Expert Opinion

Craigieburn West
Precinct Structure Plan

On Behalf of Submitter 29 (Peet Limited)

18th April 2021

Report by: **Michael Mag**
michael.mag@stormywater.com.au
www.stormywater.com.au
M 0401 861 301

Document Verification

Project Name	Craigieburn West PSP Expert Evidence
Client Contact	HWL Ebsworth Lawyers on behalf of Peet Limited
SWS Project Number	2107
Document Name	2107_SWS_Expert_Evidence_Peet_18Apr21

Document History

Issued To	Date	Version	Author	Reviewer
HWL Ebsworth	18/4/2020	V1	M. Mag	V. Mag

Accreditation

Michael Mag

- Bachelor of Engineering – Civil (Honours) 2016
- Bachelor of Science – Applied Mathematics 2016
- Master of Advanced Civil Engineering (Water) 2020

Valerie Mag

- Bachelor of Engineering (Honours) 1989
- Master of Engineering Science 1993
- Registered as a Professional Engineer (Civil and Environmental Engineering), National Engineering Register (Engineers Australia).

Climate Change Statement

Unless otherwise stated, the information in this report does not take into consideration the current understanding of climate change and its consequences on our current engineering practices. This may lead to a under (or over) estimation of hydrological calculations and as such may result in under (or over) design of aspects of this design compared to a design in which climate change is considered.

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Contents

1 Report Author

Michael Mag

Senior Hydrological Engineer

Stormy Water Solutions

PO Box 3313

Wheelers Hill 3150

Qualifications

o	Bachelor of Engineering – Civil (Honours)	2016
o	Bachelor of Science – Applied Mathematics	2016
o	Master of Advanced Civil Engineering (Water)	2020

Affiliations

- Committee Member of Stormwater Victoria 2020/2021.

Area of Expertise

- Hydrology, Hydraulics and Water Sensitive Urban Design;
- Concept and functional design of drainage infrastructure including retarding basins large, vegetated channels, sediment ponds, treatment wetlands and stormwater harvesting schemes.
- Preparation of Precinct Structure Plan drainage strategies and Melbourne Water Drainage Schemes;
- Stormwater industry trainer;
- GIS software applications.

Statement of Expertise

With my qualifications and experience, I believe that I am well qualified to provide an expert opinion on drainage matters to the standing advisory committee.

2 Report Contributors

Valerie Mag

Principal

Stormy Water Solutions

PO Box 3313

Wheelers Hill 3150

Qualifications

- Bachelor of Engineering (Honours), Monash University 1989
- Master of Engineering Science, Monash University 1993

Affiliations

- Registered as a Professional Engineer (Civil and Environmental Engineering), National Engineering Register (Engineers Australia).
- Member of Stormwater Victoria.

Area of Expertise

- Hydrology, Hydraulics and Water Sensitive Urban Design
- Concept and functional design of drainage infrastructure including retarding basins, large vegetated channels, sediment ponds, treatment wetlands and stormwater harvesting schemes.
- Preparation of drainage strategies and Melbourne Water Drainage Schemes
- Stormwater Industry Trainer
- Expert witness for drainage and flood related issues at planning panels and VCAT hearings.

Scope of contribution

Valerie assisted in the review of the report and attended the site visit.

3 Scope of Report

This report pertains to the drainage infrastructure reserve land take required to facilitate the development of 1340, 1390, 1430, 1480 Mickleham Road & 665 Craigieburn Road, Craigieburn (the **Subject Site**) within PSP 1068 - Craigieburn West Precinct Structure Plan (the **PSP**) is adequate.

Drainage reserve requirements would generally be set as per the applicable Melbourne Water Corporation (**MWC**) Drainage Scheme (**DS**). In this case the two applicable schemes are Aitken Creek DS 4480 and Upper Brodies Creek DS 4381. However, in the subject site there is also a '**Gap**' Catchment which is outside of any applicable MWC DS.

Two drainage strategy options are examined in this report being:

Option 1: As shown within the proposed Craigieburn West, Craigieburn, Concept Plan, Peet for the subject site (the **Peet Master Plan**) (reproduced in Addendum A) with Gap catchment assets split between different landowners; or

Option 2 Generally as shown within the proposed Craigieburn West, Craigieburn, Concept Plan, Peet for the subject site (the **Peet Master Plan**) (reproduced in Addendum A) except with one 'shared' Gap catchment asset (as per the proposals detailed in Addendum B).

The subject site is specified in Table 1 below.

Table 1 Specific details of the subject site

Street Address	Total Area (ha)	PSP Property ID
1340 Mickleham Road, Craigieburn	11.73	34
1390 Mickleham Road, Craigieburn	13.98	31
1430 Mickleham Road, Craigieburn	11.08	30
1480 Mickleham Road, Craigieburn	12.76	28
665 Craigieburn Road, Craigieburn	12.19	29

In relation to the above, I have been engaged on behalf of Peet Limited (**Peet**) to act as an independent expert on drainage and flooding issues relevant to the development of the subject site within the PSP.

My instructions are as detailed in Section 14 of this report.

Notwithstanding, my expert opinion only relates to the subject site (as specified within Table 1), unless specifically stated within this report.

4 Summary of Findings

It is my opinion that the Stormy Water Solutions (**SWS**) Peet 2020 SWMS (Addendum C) and the Gap Catchment Shared Asset Memo (Addendum B) are the only documents provided to (or by) the Victorian Planning Authority (**VPA**) at this stage that have demonstrated the necessary calculations to enable the allocation of reserve allocations within the subject site.

Through ongoing collaboration with the MWC, the drainage reserve required within the Aitken Creek DS (DS 4480) at location A5 (PSP location ACSB-08) is 2.0 ha (as confirmed within the correspondence in Appendix A) and should be updated in the PSP and Peet Master Plan to reflect this 2.0 ha land take.

It appears gap catchment drainage design development within the subject site has largely been overlooked by the PSP process to date.

Currently the Peet 2020 SWMS and the Peet Master Plan split the required assets within the gap catchment across two drainage reserve allocations (Option 1). Subject to ongoing negotiations between landowners, it may be possible to combine the split assets within the gap catchment into one reserve allocation (Option 2).

In my opinion, a shared gap catchment asset (Option 2) would be the preferable way of servicing the gap catchments hydrological requirements. This option results in less overall land take and is expected to have smaller ongoing maintenance requirements for Council. However, either option would be able to meet the required drainage performance targets.

Under Option 1, it is my opinion that the Peet Master Plan is generally providing appropriate drainage reserve land take allocations on the subject site. Thus, the Peet Master Plan would be suitable for implementation within the PSP's Integrated Water Management Strategy with minor amendments.

Under Option 2, I advise that the Peet Master Plan would require a revision to combine the two drainage reserves in the Gap catchment. Once revised, it would be suitable for implementation within the PSP's Integrated Water Management Strategy.

There is also scope to undertake further design development (a detailed scenario/impact analysis and/or Porter Davis Pty Ltd completing catchment augmentations) of the gap catchment asset which (under either option) may reduce the Gap catchment drainage reserve allocation from that recommended within the Gap Catchment Shared Asset Memo (Addendum B).

On review of the relevant PSP submissions, all significant issues are either suitably addressed within the Peet 2020 SWMS and the Peet Master Plan, or subject to ongoing discussions between relevant parties. As such it is my opinion that no relevant submission made to the VPA regarding the subject site precludes the adoption of any of the Peet 2020 SWMS, the Gap Catchment Shared Asset Memo or the Peet Master Plan within the PSP (with minor amendments).

5 Basis of the Report

This report focuses on the required drainage infrastructure land take required to facilitate the development of the subject site. My findings are based primarily on:

1. Craigieburn West Storm Water Management Strategy, 25th September 2020, Stormy Water Solutions (the **Peet 2020 SWMS**), developed by myself, including the models developed as part of this report (reproduced in Addendum C);
2. The Craigieburn West, Craigieburn, Concept Plan, Peet for the subject site (the **Peet Master Plan**) (reproduced in Addendum A);
3. The 12/4/21 memorandum from myself to Barbara Oh of Peet Limited detailing a shared gap catchment proposal as provided in Addendum B (the **Gap Catchment Shared Asset Memo**);
4. Craigieburn West PSP: Integrated Water Management Issues and Opportunities, March 2019, Alluvium, (the **2019 Alluvium IWM**);
5. Aitken Creek Waterway Values Assessment, December 2020, Jacobs, Melbourne Water (the **2020 Jacobs Assessment**);
6. The Melbourne Water Corporation (**MWC**), April 2017 Drainage Scheme (**DS**) plans for:
    a. Aitken Creek, DS 4480, and
    b. Upper Brodies Creek, DS 4381.
7. The following PSP 1068 - Craigieburn West Precinct Structure Plan submissions:
    a. Environmental Protection Authority Submission, PSP Submission 13, 15th December 2020;
    b. Hume City Council, PSP Submission 17, December 2020;
    c. SMEC on behalf of Porter Davis Pty Ltd, PSP Submission 24, 18th December 2020;
    d. The Melbourne Water Corporation, PSP Submission 25, 18th December 2020; and
    e. Peet Limited, PSP Submission 29, 18th December 2020;
8. Aston West Engineering Services Report, November 2018, Cossill & Webley Consulting Engineers (the **2018 ESR**); and
9. Craigieburn West Precinct Structure Plan Post-Contact Heritage Assessment, Ecology and Heritage Partners Pty Ltd, 25th January 2019 (the **PSP Heritage Assessment**).

