incorporates all of the previous work done to date and develops it further by addressing the most recent comments received from Melbourne Water dated 22nd February 2016 (above).

In particular, this report supersedes the previous reports submitted in order to provide one complete and concise document for future reference by stakeholders.

1. INTRODUCTION

This report combines the generally accepted outcomes from previous reports; ***Minta Farm - Preliminary Drainage Strategy*** (Water Technology - October 2015) and ***Minta Farm - Conceptual Design of Water Quality Works and Lake Turnover Analysis*** (Water Technology - December 2015).

This report contains conceptual wetland designs, revised MUSIC modelling of the overall treatment train and Lake Turnover Analysis in order to satisfy Melbourne Water's request for stormwater to be treated to Best Practice Management before discharging to the lakes system within the PSP 11 Site.

This report also describes the proposal to modify the North and South lakes to accommodate two constructed wetland systems. This will change the footprint and volume of the lakes and has a positive influence on future lake water quality. Details of the proposed changes to the lakes system are provided and discussed.

A 3.0 ha North wetland has been designed to cater for PSP 11 stormwater flows emanating from the proposed Baillieu Creek constructed waterway (119 ha catchment) and proposed commercial mixed-use area. This wetland has a similar footprint to the existing north lake with high flows bypassing to the south.

A 1.1 ha South wetland has been designed to cater for stormwater flows from the south-eastern residential section of the site with high flows bypassing to the north. This wetland sits within the footprint of the current South Lake.

2. EXISTING DRAINAGE CHARACTERISTICS OF THE SITE

The site is bounded to the north by the O'Shea Road PAO, to the west by Soldiers Road, to the south by Grices Road, to the east by Cardinia Creek and to the north-east by the Princes Freeway Reserve. The abutting land to the north, west and south boundaries is zoned residential and is predominantly developed.

The site is characterised by two distinctive hilltops tapering to relatively flat land in the east. One hilltop sits just west of the centre to the property with approximate RL 55.0 m AHD and is the site of an existing house and outbuildings. The second hilltop sits (central) and close to the southern boundary with approximate RL 43.0 m AHD. A straight line between the hilltops approximately defines the two catchment areas of the site. The land to the south-west falls inside Melbourne Water's Ti Tree Creek Drainage Scheme, and the land to the north-east falls into the Cardinia Creek (Westernport) catchment. The Cardinia Creek catchment area is the subject of this Report.

The natural grades across the land vary significantly. Around the hilltops grades are typically 1 in 15 and in the flatter areas to the east more typically 1 in 150.

There are several farm dams centrally located on the property. The lakes along the eastern boundary, adjacent to Cardinia Creek, are proposed to form part of the treatment train.

The lakes have been established for many decades and serve as functional farm storages as well as providing amenity values to the site.

A series of open swale drains and farm culverts traverse the site in a generally southeast direction. These drains convey stormwater flows from approximately 53 ha of external catchment plus approximately 150 ha of the PSP 11 site towards the South Lake. The existing drainage layout is shown in Figure 2-1.

Also, approximately 42 ha of the PSP 11 site currently drains towards the North and Middle Lakes via a series of shallow swale drains.

In this Stormwater Management Strategy, the three main lakes along the eastern boundary (North Lake, Middle Lake and South Lake) are proposed to be utilised (with some modifications to North Lake and South Lake) in the stormwater treatment train.

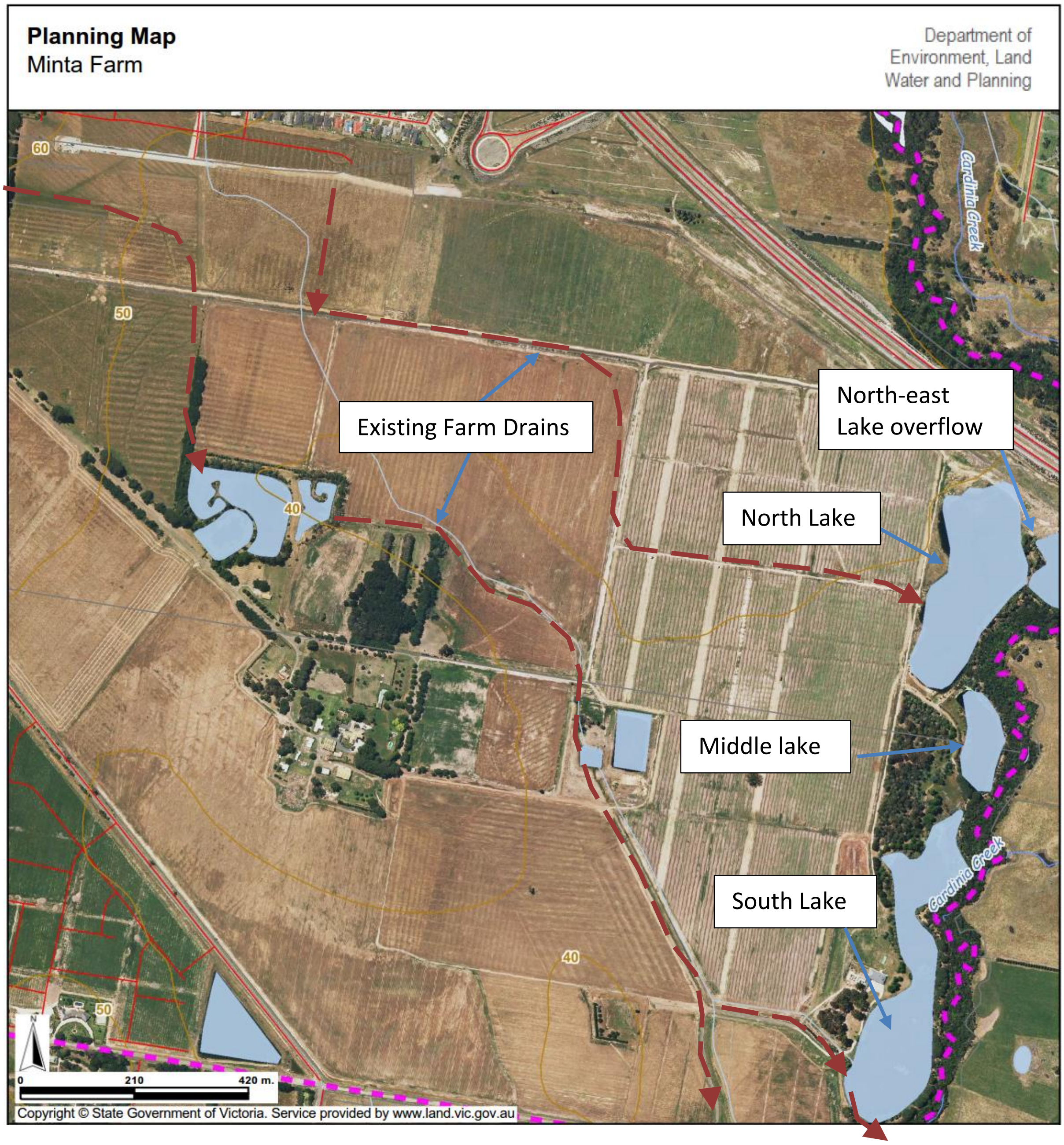

Figure 2-1 Existing PSP 11 Waterbodies and Overland Flow Paths (DELWP background, accessed 15/10/2015)

3. CURRENT PLANNING SCHEME OVERLAYS

The current planning scheme flooding overlay affecting the PSP 11 site is shown in Figure 3-1.

Figure 3-1 Current Flood Overlays (DELWP, accessed 1/06/2016)

4. CONCEPT MASTER PLAN

To enable preparation of this SWMS, a concept master plan has been prepared in consultation with Water Technology, Melbourne Water and the MPA. The current concept masterplan is shown in Figure 4-1.

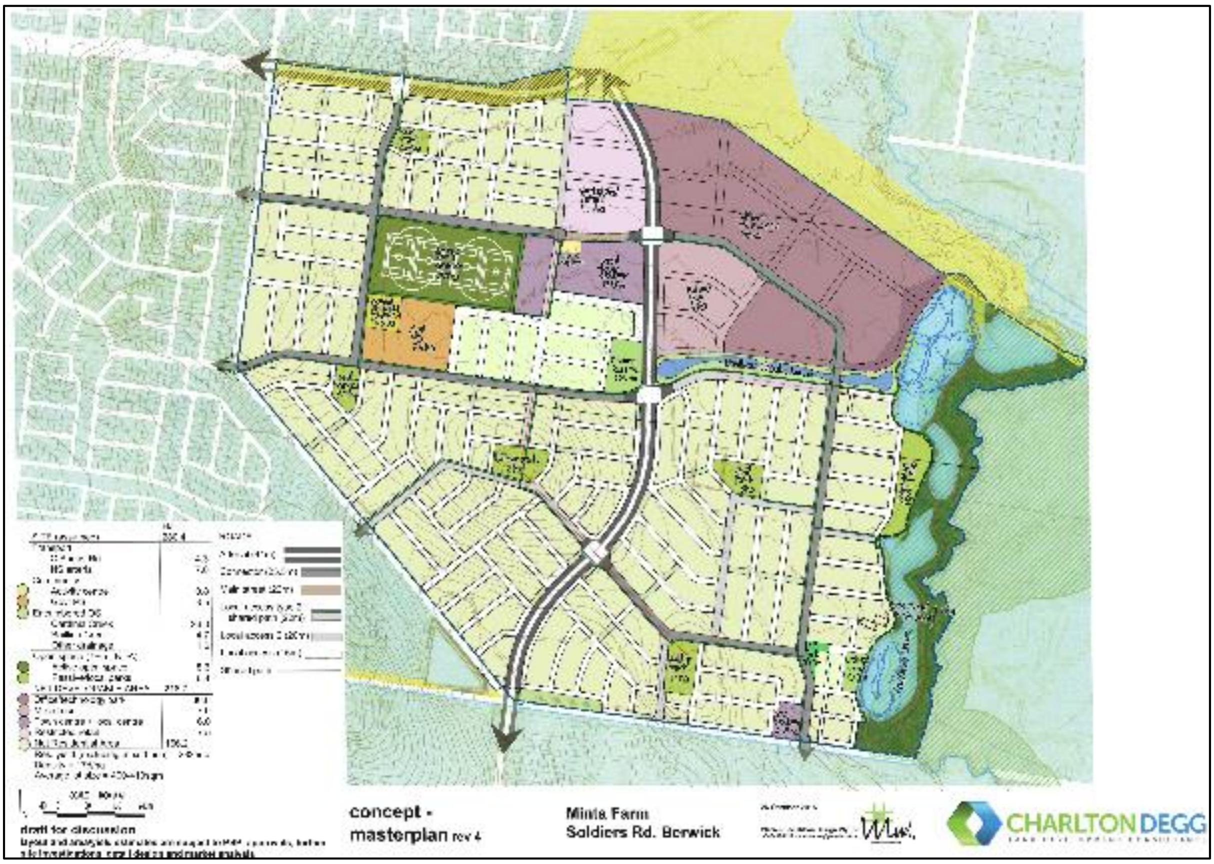

Figure 4-1 Concept Masterplan

5. SITE OPPORTUNITIES AND CONSTRAINTS

Currently the PSP 11 site drains towards four existing lakes at the eastern edge of the property which are separated from the Cardinia Creek floodplain by existing embankments. The site generally grades south-east towards the existing lakes. An 18.9 ha external residential catchment drains into the site during minor storm events, with the external catchment increasing in size during major storm events when existing pipe capacity is exceeded.

Retardation of stormwater is not a requirement (for this site) due to the location of the site within the Cardinia Creek catchment and previous determination by Melbourne Water that delay in flood peaks is not beneficial or required.

To best utilise the existing lake systems and footprints, a new central waterway is proposed to be constructed with the capacity to allow design flood flows to be conveyed towards the existing North Lake.

The following opportunities and constraints have been identified.

Opportunities & Constraints

1. The existing lake system is contained within a corridor consistent with setback requirements for development in the vicinity of Cardinia Creek. Any drainage strategy developed for the site must consider the future best use and viability of the existing lakes (and the balance of the land for that matter) taking into consideration that the vast majority of the land currently occupied by the lakes is unlikely to be developable.
2. The existing lake system is off-line and immediately adjacent to Cardinia Creek.
3. The Cardinia Creek Masterplan incorporated into the Clyde North PSP proposes an approximate 100 m to 150 m setback for development from Cardinia Creek with the following notable key design and management themes (Refer Clyde North PSP, page 47):
    - Creek Reserve boundaries, where possible, should be located by reference to landform, flood levels and natural site features rather than arbitrary setbacks.
    - Development areas adjoining the creek reserve should be designed with site layouts and landscape treatments that complement the conservation values and objectives of the creek reserve and act as a buffer to high value habitats.
    - Areas of high conservation significance should be protected and enhanced through additional planting, new wetland development and fencing where necessary.
    - Existing dams and floodways should be redeveloped where practical to provide additional wetland habitats and open space links.
4. The existing lake system has functioned in a rural setting for many years with minimal maintenance and has evolved into an important part of the Cardinia Creek ecosystem and a feature of the property. This should be protected and enhanced as far as practical.
5. A modified lake system would provide unique amenity and a sense of history and place to any future development of the land and adjacent open space areas.
6. Locating the proposed North Wetland upstream of Baillieu Creek would occupy approximately 6 ha of land which could be better utilised as developable land.
7. Locating the proposed North Wetland upstream of Baillieu Creek would significantly increase the frontage and exposure of developable land to the drainage scheme asset whereas the site of North Lake is bounded on one side by Cardinia Creek limiting exposure and access of the asset to the public.

8. Flows in the Baillieu Creek constructed waterway will be typical of an urban waterway and the colour of the water will not be clear. This will be the case regardless of the extent of treatment upstream.
9. The proposed SWMS will provide opportunity to rework parts of the existing lakes to enhance and compliment the conservation and biodiversity values along the creek corridor.
10. The proposed Baillieu Creek constructed waterway alignment provides an opportunity to incorporate landscape treatments to effectively provide a buffer between the proposed Office and Technology park to the north and Residential Development to the south.
11. The bathymetric survey of the existing lake system demonstrates that it is typically 1.0 m to 2.5 m deep. Remodelling of any part of the existing lake system into a conforming wetland would involve minimal earthworks as compared to constructing a new wetland elsewhere on the site as demonstrated by the Preliminary Cost Estimates (Refer Appendix J).
12. Diversion of stormwater flows around the lake system for reconstruction works would be efficiently implemented given the lake systems are completely offline and existing farm diversion channels are predominantly in place.
13. Preliminary modelling indicates that earthworks volumes generated by retrofitting the existing North and South Lake with wetlands are significantly less than the volumes expected from wetlands this size constructed predominantly in cut (as would be the case elsewhere on site).
14. It is estimated that construction of the key drainage scheme assets will require 100,000 m^3 of cut and 90,000 m^3 of fill which can be generated on site.
15. Fill will be required (in the order of 200,000 m^3) around the site of the Baillieu Creek Sediment Basin in order to effect the diversion of flows from the north-west to the site of the North Lake (proposed North Wetland). Given the scale of the site and the earthworks anticipated around the adjacent hilltops, this is not considered to be cost prohibitive.
16. The filling required in the vicinity of the Baillieu Creek Sediment Basin will facilitate an ideal road grade of approximately 1 in 200 for the north-south Arterial Road as it passes over Baillieu Creek.
17. The material within the existing lake beds is understood through historical information which includes the land owner's observations and recollections of the construction methodology. In general, the land was stripped of silty deposits. Clay material won from the lake excavation was used to form the embankments on the east side of the lakes. The silts were pulled back over the embankments and floor of the lakes. The ability of the lakes to hold water year round has been proven in practice over many decades, however a greater understanding through a geotechnical investigation will be necessary.

6. CATCHMENT ANALYSIS

The catchments shown in Figure 6-1 were used in the low flow determination for the wetland systems and for the MUSIC modelling described in Section 9.

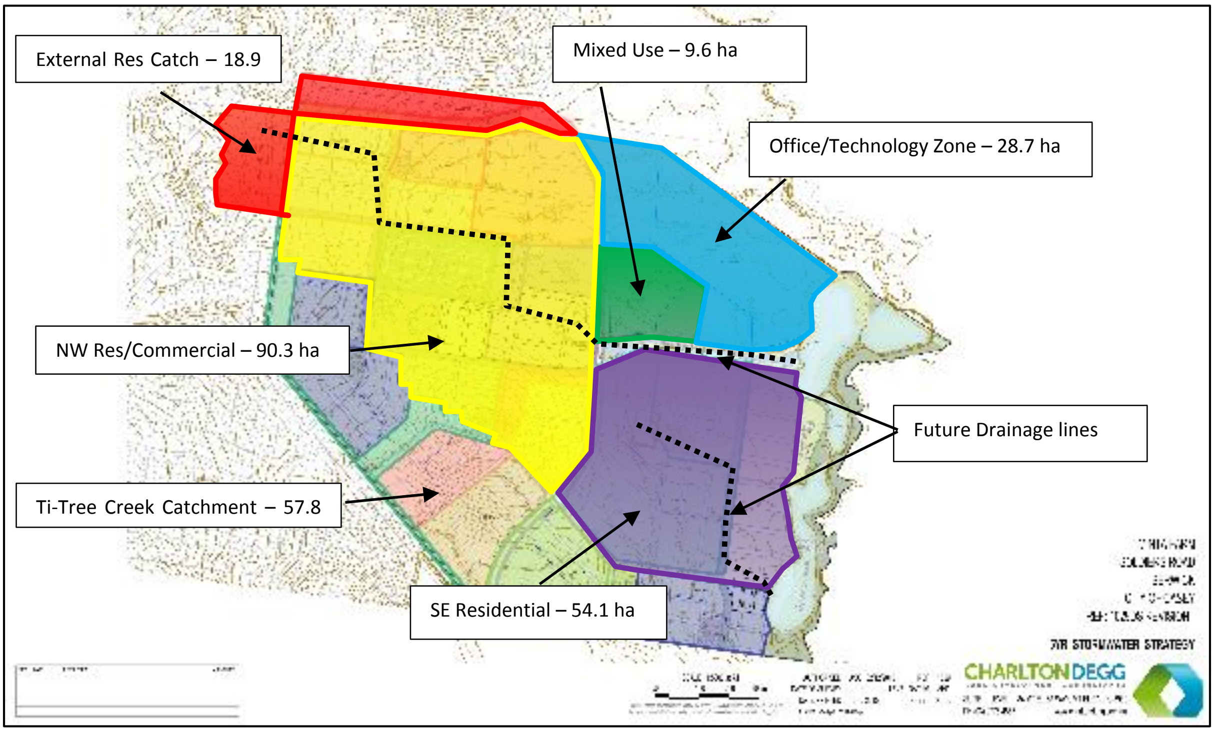

Figure 6-1 Minor Drainage Catchment Plan (~20% AEP)

The total catchment draining the major storm event (1% AEP) via the Baillieu Creek Waterway is different to the sum of the catchments shown in Figure 6-1 due to a larger external catchment contributing overland flows through the site (Refer Figure 6-2).

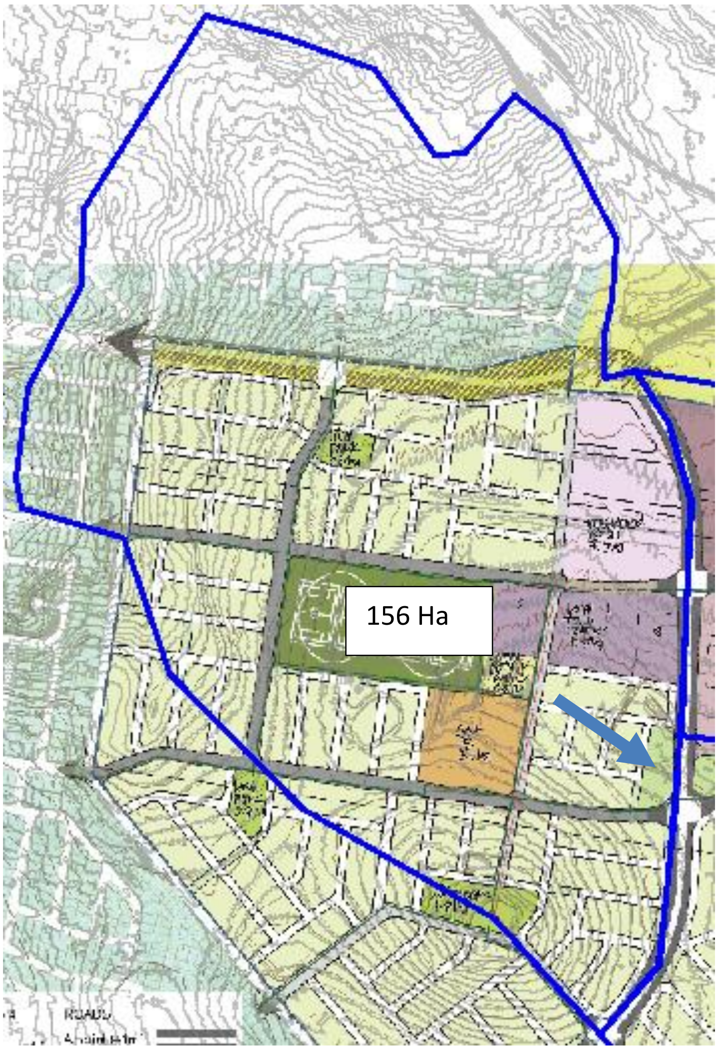

Figure 6-2 Major Drainage Catchment Plan (1% AEP, overland flow)

7. PROPOSED STORMWATER MANAGEMENT STRATEGY

The proposed major stormwater drainage infrastructure for the PSP 11 site is shown in Figure 7-1 and comprises three sediment ponds, a constructed waterway (Baillieu Creek diversion), two wetlands and three of the four lakes. The north-east lake does not have a role in the treatment train.