Further, I have relied on:

- Additional publicly available information, including LiDAR, Nearmap and Vic Map information;
- The following standards, manuals, or guidelines:
    - Australian Rainfall and Runoff (**ARR**) 2019, Geoscience Australia;
    - The flowing Melbourne Water Corporation (**MWC**) Manuals and Guidelines:
        - WSUD Engineering Procedure: Stormwater Melbourne, 2005;
        - Constructed Wetlands Design Manual, 2017;
        - MUSIC Guidelines, Input parameters and modelling approaches for MUSIC users in Melbourne Water's services area, 2018; and

- Flood Mapping Projects Guidelines and Technical Specifications Version 9: Final, 2018;

- A site visit performed by myself and Valerie Mag on the 25/09/2019.

I would also like to acknowledge that numerous other PSP submissions (15, 16, 18, 19, 20, 26, 27, 28, 31, 33, 34 and 38) relate to drainage matters. However, these matters are generally for parcels north of Craigieburn Road or relate to Greenvale Reservoir protection works and do not directly affect the drainage infrastructure requirements of the subject site. As such, these submissions are not referred to within my evidence.

6 Overview of the Proposed Peet 2020 SWMS

The full Peet 2020 SWMS is provided in Addendum C. The sections below further detail specific aspects of the Peet 2020 SWMS as instructed.

6.1 Existing Site and Catchment Description

When discussing the drainage of the subject site, it is also best to include the 1360-1370 Mickleham Road (PSP properties 32 and 33) in the discussion as the subject site bounds these landholdings as shown in Figure 1. It is my understanding 1360-1370 Mickleham Road is currently under the control of Porter Davis Project Pty Ltd and is the subject of PSP submission 24.

From Figure 1 (which is based on the MWC DS plans), the expanded subject site (i.e. the subject site including 1360-1370 Mickleham Road) currently drains into three distinct catchments being:

- An Aitken Creek DS 4480 catchment = 39.8 ha of which:
  - Subject Site = 39.8 ha
  - 1360-1370 Mickleham Road = 0.0 ha
- An Upper Brodies Creek DS 4381 catchment = 10.7 ha of which
  - Subject Site = 8.2 ha
  - 1360-1370 Mickleham Road = 2.5 ha
- A 'Gap' Catchment outside of any MWC DS = 19.4 ha of which
  - Subject Site = 13.8 ha
  - 1360-1370 Mickleham Road = 5.6 ha

Currently, the subject site is zoned either FZ3 or UGZ. The subject site is also not currently covered by any drainage overlays (i.e. Land Subject to Inundation, Special Building or Floodway).

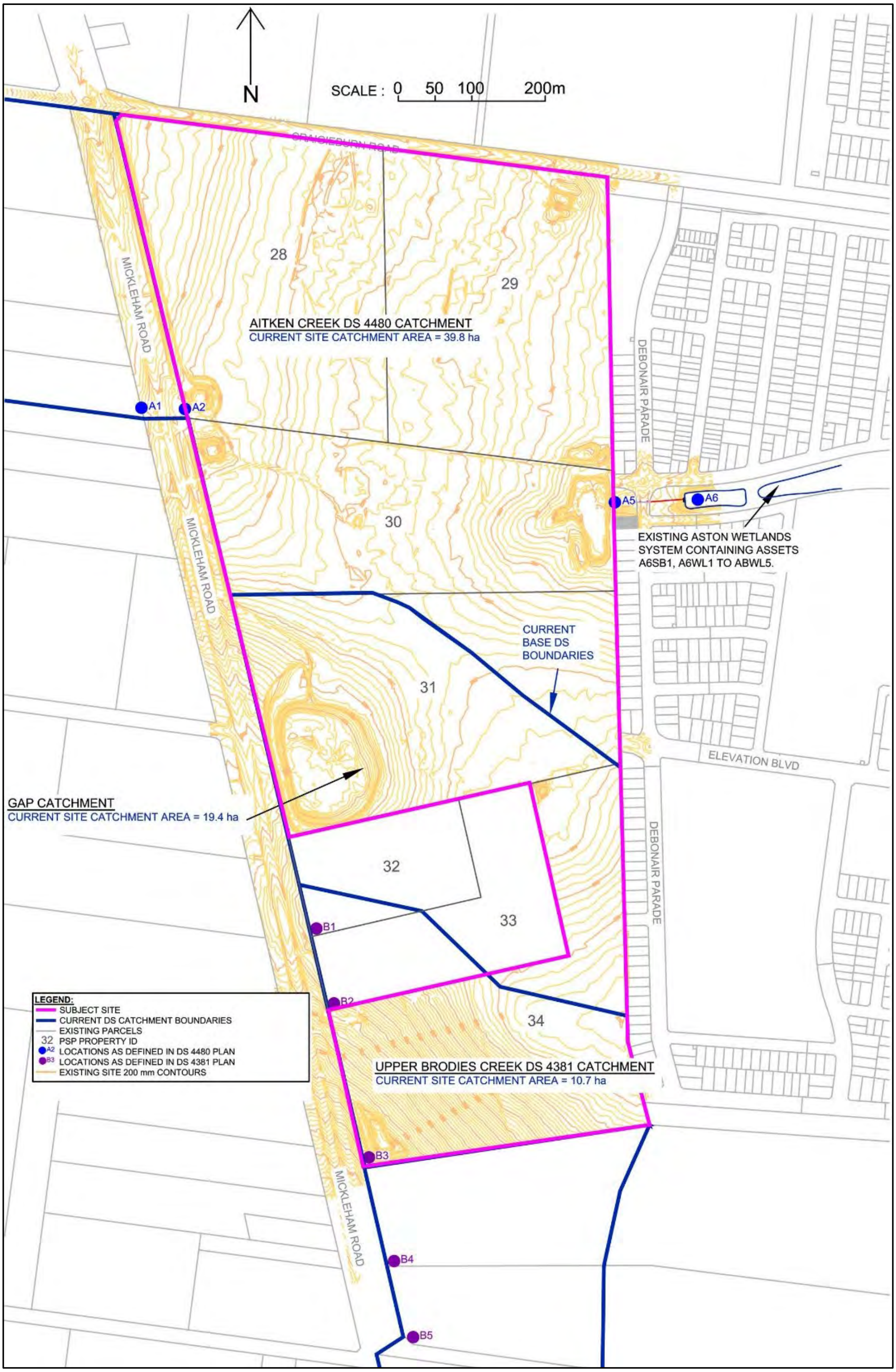

Figure 1 Existing Site Catchment Conditions

6.2 Servicing Proposal for the Subject Site

The Peet 2020 SWMS (attached as Addendum C to this report) details the full SWMS for the subject site.

Generally, it is proposed to undertake earthworks (as detailed within the 2018 ESR, that do not affect the development potential of 1360-1370 Mickleham Road) on the subject site to regrade approximately 6.9 ha of the gap catchment into the Aitken Creek DS region and approximately 0.4 ha of the gap catchment into the Upper Brodies Creek DS region. An overview of the Peet 2020 SWMS is reproduced in Figure 2.

A 0.4 ha change within the Upper Brodies Creek DS region has negligible effects on the servicing proposals with this catchment.

The extra 6.9 ha into the Aitken Creek DS region slightly increases the required drainage reserve land take estimate at location A5 of the Aitken Creek DS from 1.6 ha (original boundaries) to 2.0 ha (proposed boundaries).

I do note, that the Peet 2020 SWMS proposed a 2.1 ha land take at location A5 of the Aitken Creek DS. However, ongoing discussions with MW have resolved that a 2.0 ha land take at A5 of the Aitken Creek DS is appropriate (see Appendix A.2).

The significant benefits of the catchment change are seen on the required drainage reserve land take estimates within the gap catchment. This is discussed in further detail within Section 6.3 below.