The North Lake is to be reconstructed to incorporate a 3.0 ha wetland, whilst the South Lake is to be reconstructed to incorporate a 1.1 ha wetland. Accordingly, both these lakes will be significantly reduced in terms of open water area and lake volume.

The middle lake is understood to have particular BCF values and is not proposed for modification other than for regulation of the Normal Water Level and associated inlet and spillway provisions.

Major drainage flow paths are indicated within Figure 7-1.

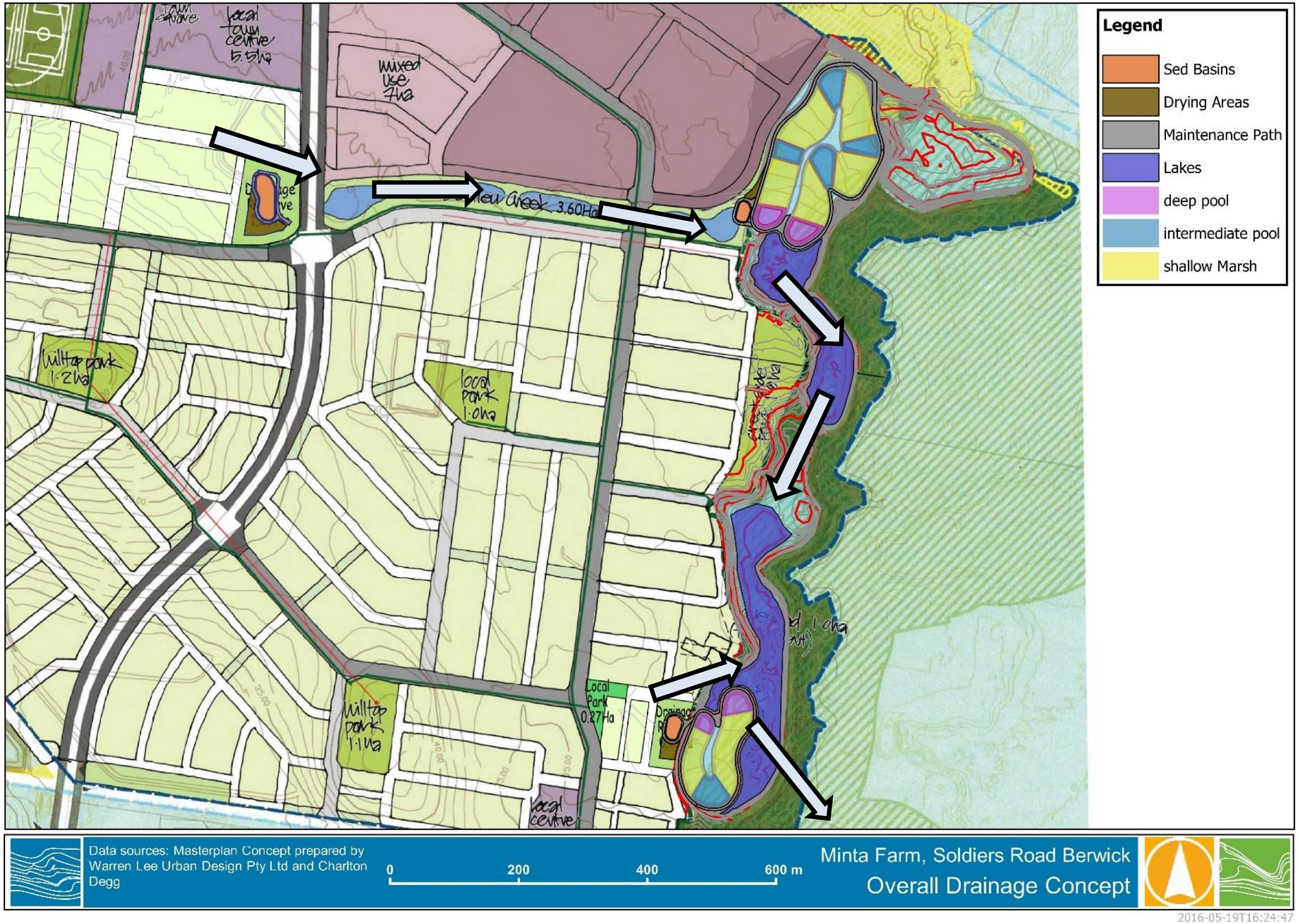

Figure 7-1 Drainage Concept Plan

8. BAILLIEU CREEK (1% AEP CONSTRUCTED WATERWAY)

It is proposed to drain the 156 ha catchment west of the future arterial road via a 1% AEP constructed waterway to the North Wetland.

A Rational Method estimate has determined that the 1% AEP flow requiring conveyance by the waterway is 23.5 m^3/s.

To allow for the 1% AEP design flows to drain toward the site of the existing North Lake, the upstream invert level is required to be lifted from the existing conditions and the Normal Water Level (NWL) of the proposed North Wetland will be lowered compared to the notional current North Lake level (it is noted that the current lake level experiences significant seasonal variation and does not have a fixed normal water level).

A preliminary waterway design has been undertaken setting the upstream invert level at 37.75 m AHD (approximately 0.5 m above current levels) and the proposed North Wetland NWL to 37.25 m AHD (approximately 1.0 m lower than the present North Lake NWL).

Due to the low grade available for the waterway (approximately 1 in 1400), a series of two online ponds are proposed. The western pond extends for ~300 m with a NWL of 37.75 m AHD, and the eastern pond extends for ~320 m with a NWL of 37.50 m AHD.

The 1% AEP design flood level was determined through HEC-RAS modelling of the system with the 1% AEP flood level grading from 38.75 m AHD to 38.25 m AHD west to east. The average flood depth above pond water level is approximately 1.0 m. The waterway reserve width is currently set at 50 m which allows flexibility for future design refinements. A plan view of the waterway is shown in Figure 8-1.

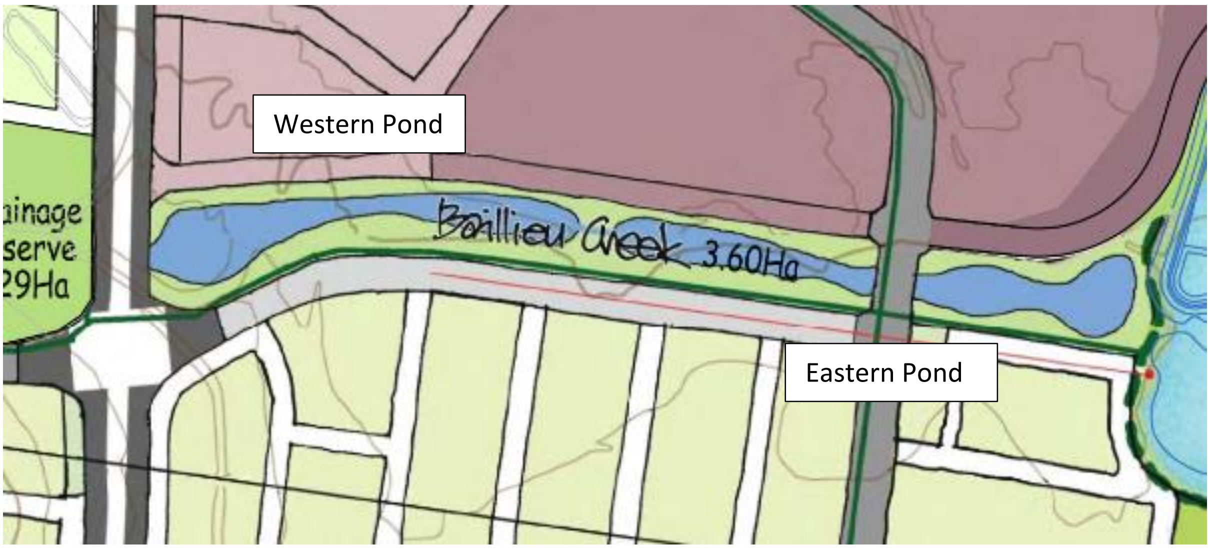

Figure 8-1 Baillieu Creek Constructed Waterway Plan

A major culvert crossing will be required under the arterial road to convey the 1% AEP design flow of 23.5 m^3/s.

The Baillieu Creek Sediment Basin is proposed directly upstream of the arterial road (described later). The current preliminary design tail water level of the culvert crossing is 38.75 m AHD. Assuming

250 mm head loss across the future culvert, the 1% AEP design flood level for the sediment basin is 39.0 m AHD.

Preliminary longitudinal section and cross-sections of the waterway designs can be found in Appendix F.

The 1% AEP flood level in Cardinia Creek in the vicinity of the North Wetland is understood to be approximately 37.7 m AHD and the top of bank is approximately 39.5 m AHD. The lake and wetland systems are well separated from Cardinia Creek flood waters.

The Baillieu Creek Waterway will be designed to incorporate pools and riffles to accommodate its flat grade in accordance with the principals of Melbourne Waters “Constructed Waterways in Urban Developments Guidelines”.

The Waterway will incorporate a variety of landscape treatments to complement the proposed Office and Technology Park to its north and the Residential Development to its south. It will also act as a buffer between the proposed Office and Technology Park and the residential areas within PSP 11.

A previous example of a similar constructed waterway that has been constructed recently is the Kimberley Downs Estate in Narre Warren South. Figsss to fiigg shown examples of this well-established waterway.

Figure 8-2 Kimberley Downs Estate Constructed Waterway Showing Edge Vegetation

Figure 8-3 Kimberley Downs Estate Constructed Waterway Showing Riffle Section

Figure 8-4 Kimberley Downs Estate Constructed Waterway Showing Pond Section

9. MUSIC MODELLING SUMMARY

The layout of the MUSIC modelling for the treatment train is shown in Figure 9-1. The performance of each of the wetland nodes is shown in Table 9-1 and Table 9-2 .

These results do not take into consideration any water quality treatment or benefit from the lake systems. The MUSIC results show that flows entering the lakes meet current Best Practice targets.

The amount of additional sediment removal performed by the lake system has been calculated by the MUSIC modelling as shown in Table 9-3 . This additional sediment capture indicates that SEPP F8 requirements for sediment removal will be met through utilisation of the existing lake system in combination with the constructed sediment ponds and wetlands.

Figure 9-1 MUSIC Modelling Layout

Table 9-1 MUSIC Modelling Treatment Train Performance at North Wetland

Parameter	Load In	Load Out	Load Removed	Reduction (%)	Target (%)
Total Suspended Solids (kg/yr)	142,000	24,000	118,000	83.1%	80%
Total Phosphorous (kg/yr)	296	87	209	70.5%	45%
Total Nitrogen (kg/yr)	2,090	1,150	940	45.0%	45%
Gross Pollutants (kg/yr)	30,500	700	29,800	97.7%	70%

Table 9-2 MUSIC Modelling Treatment Train Performance at South Wetland

Parameter	Load In	Load Out	Load Removed	Reduction (%)	Target (%)
Total Suspended Solids (kg/yr)	52,900	9,210	43,690	82.6%	80%
Total Phosphorous (kg/yr)	111	34	77	69.5%	45%
Total Nitrogen (kg/yr)	787	428	359	45.6%	45%
Gross Pollutants (kg/yr)	11,400	0	11,400	100.0%	70%

Table 9-3 Total Sediment Removal of Entire Stormwater System

Parameter	Load In	Load Out	Load Removed	Reduction (%)
Total Suspended Solids (kg/yr)	195,000	14,800	180,200	92.4%

10. SEDIMENT BASIN CONCEPTUAL DESIGNS

Three designs have been completed for water quality pre-treatment works in the form of sediment basins, prior to stormwater entering the wetland systems. The location of the three sediment basins are shown in Figure 10-1.

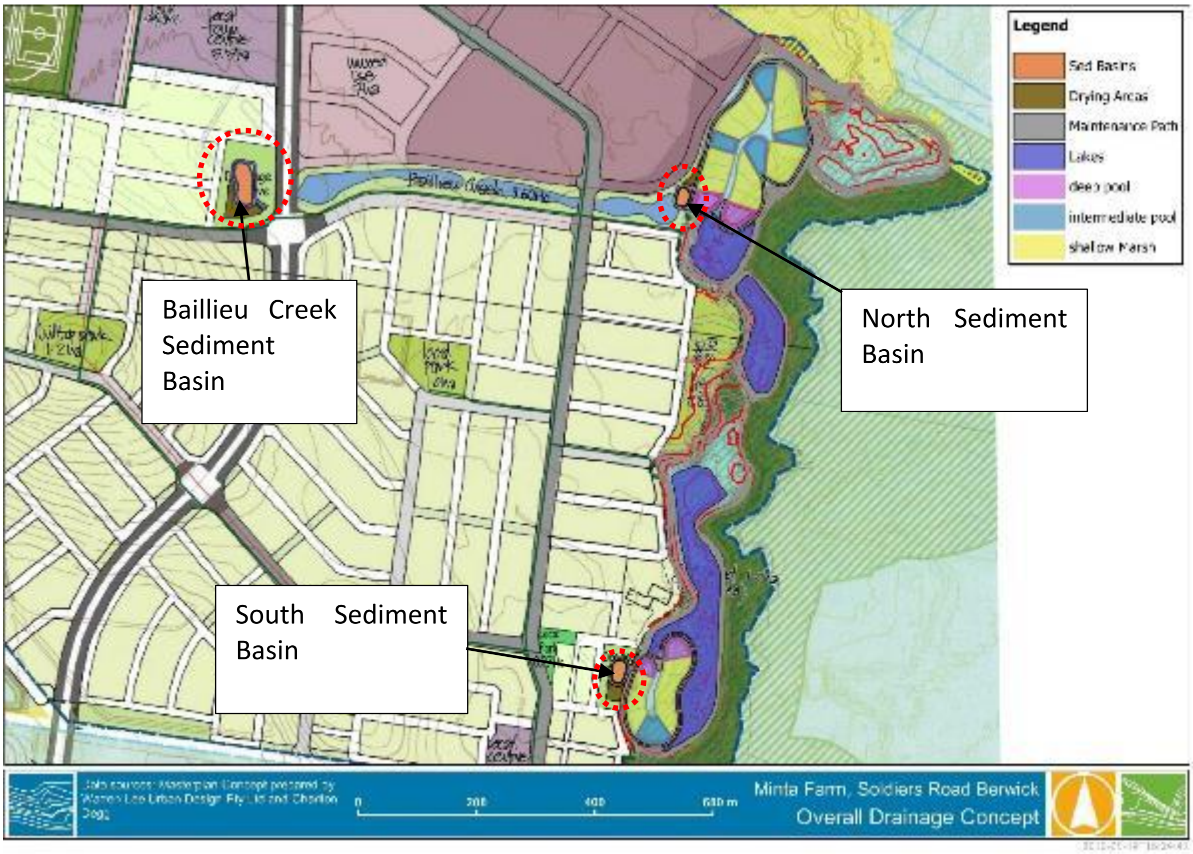

Figure 10-1 Sediment Basin Locations

In all three sediment basin designs, the edge treatment is consistent with Melbourne Water's wetland guidelines specification. Melbourne Water's typical edge treatment is shown below in Figure 10-2.

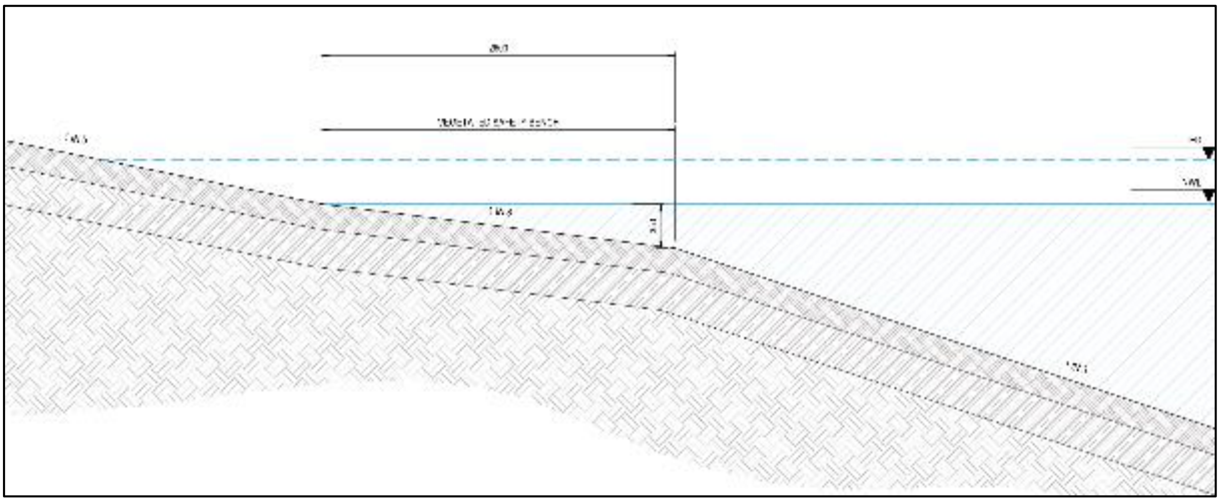

Figure 10-2 Melbourne Water Typical Edge Treatment with Safety Bench

10.1 Baillieu Creek Sediment Basin

Table 10-1 lists the proposed design parameters for the Baillieu Creek Sediment Basin. Due to the large catchment it is proposed to bypass flows greater than the 3 month ARI to ensure velocities within the basin do not exceed 0.5 m/s. A 100 year ARI bypass has been incorporated into the design to ensure the basin is offline during a major flow event.

Table 10-1 Baillieu Creek Sediment Basin Design Details

Baillieu Creek Sediment Basin		
3 month ARI inflow	1.6	m^3/s
Estimated peak velocity (3 month flow at TED level, >3 month bypassed)	0.2	m/s
Normal Water Level	38.0	m AHD
Top of Extended Detention	38.35	m AHD
Invert Level of Basin	36.5	m AHD
Surface Area Requirement to meet 95% capture rate	1,600	m^2
Surface Area at NWL	1,610	m^2
3 year Accumulated Sediment Load	750	m^3
Permanent Pool Volume Available (500 mm below NWL)	880	m^3
Sediment Drying Area Required	1,500	m^2
Sediment Drying Area Supplied	1,600	m^2

A plan view of the conceptual design of the Baillieu Creek sediment basin is shown in Figure 10-3