For clarity, the proposed catchment augementations presented within the Peet 2020 SWMS are detailed in Table 2. It should be noted that the exact size of each catchment may (and are expected to) slightly change from the Peet 2020 SWMS as development layouts are updated.

Table 2 Proposed Catchment Delineations within the Peet 2020 SWMS

Catchment		Original 'Base Case' DS Area	Proposed SWMS DS Area	Change[2.]
Aitken Creek DS 4480		39.8 ha	46.7 ha	+ 6.9 ha
Upper Brodies Creek DS 4381		10.7 ha	11.1 ha	+ 0.4 ha
Gap	**Subject Site**	13.8 ha	6.6 ha	- 7.2 ha
	1360-1370 Mickleham Road[1.]	5.6 ha	5.6 ha	0 ha

Notes: [1.] *Catchment areas include 1360-1370 Mickleham Road (which is outside of the client's control).*
[2.] *Small rounding errors result in the sum of the changes not equalling zero.*

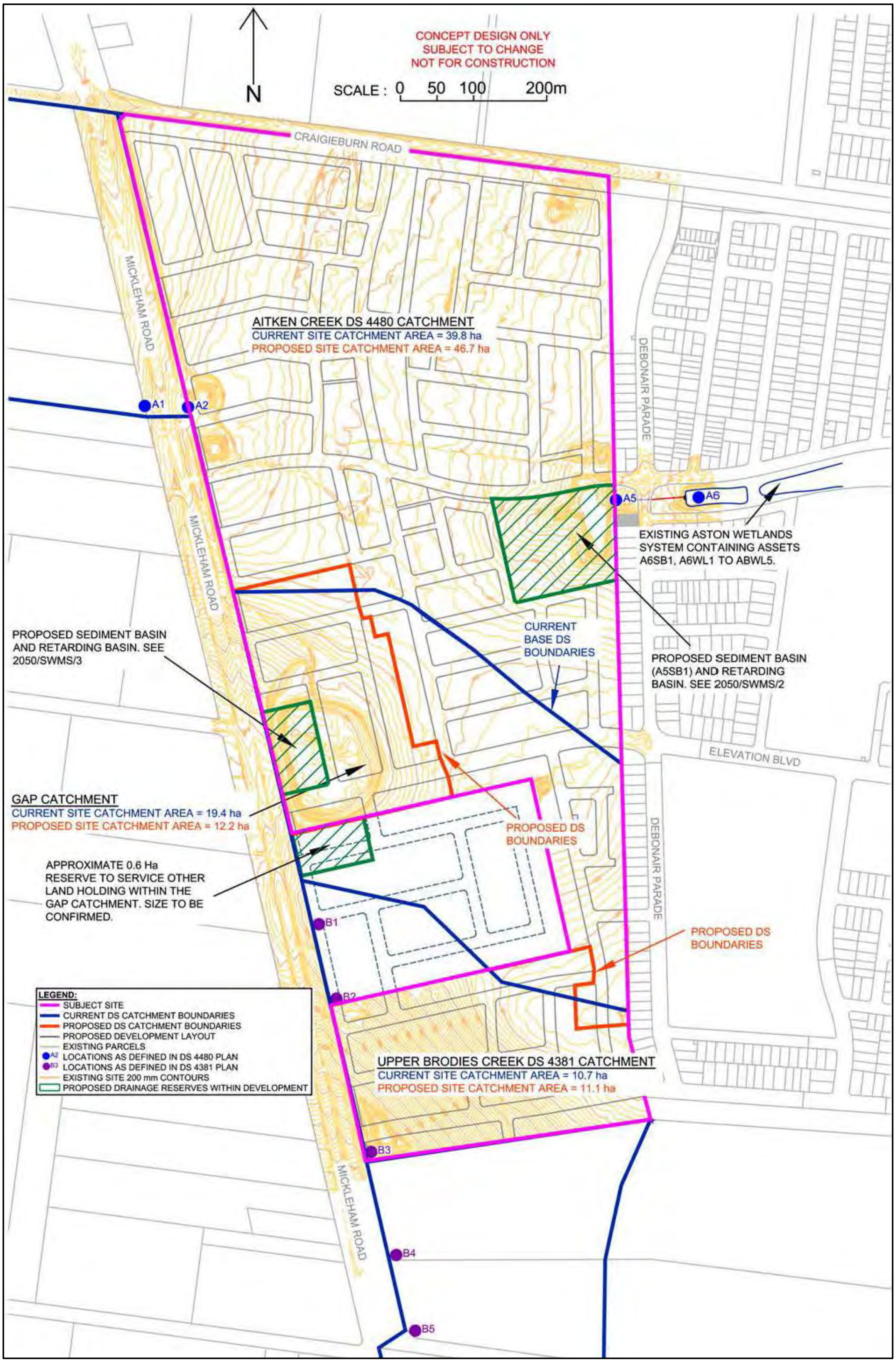

Figure 2 **Craigieburn West - Proposed Catchment changes as per the Peet 2020 SWMS (development layout subject to change)**

6.3 Gap Catchment Specific Comments

6.3.1 Design Targets

The gap catchment is currently not within any formal MWC DS. Given my analysis of the available PSP background documentation (see Section 8), it appears as though prior to the Peet 2020 SWMS there was no formal, documented, stormwater management strategy or plan which was developed as part of the PSP process for the gap catchment.

Development within this catchment is required to be designed to meet clause 56.07-4 of the Victorian State Planning Provisions. Particularly Standard C25 which states:

> *"The stormwater management system must be:*
>
> - *Designed and managed in accordance with the requirements and to the satisfaction of the relevant drainage authority.*
> - *Designed and managed in accordance with the requirements and to the satisfaction of the water authority where reuse of stormwater is proposed.*
> - *Designed to meet the current best practice performance objectives for stormwater quality as contained in the Urban Stormwater - Best Practice Environmental Management Guidelines (Victorian Stormwater Committee, 1999).*
> - *Designed to ensure that flows downstream of the subdivision site are restricted to pre-development levels unless increased flows are approved by the relevant drainage authority and there are no detrimental downstream impacts.*
> - *Designed to contribute to cooling, improving local habitat and providing attractive and enjoyable spaces."*

Generally, the Peet 2020 SWMS takes the above to be two 'simple' targets for the gap catchment as a whole:

Target 1: Achieve Best Practice Environmental Management (**BPEMG**) stormwater treatment at the outfall across Mickleham Road; and

Target 2: 1% AEP post-development outflows are retarded to the capacity of the existing Mickleham Road culverts (0.35 m^3/s).

Currently there are two large farm dams at the gap catchment outfall on the boundary of the PSP region. These dams, though likely not up to current structural standards, have a significant flood storage capacity and are signficantly large (being approximatly 10% of the gap catchment area). Preliminary anlaysis has shown that they are likely to capture the entire 1% AEP runoff from the gap catchment. As such, rather than assume the dams are full when a flood occurs, I have (conservativly) assumed that, in the pre-development conditions, there is likely to be no flood runoff from the 19.4 ha of gap catchment crossing Mickleham Road and that the existing dams can capture the entire 1% AEP pre-development runoff.

I have assumed (in the Peet 2020 SWMS) that these dams should be included in any pre-development scenario as the 1938 Ordinance Plan of Sunbury shown within the PSP Heritage Assessment clearly shows a large dam (similar to the current largest dam) on the gap catchment at Mickleham Road.

I recognise that there may be the option to review the assumption that the existing dams capture the entire 1% AEP pre-development runoff from the gap catchment via a detailed scenario/impact analysis. However, in my opinion, Target 2 above is a conservatve assumption in regard to drainage reserve requirements. A conservative approach is required at the PSP stage to ensure that there are no adverse flood effects downstream (west) of Mickleham Road.

Subject to the above mentioned scenario/impact analysis, it may be possible to discharge at a rate greater than the 0.35 m^3/s assumed within Target 2. Given this, there may be the potential to reduce the gap catchment reserve allocations specified below as the drainage design proposals are developed further.

6.3.2 Option 1 - Split Assets

At the time of the Peet 2020 SWMS, to my knowledge, there was not a suitable cost sharing mechanism (for drainage works) within the gap catchment. As such, Peet advised SWS within the Peet 2020 SWMS to assume each landholder within the gap catchment was to manage their stormwater runoff independently. Thus, the servicing proposed within the gap catchment was a 'split' asset on each of Peet's and 1360-1370 Mickleham Road. This would then allow Peet, and the owners of 1360-1370 Mickleham Road to develop independently.

Within the Peet 2020 SWMS, the flow target for the two gap catchment reservations was scaled by the relative pre-development catchment area of each parcel resulting in a restricted outflow targets of:

- 0.25 m^3/s for the Subject Site and
- 0.10 m^3/s for 1360-1370 Mickleham Road.