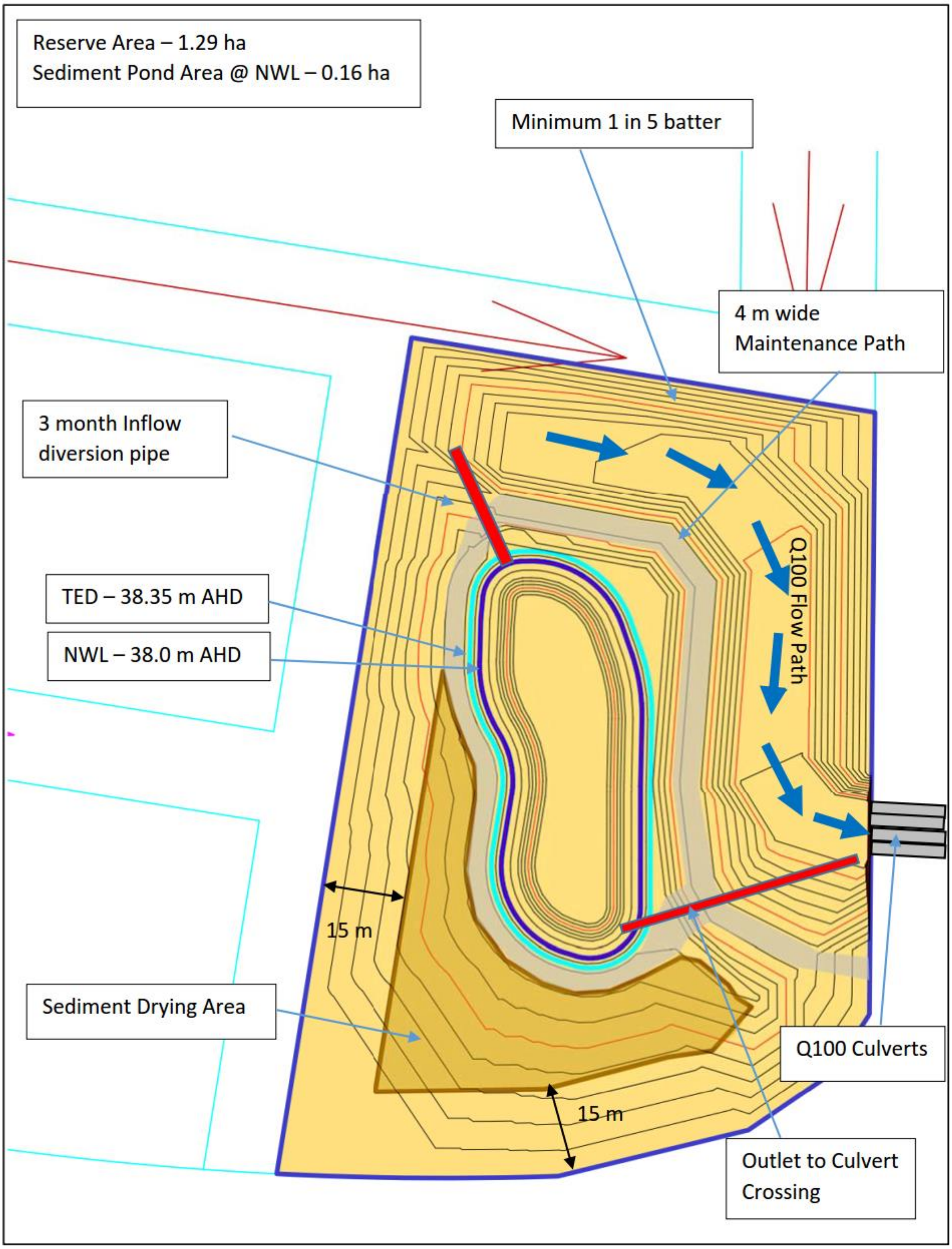

Figure 10-3 Baillieu Creek Sediment Basin Design

10.2 North Sediment Basin

Table 10-2 North Sediment Basin Design Details lists the proposed design parameters for the North Sediment Basin. It is proposed to divert > 5 year ARI overland flows around the basin and direct these flows via the road network into the downstream lake system.

Table 10-2 North Sediment Basin Design Details

North Sediment Basin		
3 month ARI inflow	0.5	m^3/s
Estimated peak velocity (5 year ARI flow at TED level, >5 year bypassed)	0.3	m/s
Normal Water Level	37.6	m AHD
Top of Extended Detention	37.95	m AHD
Invert Level of Basin	36.1	m AHD
Surface Area Requirement to meet 95% capture rate	510	m^2
Surface Area at NWL	570	m^2
3 year Accumulated Sediment Load	150	m^3
Permanent Pool Volume Available (500 mm below NWL)	190	m^3
Sediment Drying Area Required	300	m^2
Sediment Drying Area Supplied	315	m^2

A plan view of the conceptual design of the North Sediment basin is shown in Figure 10-4

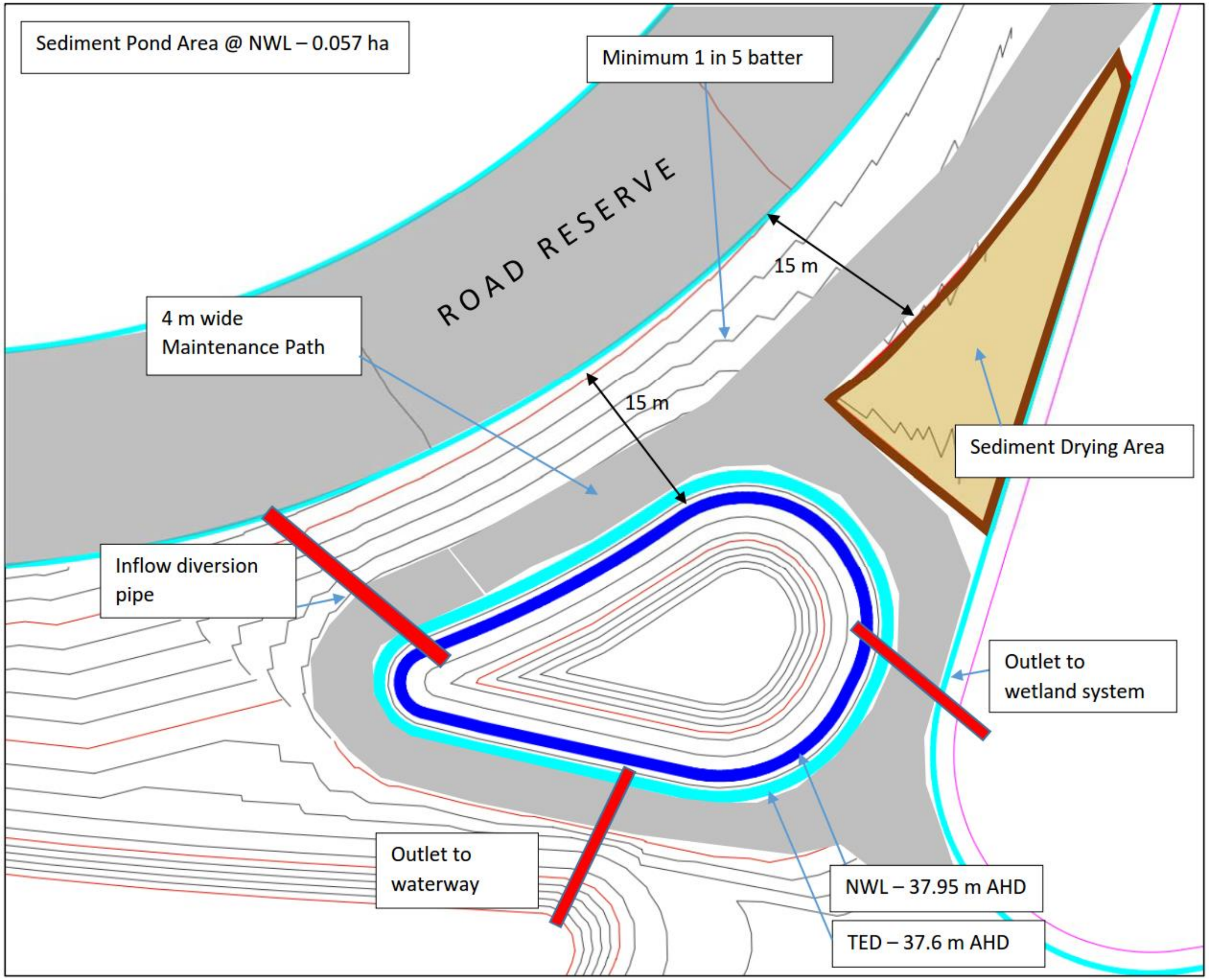

Figure 10-4 North Sediment Basin Design

10.3 South Sediment Basin

Table 10-3 South Sediment Basin Design Details lists the proposed design parameters for the South Sediment Basin. It is proposed to divert > 5 year ARI overland flows around the basin and direct these flows via the road network and reserve areas into the downstream lake system.

Table 10-3 South Sediment Basin Design Details

South Sediment Basin		
3 month ARI inflow	0.7	m^3/s
Estimated peak velocity (5 year ARI flow at TED level, >5 year bypassed)	0.4	m/s
Normal Water Level	35	m AHD
Top of Extended Detention	35.35	m AHD
Invert Level of Basin	33.5	m AHD
Surface Area Requirement to meet 95% capture rate	700	m^2
Surface Area at NWL	750	m^2
3 year Accumulated Sediment Load	250	m^3
Permanent Pool Volume Available (500 mm below NWL)	330	m^3
Sediment Drying Area Required	500	m^2
Sediment Drying Area Supplied	660	m^2

A plan view of the conceptual design of the South Sediment Basin is shown in Figure 10-5