The above is proposed to be achieved via separate assets on each landholding enabling independent development of each landholding as proposed in Figure 2.

The option 1 split gap catchment reserve allocations proposed are:

Subject Site	0.76 ha; and
1360-1370 Mickleham Road	0.60 ha (approx.).

6.3.3 Option 2 – Shared Asset

On the 9th of April 2021, I was advised to include a discussion within this evidence on the option of a singular, combined, shared gap catchment asset.

Addendum B details the Gap Catchment Shared Asset Memo which provides a high level concept design for a shared gap catchment asset.

With the assumptions made within the Gap Catchment Shared Asset Memo and to meet the targets specified in Section 6.3.1, a singular gap catchment asset would require a land take of 1.0 ha.

It is recognised that if:

- Porter Davis Pty Ltd are able reduce their gap catchment areas (similar to Peet's proposals) the above 1.0 ha allocation may be able to be reduced; and/or
- A detailed scenario/impact analysis is undertaken quizing the Target 2 assumption, it may be possible to discharge at a rate greater than 0.35 m^3/s and hence potentially reduce the reserve allocation further.

I do note that a drainage reserve (of some type) will always be required within the gap catchment to meet Target 1, even if the above two points are completed.

7 Gap Catchment Scenario Comparisions and Recommendations

7.1 Option 1 compared to Option 2

Comparing Option 1 (split gap catchment assets) to Option 2 (a singular gap catchment asset) shows that the required infrastructure is reduced by a singular asset.

Option 1 would be a total of 1.36 ha (approx.) of drainage reserve. Option 2 is a total drainage reserve of 1.0 ha.

This reduction in reserve size from Option 1 to Option 2 was always expected as when providing two assets, aspects such as batter requirements and minimum offsets are counted twice.

I expect Option 2 (singular asset) would also be preferable to Council as it would have less ongoing maintenance liabilities compared to two assets.

Provided an appropriate cost sharing mechanism implemented and/or agreement between the separate landholders within this catchment can be obtained, <u>I recommend that a singular gap catchment asset be provided (as per Option 2) to meet the hydrological requirements of the gap catchment</u>.

7.2 Option 1 compared to Split assets with no catchment augmentations

The base case scenario (no catchment augmentations) for the Gap catchment involves retaining the current MWC DS boundaries and split drainage reserve assets as defined within the Peet 2020 SWMS. The concept design of the required 1.41 ha reserve to service Peet's 13.8 ha of gap catchment in this scenario is shown in Figure 3.

The proposed case (performing catchment augmentations) as per the Peet 2020 SWMS involved catchment shaping to minimise the catchment area discharging to the Gap catchment outfall. The proposed case concept design of the required reserve to service Peet's 6.6 ha of gap catchment is provided in Figure 4. The proposed case drainage reserve requirement is 0.76 ha.

Clearly, by performing the catchment augmentation, Peet are significantly reducing the required land take estimate within the gap catchment.

I expect that this reduction in reserve and asset size would significantly reduce the ongoing maintenance liability for Hume City Council.

Furthermore, the proposed catchment changes are also expected to significantly reduce the total post-development volume of stormwater conveyed through downstream rural properties compared to what it would have been with the original DS boundaries.

I have not undertaken a scenario analysis of Option 2 compared to a singular asset with no catchment augmentation as this is outside my scope. However, I would expect that the catchment augmentation would be providing similar benefits within this scenario.

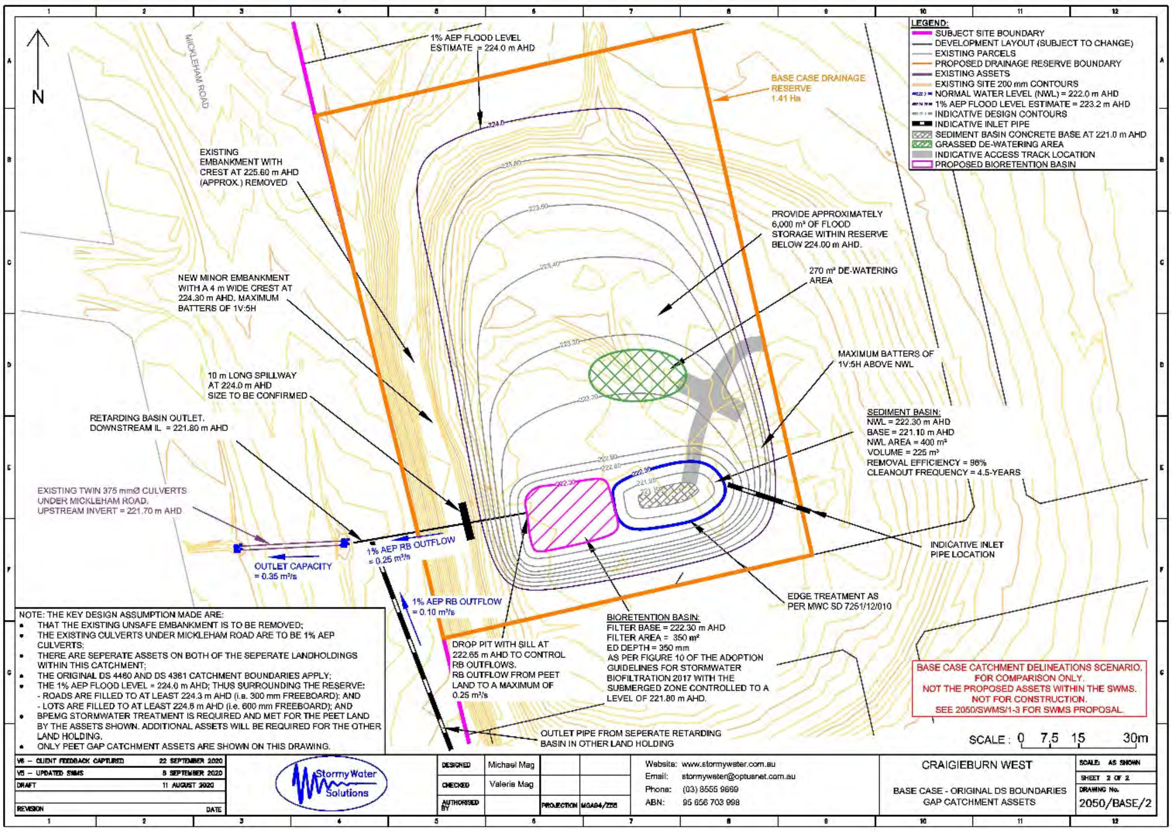

Figure 3 Peet 2020 SWMS, Base Case, Gap Catchment Reserve Concept Design

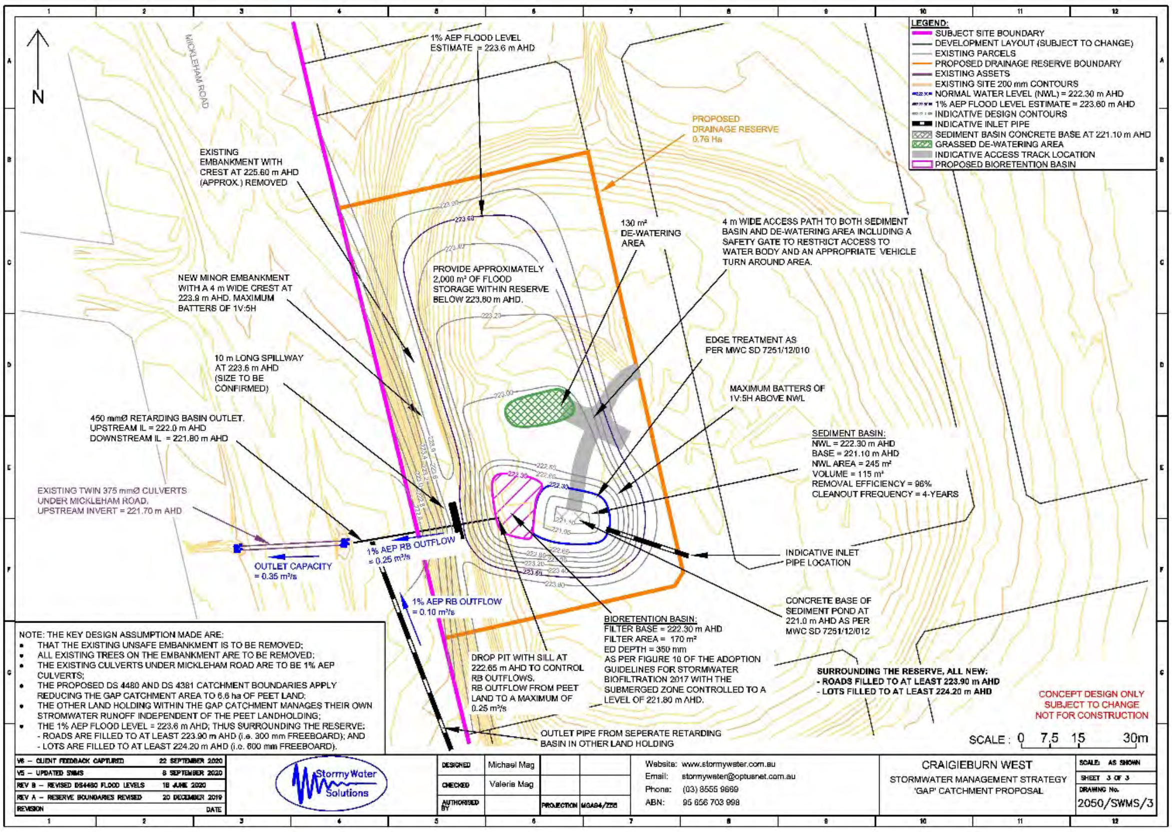

Figure 4 Peet 2020 SWMS, Proposed Case, Gap Catchment Reserve Concept Design

8 Review of other relevant PSP Background Studies

Two drainage related background studies were completed as part of the PSP:

- Aitken Creek Waterway Values Assessment, December 2020, Jacobs, Melbourne Water (the **2020 Jacobs Assessment**); and
- Craigieburn West PSP: Integrated Water Management Issues and Opportunities, March 2019, Alluvium, (the **2019 Alluvium IWM Report**).

The 2020 Jacobs Assessment concerns only land north of Craigieburn road and does not affect the land take servicing estimates within the subject site. As such, this document is not relevant to the subject site and I have not reviewed it in detail.

The 2019 Alluvium IWM Report is not an integrated water management plan (**IWMP**) (or strategy) for the PSP region. It does not detail how to service the region, only what issues and opportunities are present within the region.

P9 of the 2019 Alluvium IWM Report does state based on the provided MWC DS plans is that "*what can be observed is that there are no flood mitigation assets or wetlands recommended for the PSP*". However, clearly, as discussed within the Peet 2020 SWMS, flood mitigation assets are required within the PSP. In my opinion, this is a significant flaw in the 2019 Alluvium IWM Report as it largely neglects the gap catchment region and its requirements.

Further, the lack of a dedicated IWMP or drainage strategy in preparation of the PSP by the VPA is of concern to me. That is, I question how have the land take estimates generated within Plan 6 of the Draft PSP been formulated? Drainage design requires intertwined hydrologic, hydraulic, and stormwater treatment modelling along with consideration of site constraints to generate reasonable estimates of the reserve requirements. As it states in 'Next Steps' Section (section 7.1) of the 2019 Alluvium IWM Report:

> "*Where an identified priority action requires technical analysis, perform investigations such as determining feasibility by examining parameters like land take, cost and responsibility for design through ongoing management and maintenance.*"

The above referenced technical analysis in my opinion has not been provided by the VPA at this stage. Thus, there appears to be no suitable justification for the VPA's proposed drainage reserve land take estimates within the subject site.

9 Addressing Relevant PSP Submissions

9.1 Environmental Protection Authority Submission, PSP Submission 13, 15th December 2020

The EPA submission notes:

> *"that the draft PSP includes guidelines and a requirement for managing the risks associated with sodic and dispersive soils; designed to mitigate the potential risk for erosion and stormwater runoff impacts. The proposed schedule to the UGZ also includes the requirement for a 'sodic and dispersive soils management plan'.*
>
> *Whilst EPA has not undertaken a technical assessment as to whether the measures set out in these documents are adequate, we do support the inclusion of the requirement to manage the impact of sodic soils on nearby waterways in general terms."*

It is expected that a sodic and dispersive soils management may be required for the subject site. However, given that no waterways are proposed within the subject site, the effect of any potential sodic and dispersive soils within the subject site should be minimal, and be able to be suitably managed with the two sediment basins proposed within the Peet 2020 SWMS.

9.2 Hume City Council, PSP Submission 17, December 2020

The Hume City Council (**Council**) submission states (on Drainage):

> "*Council notes that Melbourne Water has undertaken a review of the three Drainage Services Schemes (DSS) affecting the Craigieburn West PSP, and the drainage infrastructure identified in Plan 6 and Table 3 of the PSP is based on this review.*
>
> *Council will engage with Melbourne Water during their consultation process for the proposed changes to the DSS to determine ownership and management responsibilities of the proposed assets.*
>
> *Council also acknowledges the area of land that is not within the catchment of a Melbourne Water DSS. The drainage requirements of this land are still to be resolved to the satisfaction of Melbourne Water and Council.*
>
> *Any proposed drainage review for this land should be done in consultation with all affected landowners and agencies, particularly where seeking alterations to DSS boundaries."*

As per correspondence from the MWC (Laurence Newcome, Precinct Structure Planning Coordinator, 18/02/21) which is reproduced in Appendix A.1:

> *"Melbourne Water has been working closely with the project team for Peet's Aston West Precinct for the past 18 months in the development and refinement of a drainage servicing strategy for their land-holdings and the corresponding sub-catchments.*

Peet's Aston West Precinct is partially serviced by the Aitken Creek and Upper Brodies Creek Development Services Schemes, however, there is also a small catchment which drains towards Mickleham Road, known as the "Gap Catchment". The Project Team have proposed minor changes in these catchment boundaries to create efficiencies in the delivery of this section of the Craigieburn West PSP and to minimise the impacts of urban flows on the areas downstream of Mickleham Road.

Following multiple iterations of the stormwater management strategy and supporting memos prepared by Stormy Water Solutions, Melbourne Water is generally in agreement with the intent of the outcomes proposed (including the scheme boundary changes), as it relates to our Development Services Schemes, noting that there are still ongoing discussions regarding the specific design parameters and land-take relevant to the small retarding basin and sediment pond proposed on the eastern boundary of this site.

Melbourne Water considers the "Gap Catchment" to be a local drainage catchment and therefore it should be managed by the local drainage authority (Hume City Council), noting that the combined catchment of 12.2 hectares it is much less than 60 hectares in size. It is understood that consultation with the other landowners is yet to be undertaken. Hume City Council is responsible for approving the drainage servicing outcome for the Gap Catchment."

Given the above, it is concluded that the MWC are generally supportive of the Peet 2020 SWMS and that the only outstanding matter for Council consideration is the drainage reserve land take requirements of the gap catchment.

As shown in Section 6.3, there are currently two options to service the gap catchment. Either Option can function and meet the required targets. Provided an appropriate cost sharing mechanism implemented and/or agreement between the separate landholders within this catchment can be obtained, I recommend that a singular gap catchment asset be provided (as per Option 2).

9.3 SMEC on behalf of Porter Davis Pty Ltd, PSP Submission 24, 18th December 2020,

This submission makes no direct mention of any drainage matters as the current draft PSP does not allocate any gap catchment assets on these landholdings.

However, as per the Peet 2020 SWMS (and as discussed in Section 6) above, these landholdings will be required to manage their stormwater runoff upstream of Mickleham Road and are expected to require a drainage reserve within their landholdings to achieve the appropriate targets in line with Clause 56.07-4 of the Victorian State Planning Provisions (Option 1) or contribute to a shared asset (Option 2).

Ongoing discussions are expected to be had with Porter Davis Pty Ltd regarding which gap catchment option is preferable.

9.4 The Melbourne Water Corporation, PSP Submission 25, 18th December 2020

Given the Correspondence provided within Appendix A, it is deemed that there are no outstanding issues for the MWC within the subject site given:

- All parties agree on a 2.0 ha Aitken Creek A5SB1 reserve allocation (PSP location ACSB-08); and
- The MWC is not concerned with management of the gap catchment (see Appendix A.1).