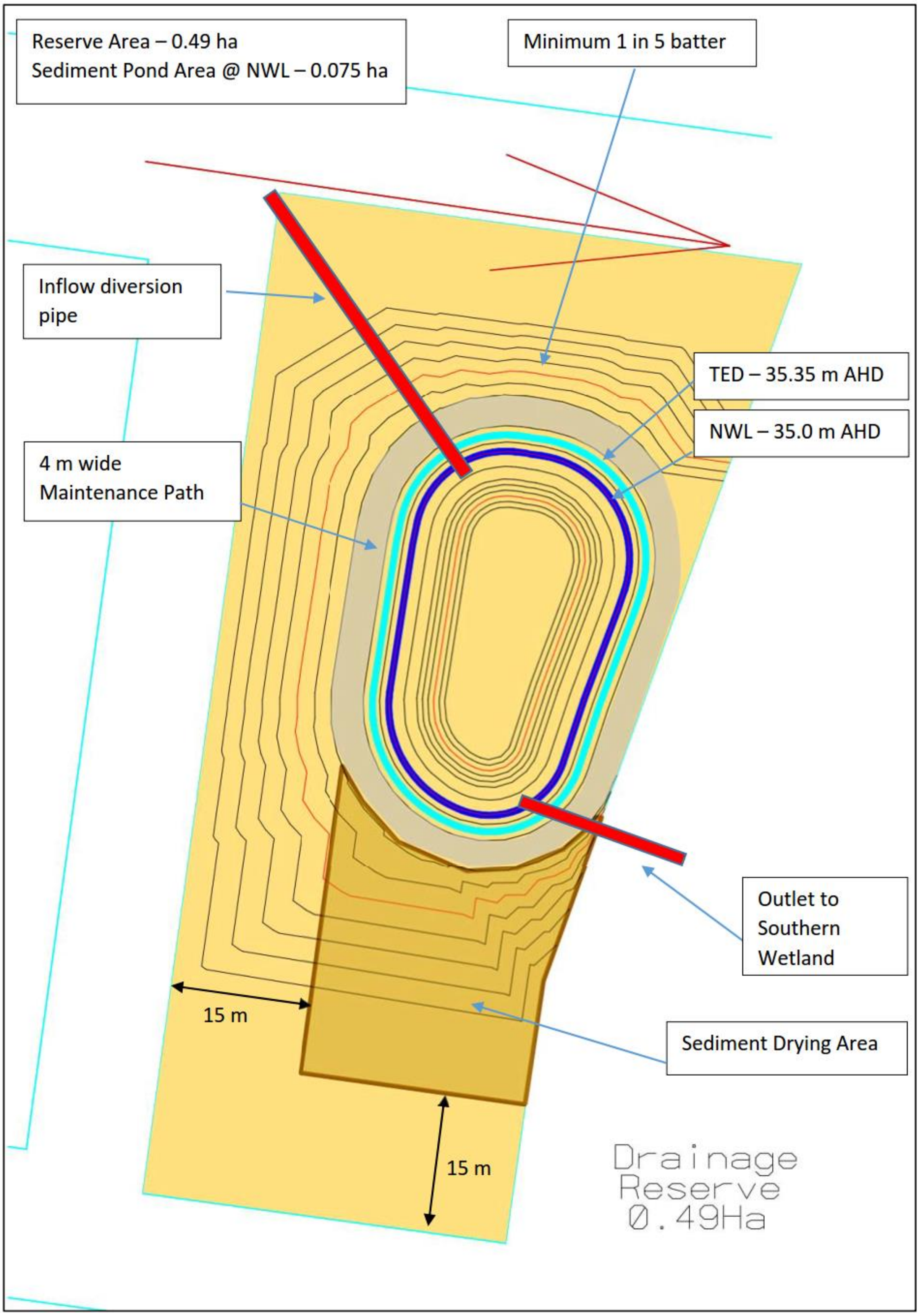

Figure 10-5 South-Eastern Sediment Design

11. WETLAND LAYOUT AND DESIGN INTENT

Figure 11-1 to Figure 11-4 illustrate the general layout of the North and South Wetlands.

The North Lake and South Lake are proposed to be modified to cater for the proposed wetland macrophyte zones. The Normal Water Levels of the two lakes have been adjusted to 100 mm below the Normal Water Levels of the adjacent wetlands.

Water balance modelling has determined the likelihood of the lake system drowning the wetland systems. The result of the water balance modelling (undertaken in EPA SWMM for 10 years of relevant daily data) has shown that the number of days where the lake water levels exceed the wetland normal water levels is 6 days for the North Wetland and 5 days for the South wetland. These low exceedance values illustrate that the lakes system will have little hydraulic impact on wetland water levels. Further details on the water balance modelling are provided in Appendix E.

Figure 11-1 North Wetland Plan

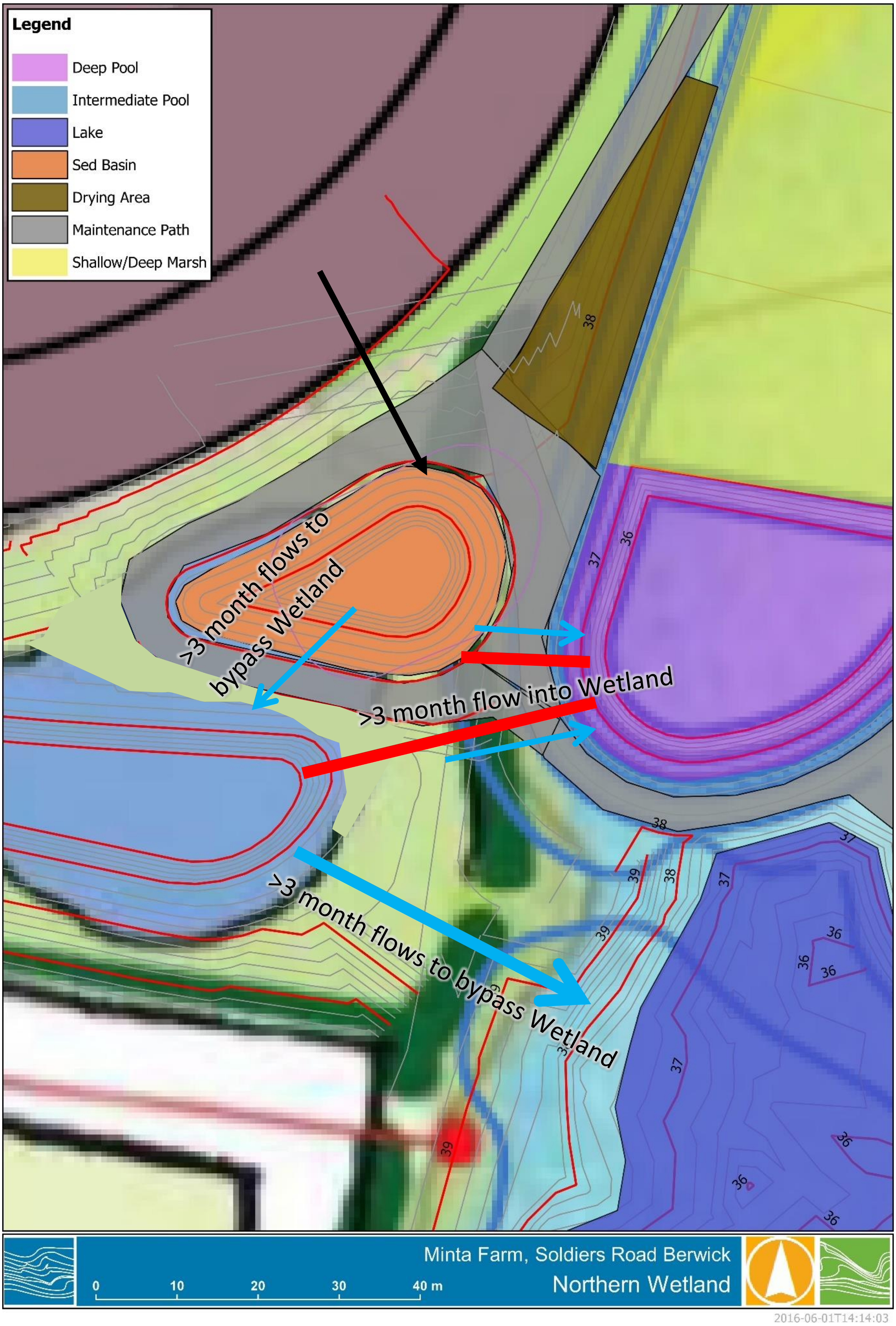

Figure 11-2 North Wetland Inlet Configuration

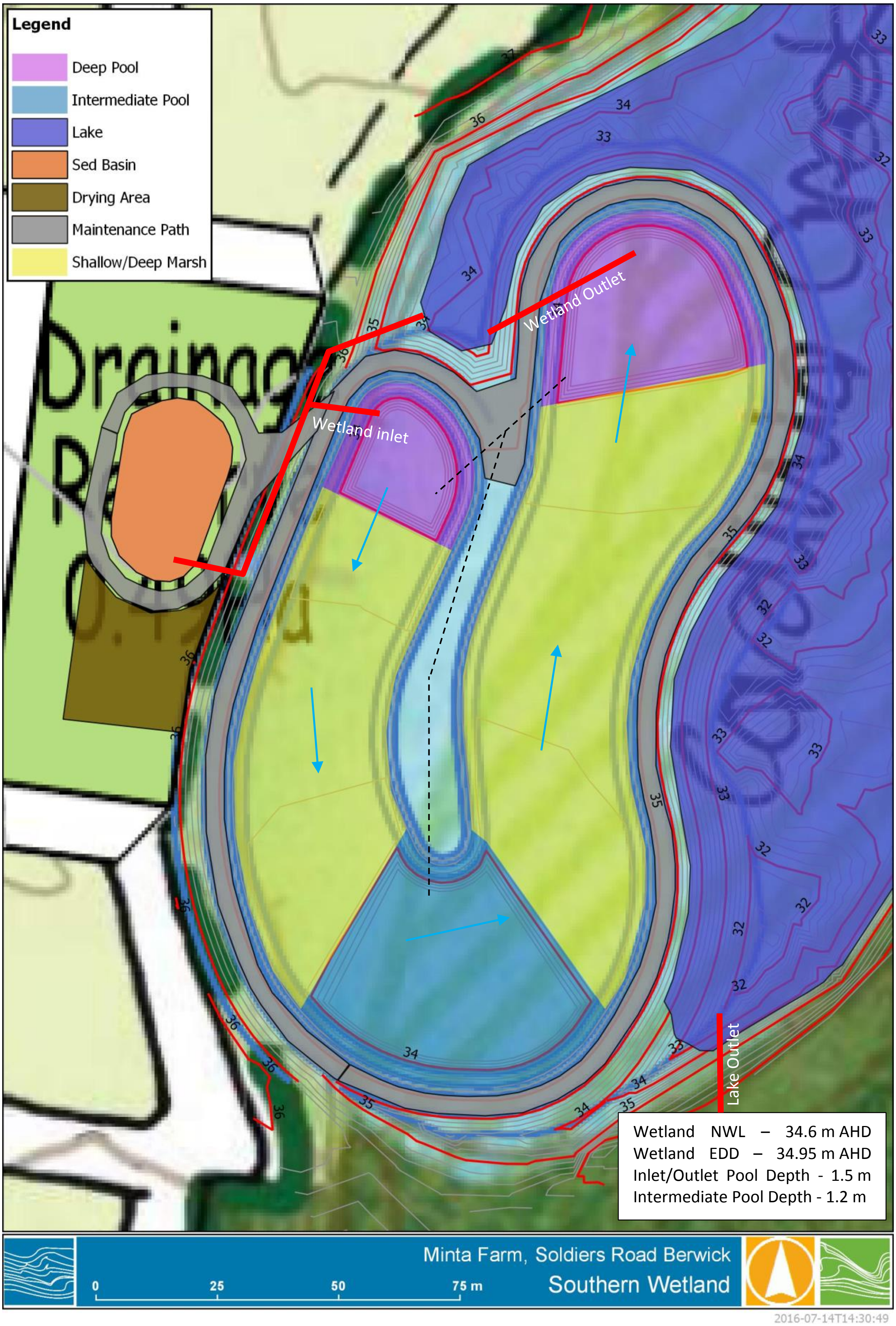

Figure 11-3 South Wetland Plan

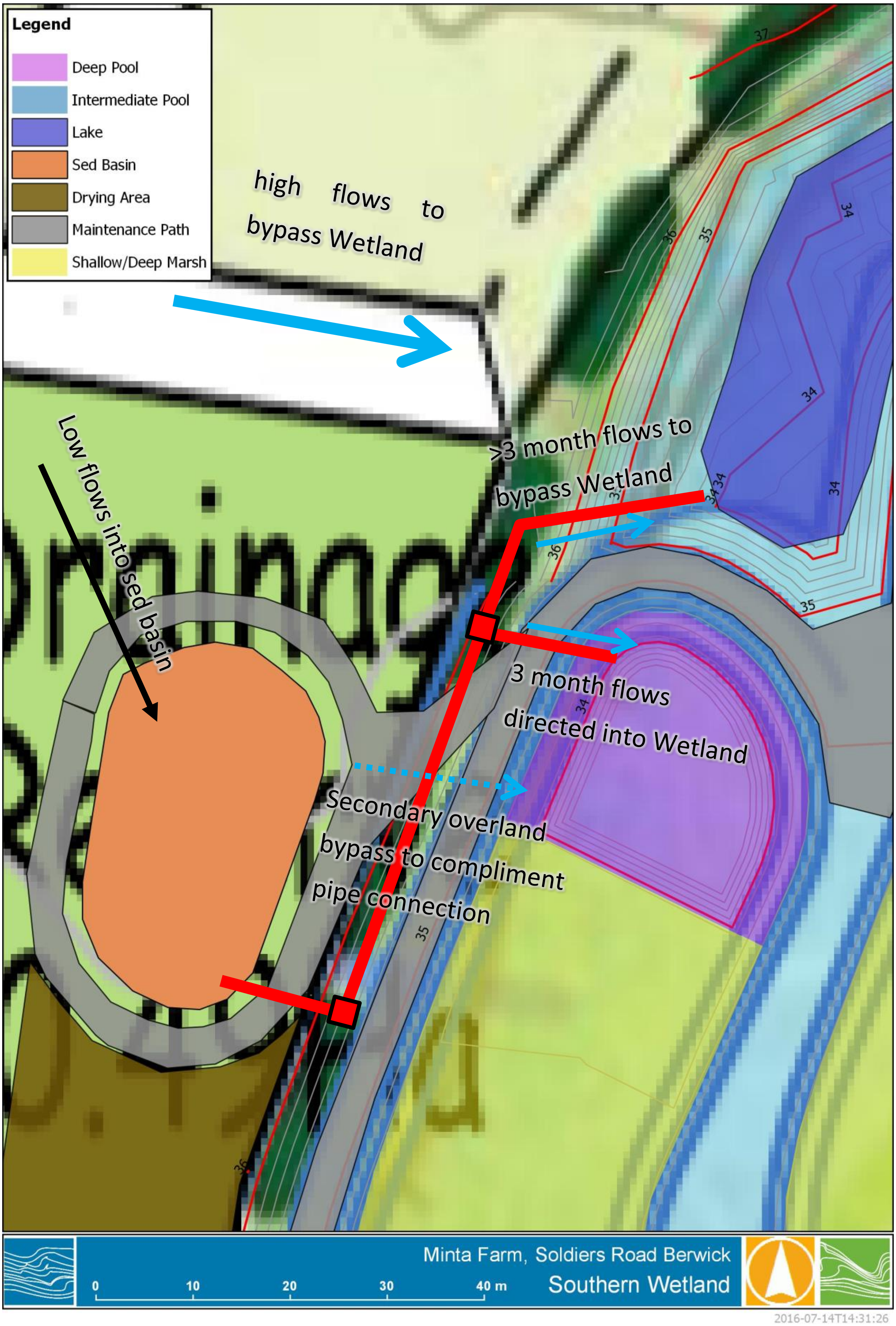

Figure 11-4 South Wetland Inlet Configuration

12. DEEMED TO COMPLY STATEMENT

Melbourne Water's Conceptual Design Deem to Comply checklist has been followed for the two wetland designs. These checklists can be found in Appendix A.

13. MODIFIED LAKE ARRANGEMENT AND LAKE TURNOVER ANALYSIS

The proposed stormwater management strategy has resulted in significant modification of the existing lake system at the Minta Farm. Figure 13-1 shows the current general lake arrangement alongside the newly proposed lake arrangement. Table 13-1 outlines the proposed changes in lake properties from existing conditions.

The north-east lake is currently fed from overflows from the northern lake, with the potential to continue this arrangement from the proposed northern wetland. Another alternative would be to reconnect this lake system back to the Cardinia Creek Floodplain to allow an ephemeral billabong system to be reinstated. Final design options for the north east lake have not been extensively explored as part of the drainage strategy as it does not influence the functionality of the overall Minta Farm drainage strategy. The final outcome of the north-east lake could be dependent on the potential ecological values within the lake area.

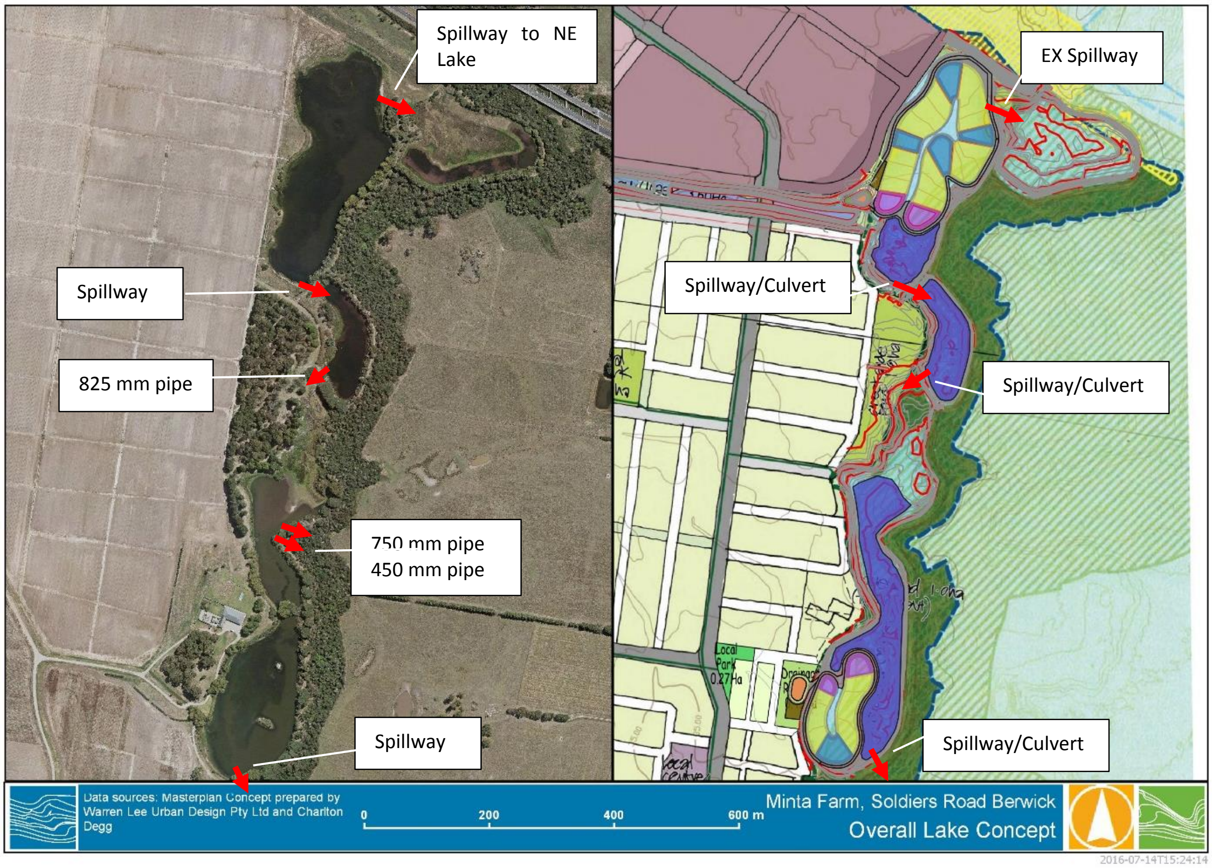

Figure 13-1 Existing Lake Arrangement Vs Proposed Lake Arrangement

Table 13-1 Existing Vs Proposed Lake Arrangment

		Existing Lake Arrangement	Proposed Lake Arrangement
North-east Lake NWL	m AHD	NA	NA
North-east Lake outlet		no outlet	no outlet
North-east Lake Volume at NWL	m^3	9,950 @ 1.6 m Depth	9,950 @ 1.6 m Depth
Northern Lake NWL	m AHD	38.2	37.25
Northern Lake outlet		Spillway @ 38.2, Spillway @ 38.5 to NE Lake	Spillway/culvert at 37.25
Northern Lake Volume at NWL	m^3	78,500	9,200
Middle Lake NWL	m AHD	36.3	36.3
Middle Lake outlet		825 mm dia pipe at 36.3 plus spillway @ 37.77	825 mm dia pipe at 36.3 plus spillway @ 37.77
Middle Lake Volume at NWL	m^3	13,300	13,300
Southern Lake NWL	m AHD	34.5	34.45
Southern Lake outlet		750 mm dia pipe at 34.5, 450 mm dia pipe @ 35.0, spillway at 35.6	spillway/culvert at 34.45 at southern end of Lake
Southern Lake Volume at NWL	m^3	45,900	30,000

The modified lake systems has been analysed through MUSIC modelling to determine lake residence times. The methodology outlined in the latest draft *Melbourne Water Constructed Wetland Guidelines* has been utilised to produce the residence time estimates. The results of the residence time calculations are shown in Figure 13-2 through to Figure 13-4 and summarised in Table 13-2.

The results of the turnover analysis illustrate that the modified lakes system are likely to have a low risk of algal blooms according to the scenarios listed in Table 1 of Melbourne Water's *Constructed Shallow Lake Systems* guidelines (2005). The significant flushing flows relative to lake volume and the subsequently reduced residence times are illustrated in the figures and table below.