9.5 Peet Limited, PSP Submission 29, 18th December 2020

In my opinion, the Peet submission concisely relays the required changes in the Draft PSP to ensure that it is consistent with both the Peet Master Plan and the Peet 2020 SWMS (reflective of Option 1), being:

- *"Update Plan 6 (Integrated Water Management) to show revised Aitken Creek, Upper Brodies Creek and 'gap' drainage catchment boundaries.*
- *Amend Table 3 to increase the size of ACSB-08 size from 1.43 hectares to 2.1 hectares.*
- *Amend Table 3 to increase the 'gap' asset size from 0.52 hectares to include two assets, one of 0.76 hectares on Property 31 and the other 0.60 hectares on Property 32.*
- *Amend Plan 6 to show a 0.60 hectare drainage asset on Property 32 and increase the size of the drainage asset on Property 31 to 0.76 hectares.*
- *Remove the reference on Plan 6 to 'potential asset (no DSS)' and replace with 'drainage asset (no DSS)'.*
- *Update Requirement 13 to provide clear date reference to the Best Practice performance targets that must be met.*
- *Update Requirement 15 to include performance targets so compliance can be appropriately assessed*
- *Amend the Property Specific Land budget table to update the waterway & drainage reserve areas."*

It is however noted, that if the option of a singular gap catchment asset is adopted (Option 2) the above should change slightly. This is also the case for the slightly reduced agreed asset size of ACSB-08. As such, if Option 2 is adopted, I recommend above PSP changes should be reworded to (note the changes in *italic purple*):

- *"Update Plan 6 (Integrated Water Management) to show revised Aitken Creek, Upper Brodies Creek and 'gap' drainage catchment boundaries.*
- *Amend Table 3 to increase the size of ACSB-08 size from 1.43 hectares to 2.0 hectares.*
- *Amend Table 3 to increase the 'gap' asset size from 0.52 hectares to include a singular 1.0 ha asset on Property 31.*
- *Amend Plan 6 to increase the size of the drainage asset on Property 31 to 1.0 hectares.*

- *Remove the reference on Plan 6 to 'potential asset (no DSS)' and replace with 'drainage asset (no DSS)'.*
- *Update Requirement 13 to provide clear date reference to the Best Practice performance targets that must be met.*
- *Update Requirement 15 to include performance targets so compliance can be appropriately assessed*
- *Amend the Property Specific Land budget table to update the waterway & drainage reserve areas."*

10 Appropriateness of the Peet Master Plan

From the above, it can be seen that extensive analysis has been undertaken within the Peet 2020 SWMS (Addendum C) and the Gap Catchment Shared Asset Memo (Addendum B).

It is my opinion that the Peet 2020 SWMS and the Gap Catchment Shared Asset Memo are the only documents provided to the VPA at this stage that have demonstrated the necessary calculations that would enable the setting of reserve allocations within the subject site.

As previously stated, in my opinion, a shared gap catchment asset (Option 2) would be the preferable way of servicing the gap catchments hydrological requirements.

10.1 Under Option 1

Given the Peet Master Plan generally reflects the Peet 2020 SWMS, in my opinion the Peet Master Plan is providing suitable drainage reserve land take allocations. Thus, the Peet Master Plan would be suitable for implementation within the PSP's Integrated Water Management Strategy.

The only amendments I would make to the Peet 2020 SWMS or the Peet Master Plan is amending the ACSB-08 drainage reservation from 2.10 ha to 2.00 ha as discussed within Section 6.2 of this expert evidence statement.

I would recommend the following drainage reserve allocations be shown within the PSP (Plan 6 and Table 3 of the PSP) in this option:

- 2.00 ha allocation at ACSB-08 on PSP property 30;
- 0.76 ha allocation for the gap catchment on PSP property 31; and
- 0.60 ha allocation for the gap catchment on PSP property 32.

10.2 Under Option 2

The Peet Master plan should be updated under this option to incorporate:

- A 2.0 ha reserve allocation at ACSB-08 on PSP property 30; and
- A 1.0 ha reserve allocation within the gap catchment on PSP property 31.

I expect that the above would also be reflected within the PSP (Plan 6 and Table 3 of the PSP) in this option.

I would like to note that, subject to a detailed scenario/impact analysis and/or Porter Davis Pty Ltd completing catchment augmentations, there may be scope to alter the 1.0 ha reserve allocation. This potential flexibility should be captured within the PSP if possible.

11 Conclusion

It is my opinion that the SWS Peet 2020 SWMS (Addendum C) and the Gap Catchment Shared Asset Memo (Addendum B) are the only documents provided to (or by) the VPA at this stage that have demonstrated the necessary calculations to enable the allocation of reserve allocations within the subject site.

Through ongoing collaboration with the MWC, the drainage reserve required within the Aitken Creek DS (DS 4480) at location A5 (PSP location ACSB-08) is 2.0 ha (as confirmed within the correspondence in Appendix A) and should be updated in the PSP and Peet Master Plan to reflect this 2.0 ha land take.

It appears gap catchment drainage design development within the subject site has largely been overlooked by the PSP process to date.

Currently the Peet 2020 SWMS and the Peet Master Plan split the required assets within the gap catchment across two drainage reserve allocations (Option 1). Subject to ongoing negotiations between landowners, it may be possible to combine the split assets within the gap catchment into one reserve allocation (Option 2).

<u>In my opinion, a shared gap catchment asset (Option 2) would be the preferable way of servicing the gap catchments hydrological requirements</u>. This option results in less overall land take and is expected to have smaller ongoing maintenance requirements for Council. However, either option would be able to meet the required drainage performance targets.

Under Option 1, it is my opinion that the Peet Master Plan is generally providing appropriate drainage reserve land take allocations. Thus, the Peet Master Plan would be suitable for implementation within the PSP's Integrated Water Management Strategy with minor amendments.

Under Option 2, I advise that the Peet Master Plan would require a revision to combine the two drainage reserves in the Gap catchment. Once revised, it would be suitable for implementation within the PSP's Integrated Water Management Strategy.

There is also scope to undertake further design development (a detailed scenario/impact analysis and/or Porter Davis Pty Ltd completing catchment augmentations) of the gap catchment asset which (under either option) may reduce the Gap catchment drainage reserve allocation from that recommended within the Gap Catchment Shared Asset Memo (Addendum B).

On review of the relevant PSP submissions, all significant issues are either suitably addressed within the Peet 2020 SWMS and the Peet Master Plan, or subject to ongoing discussions between relevant parties. As such it is my opinion that no relevant submission made to the VPA regarding the subject site precludes the adoption of any of the Peet 2020 SWMS, the Gap Catchment Shared Asset Memo or the Peet Master Plan within the PSP (with minor amendments).

12 Declaration

I have made all the inquiries that I believe are desirable and appropriate and that no matters of significance (save those covered by legal professional privilege) which I regard as relevant have, to my knowledge, been withheld from the Standing Advisory Committee.

Michael Mag
BSc, BEng Civil (Hons), MAdvCivWaterEng
18 April 2021

13 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which are referred to in this report.

Abbreviation / Descriptions	Definition
AHD - Australian Height Datum	Common base for all survey levels in Australia. Height in metres above mean sea level.
ARI - Average Recurrence Interval.	The average length of time in years between two floods of a given size or larger. A 100 Year ARI event has a 1 in 100 chances of occurring in any one year.
AEP – Annual Exceedance Probability	The chance of a storm (flow) of that magnitude (or larger) occurring in a given year. $\boldsymbol{AEP = 1 - e^{(\frac{-1}{ARI})}}$. i.e., 18.13% AEP = 5 Year ARI
BPEMG	Best Practice Environmental Management Guidelines available from CSIRO (2009).
EY – Exceedances per year	The number of times a storm (flow) of that magnitude is expected to be exceeded per year. i.e., 4 EY = 3 Month ARI
Hectare (ha)	10,000 square metres
HECRAS	A hydraulic software package that enables the calculations of flood levels and velocities along a waterway given a specified flow.
Kilometre (km)	1000 metres
IL	Invert Level of the Drain
m^3/s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
Megalitre (ML) (1000 cubic metres)	1,000,000 litres = 1000 cubic metres. Often a unit of water body (e.g., pond) size
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC	Melbourne Water Corporation
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
NWL - Normal Water Level	Water level of a wetland or pond defined by the lowest invert level of the outlet structure
NSL – Natural Surface Level	The surface level of the natural (existing) surface before works.
RORB	Hydrologic computer program used to calculate the design flood flow (in m^3/s) along a stormwater conveyance system (e.g., waterway)
RCP	Representative Concentration Pathway. A relative greenhouse gas concentration into the future. RCP 8.5 represents no significant reduction in emissions until 2100 resulting in significant global warming.
Sedimentation basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by settlement processes.
Swale	A small shallow drainage line designed to convey stormwater discharge. A complementary function to the flood conveyance task is its WSUD role (where the vegetation in the base acts as a treatment swale).
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
TuFlow	A hydrologic software package that enables the calculations of flood levels and velocities along a waterway and flood plain system.
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to: o Convey stormwater safely o Retain stormwater pollutants o Enhance local ecology o Enhance the local landscape and social amenity of built areas
Wetland	WSUD element, which is used to collect TSS, TP and TN. Usually incorporated at normal water level (NWL) below which the system is designed as shallow marsh, marsh, deep marsh and open water areas.