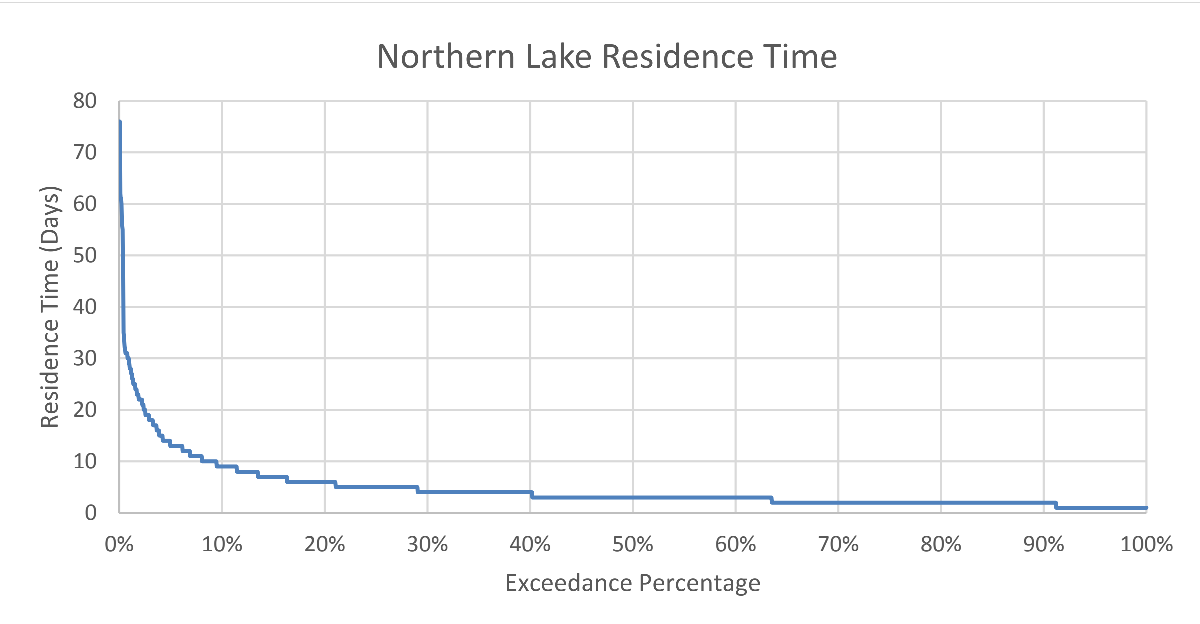

Figure 13-2 North Lake Residence Time

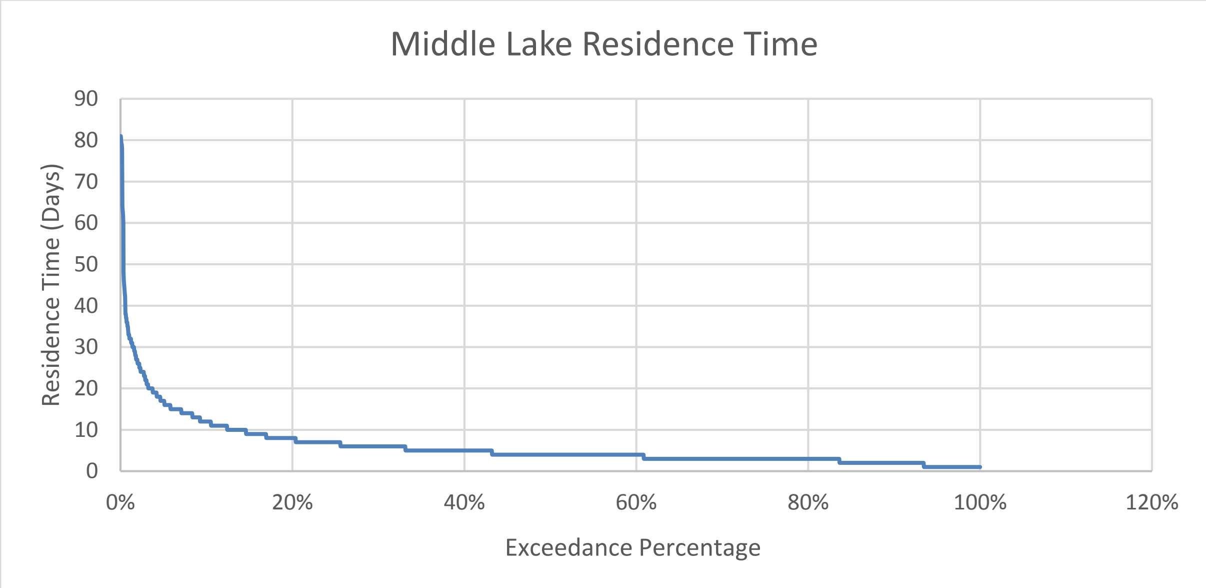

Figure 13-3 Middle Lake Residence Time

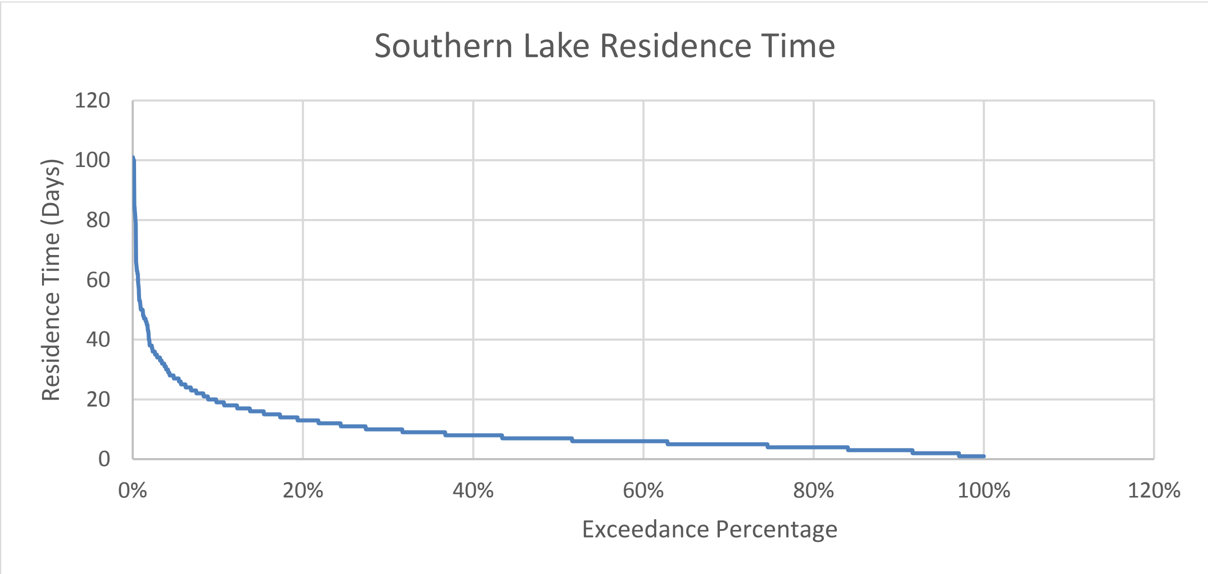

Figure 13-4 South Lake Residence Time

Table 13-2 Lake Residence Times

	80% Residence time
North Lake	6 days
Middle Lake	8 days
South Lake	13 Days

14. WATER BALANCE MODELLING

Lake inflows were obtained from a MUSIC model of the north and south catchments, with inflows modelled from pluviographic rainfall records for a 10 year period (1971 to 1980) from the nearby Koo Wee Rup gauge. An EPA SWMM model was created for the proposed wetland and modified lake system to simulate the hydraulic interaction between the ponds and wetlands, and also account for evaporation and seepage.

The water balance plots for the North, Middle and South Lakes are shown in Appendix E. These results suggest there will be ample inflow volume to sustain water levels within the modified lake system to an acceptable range.

15. PRELIMINARY ANCOLD 'HAZARD ASSESSMENT'

An initial ANCOLD assessment has been undertaken for the existing lake embankments within the Minta Farm property with the full analysis shown in Appendix K. The 'Initial Assessment' approach defined all four lakes as having a 'Very Low' Consequence Category. Based on these findings, no further detailed consequence assessments are deemed necessary.

These findings should be used to guide the discussions on the management and design safety standards for the lakes. Given the lakes 'Very Low' consequence category, the 1% or 0.1% AEP flood event would typically be selected as the fall back upper limit for design standards.

16. CONCLUSION

This report combines and builds on the work previously undertaken by Water Technology and Charlton Degg and provided to MPA and Melbourne Water over the past 10 months. The following has been achieved:

1. Extensive consultation with Melbourne Water, MPA and more recently the City of Casey.
2. Survey of the overall site, site inspections, and a level and feature survey of the lake beds and all land areas where drainage scheme assets are proposed.
3. Extensive external and internal catchment analysis.
4. Preparation of a Concept Masterplan to comply with the objectives of PSP 11 and illustrate the key elements of the Storm Water Management Strategy beneficially utilising the existing lakes and assuring their sustainability in modified form.
5. Overland Flow Layout and Analysis.
6. Sediment Pond Design and Analysis.
7. Baillieu Creek Constructed Waterway Design and Analysis.
8. Constructed Wetlands Design and Analysis.
9. MUSIC modelling.
10. Lake Turnover Analysis.

Best practice water quality treatment can be achieved for the Cardinia Creek Catchment through the provision of constructed wetlands within the existing lakes footprint. The existing lakes (as modified) will remain viable and sustainable.

Significant areas of open lake area will remain and provide additional water quality “polishing” effects critical for the sensitive Westernport Catchment Area.

Substantial amenity and connection with the existing landscape will be maintained through the incorporation of the existing lakes into the future development of the site. The Cardinia Creek Masterplan vision for the Clyde North PSP immediately south of the site will be enhanced.

Constructed sediment ponds and wetlands will ensure Best Practice water quality treatment standards are achieved prior to stormwater discharging to the balance of the lakes system and ultimately Cardinia Creek. This, along with the rate of lake turnover from catchment inflows will ensure water quality within the lake system remains high. The additional polishing of catchment runoff through the balance of the lakes system in the form of additional sediment removal and residence time will ensure that SEPP F8 requirements are met and potentially exceeded for the Cardinia Creek (Western Port) catchment.

The incorporation of the existing lake system (with embedded wetlands) as an integral component of surface water management for PSP 11 and will provide significant benefits to the overall amenity. The alignment of the stormwater treatment wetland system within the Cardinia Creek corridor will further enhance the biodiversity and waterway/floodplain values of the area.