14 Instructions

14.1 Initial Instructions

Instructions received from James Lofting and Sonia Turnbull of HWL Ebsworth Lawyers on the 22nd December 2020:

Peet has instructed us to brief you to provide expert drainage and hydrology evidence to the SAC. In particular, you are instructed to consider:

- *the PSP, background documents and technical reports, as relevant;*
- *the Peet Master plan and submission to the VPA dated 18 December 2020;*
- *the physical context of the site and surrounding development; and*
- *any others matters you think appropriate.*

You are directed to:

- *conduct an in depth review of the material supplied to you in relation to the Craigieburn West PSP and Amendment;*
- *consider and formulate your own opinions, within the limits of your expertise, with respect to the appropriateness of the Peet Master plan;*
- *respond to other submissions provided to the VPA, as relevant;*
- *conduct a site inspection, if necessary;*
- *prepare a covering report which will annex the Strategy that further explains and describes the:*
    - *gap catchment as identified in part 2.3 of the Strategy;*
    - *DS layout in part 2.3.1 of the Strategy;*
    - *hydrologic targets in part 2.3.4 of the Strategy;*
    - *levelling required on the Land to achieve the proposed gap catchment; and*
    - *existing and proposed gap catchments in a clearer pictorial form i.e. side by side images or the like.*
- *The report should clearly state the basis on which you have arrived at your conclusions, including any analysis and facts you have relied upon or assumption which you have made which form part of the reasoning by which you reach your conclusions; and*
- *consider any other matter you deem appropriate.*

We note that you will be called as a project drainage and hydrology expert who has advised and assisted Peet through the PSP process.

We confirm that are our instructions are to you personally and that the opinions that you provide should be your own opinions. It may be the case that you require assistance of others in carrying out the tasks and in forming and expressing your opinions. Please ensure that those persons are identified, and their roles are clearly explained in your report and that the opinions expressed in your report are your own.

The content, format and layout of your report, the manner of expression and the way in which you seek to address yourself to the tasks you have been engaged to undertake are all matters for you.

14.2 Additional Instructions

Instructions received from James Lofting and Sonia Turnbull of HWL Ebsworth Lawyers on the 9th of April 2020:

Hi Michael

We appreciate that you are working on your evidence for the above matter and that you want further direction on the scope of your evidence.

We have spoken with the client and are of the view that you should prepare evidence as outlined in the brief and in accordance with Peet's December submissions to the VPA (Option 1), however we also instruct you to include a 'Porter Davis Option' (Option 2) with all the requisite detail on how a shared asset would work and what effect Option 2 would have on the asset size, land take etc.

The client is in the process of trying to establish an MoU with Porter Davis to confirm that the drainage asset will be shared and that the cost can be apportioned between the 2 entities - at this stage it looks promising that this will occur. Depending on where negotiations end by late next week (15 April) we will either retain just Option 1 or Option 2 in your expert evidence or we may seek to provide both but we will obtain instructions from the client on this.

I note that we will require a draft of your evidence by 12noon on Friday 16 April 2021 as it must be circulated by 12noon on Monday 19 April 2021.

Appendix A Melbourne Water Correspondence

The following correspondence is from Laurence Newcome, the Precinct Structure Planning Coordinator at the Melbourne Water Corporation

A.1 General Subject Site Comments – 18/02/2021

From: Laurence Newcome
To: Craig Barrow; "David Hajzler"; "Jillian McQuade"; JohnDa
Cc: Carolina Balagtas; Stephen Miller; Barbara Oh; Brock Jeffery-Monck; michael.mag@stormywater.com.au; James Paull (VPA); Rajanne Mata (VPA); stephen.davis@vpa.vic.gov.au
Subject: Craigieburn West PSP - Aston West Precinct, Mickleham Road Craigieburn
Date: Thursday, 18 February 2021 11:36:18 AM

Hi All,

I hope that all is well with you.

Melbourne Water has been working closely with the project team for Peet's Aston West Precinct for the past 18 months in the development and refinement of a drainage servicing strategy for their land-holdings and the corresponding sub-catchments.

Peet's Aston West Precinct is partially serviced by the Aitken Creek and Upper Brodies Creek Development Services Schemes, however, there is also a small catchment which drains towards Mickleham Road, known as the "Gap Catchment". The Project Team have proposed minor changes in these catchment boundaries to create efficiencies in the delivery of this section of the Craigieburn West PSP and to minimise the impacts of urban flows on the areas downstream of Mickleham Road.

Following multiple iterations of the stormwater management strategy and supporting memos prepared by Stormy Water Solutions, Melbourne Water is generally in agreement with the intent of the outcomes proposed (including the scheme boundary changes), as it relates to our Development Services Schemes, noting that there are still ongoing discussions regarding the specific design parameters and land-take relevant to the small retarding basin and sediment pond proposed on the eastern boundary of this site.

Melbourne Water considers the "Gap Catchment" to be a local drainage catchment and therefore it should be managed by the local drainage authority (Hume City Council), noting that the combined catchment of 12.2 hectares it is much less than 60 hectares in size. It is understood that consultation with the other landowners is yet to be undertaken. Hume City Council is responsible for approving the drainage servicing outcome for the Gap Catchment.

Please do not hesitate to contact me via email or phone if you have any further queries.

Kind Regards

Laurence Newcome | Precinct Structure Planning Coordinator, Catchment Strategies and Services, Development Services | Waterways and Catchment Operations |
Melbourne Water | T: (03) 9679 7183 | 990 Latrobe Street, Docklands, VIC 3008 |
PO Box 4342 Melbourne VIC 3001
melbournewater.com.au

Enhancing Life and Liveability.

A.2 Aitken Creek DS Asset – 1/04/2021

From: Laurence Newcome
To: michael.mag@stormywater.com.au
Cc: "Barbara Oh"; "Rhys Dudley"; "Brock Jeffery-Monck"; Carolina Balagtas; James Paull (VPA); Laurie Mitchell (VPA); Samuel Duff (VPA)
Subject: RE: Peet Aitken Creek DS Asset Reserve PSP Allocation
Date: Thursday, 1 April 2021 2:47:04 PM

Hi Michael,

Thank you for your email.

Based on the reports, memos and supporting modelling prepared by Stormy Water Solutions for this site, and the relevant project correspondence with Melbourne Water, I can confirm that Melbourne Water is supportive of a conceptual land take of 2.0 ha being adopted for asset ACSB-08 in the Craigieburn West PSP.

It would be much appreciated if you could provide the updated shape files relevant to this asset.

Kind Regards

Laurence Newcome | Precinct Structure Planning Coordinator, Catchment Strategies and Services, Development Services | Waterways and Catchment Operations | **Melbourne Water** | T: (03) 9679 7183 | 990 Latrobe Street, Docklands, VIC 3008 | PO Box 4342 Melbourne VIC 3001
melbournewater.com.au

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From: michael.mag@stormywater.com.au <michael.mag@stormywater.com.au>
Sent: Friday, 26 March 2021 4:18 PM
To: Laurence Newcome <Laurence.Newcome@melbournewater.com.au>
Cc: 'Barbara Oh' <Barbara.Oh@peet.com.au>; 'Rhys Dudley' <Rhys.Dudley@peet.com.au>; 'Brock Jeffery-Monck' <brockj@cosweb.com.au>; Carolina Balagtas <Carolina.Balagtas@melbournewater.com.au>
Subject: Peet Aitken Creek DS Asset Reserve PSP Allocation

CAUTION: This email originated from outside of the organisation. Do not click links or open attachments unless you recognise the sender and know the content is safe.

Hi Laurence,

Upon reflection, and consultation with my client, Peet are happy to propose a 2.0 ha land take being shown in the Craigieburn West PSP (PSP-1068) for the Aitken Creek Drainage Scheme (DS 4480) asset A5SB1 (noting that this asset is labelled ACSB-08 in the PSP documentation).

As previously discussed, I have performed enough analysis to date to show that a 2.0 ha land take will be suitable given the current catchment alignments.

Can Melbourne Water confirm in writing their support to changing the land budget table in the PSP to reflect a 2.0 ha land take for the DS asset A5SB1 (ACSB-08 in the PSP)?

Regards,

Michael Mag

Senior Hydrologic Engineer – Stormy Water Solutions
Mob: 0401 861 301
Website: www.stormywater.com.au

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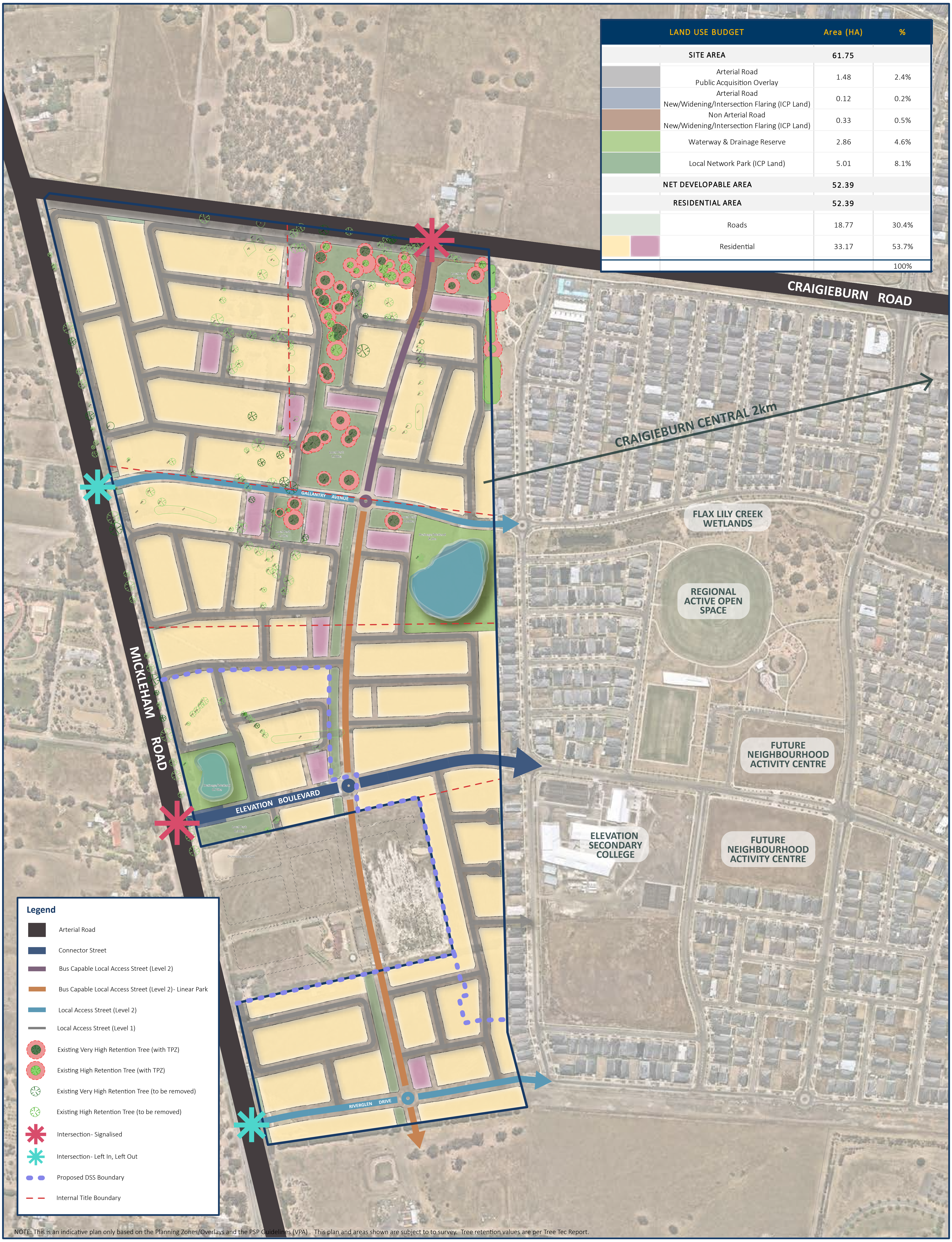
Addendum A Peet Master Plan



LAND USE BUDGET	Area (HA)	%
SITE AREA	61.75	
Arterial Road Public Acquisition Overlay	1.48	2.4%
Arterial Road New/Widening/Intersection Flaring (ICP Land)	0.12	0.2%
Non Arterial Road New/Widening/Intersection Flaring (ICP Land)	0.33	0.5%
Waterway & Drainage Reserve	2.86	4.6%
Local Network Park (ICP Land)	5.01	8.1%
NET DEVELOPABLE AREA	52.39	
RESIDENTIAL AREA	52.39	
Roads	18.77	30.4%
Residential	33.17	53.7%
		100%

NOTE: This is an indicative plan only based on the Planning Zones/Overlays and the PSP Guidelines (VPA). This plan and areas shown are subject to to survey. Tree retention values are per Tree Tec Report.

CONCEPT PLAN

N

Job No: 18-003046
Drawing No: 18-003046CPVL
Version: L
Created by: DSC
Date: 17.12.20
Scale @ A3 1:5000

Craigieburn West
Craigieburn
Hume City Council, Vic

calibre

PEET

Addendum B Gap Catchment Shared Asset Memo

Memorandum

ABN: 95 656 703 998

12 April 2021

To: Barbara Oh
Development Manager
Peet

Re: Gap Catchment Required Drainage Reserve for a Singular Asset

Barbara,

As requested, Stormy Water Solutions (**SWS**) have investigated the required asset size for a singular asset within the gap catchment of the Craigieburn West PSP region.

SWS have assumed a 11.4 ha gap catchment boundary as shown in Figure 1 of which:

- 5.8 ha is Peets landholdings (having assumed the Drainage Scheme (**DS**) boundary augmentations); and
- 5.6 ha is Porter Davis' landholdings (assuming no catchment augmentation and the original DS boundaries).

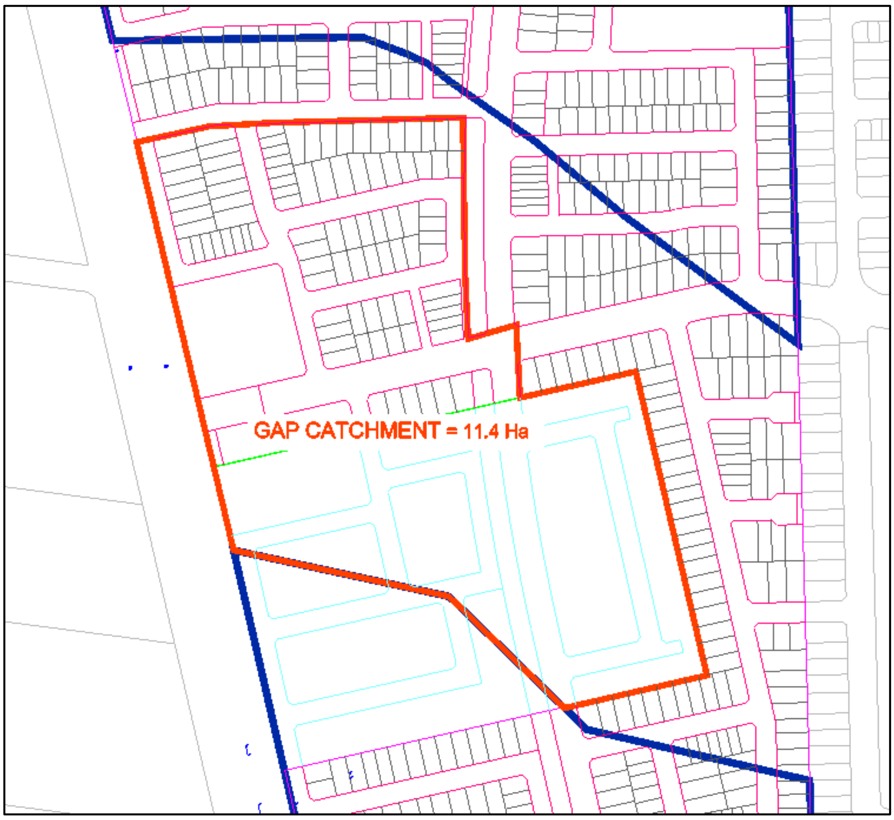


Figure 1 Gap Catchment Boundaries Assumed – Note: Site Layouts Subject to Change

As discussed within the Craigieburn West Storm Water Management Strategy, 25th September 2020, Stormy Water Solutions (the **Peet 2020 SWMS**) the following targets have been adopted for the design of the gap catchment:

- Retard 1% AEP flows to 0.35 m^3/s; and
- Provide stormwater treatment to the Best Practice Environmental Management Guidelines (**BPEMG**).

SWS (within the associated attachments to this memorandum) have shown that a 1.0 ha drainage reserve allocation is suitable to achieve the above targets with a combined asset. This drainage reserve will contain:

- 3,640 m^3 of flood storage in the airspace between 222.65 m AHD and 223.60 m AHD;
- Stormwater treatment infrastructure including:
  - A 380 m^2, 220 m^3 sediment basin with a normal water level of 222.30 m AHD; connecting to
  - A 280 m^2 bioretention system with a filter base at 222.30 m AHD and 0.35 m of extended detention.

Given there are still some uncertainties regarding the catchment delineations, SWS have completed a small sensitivity analysis with a 0.5 ha smaller and 0.5 ha larger catchment. Either of these scenarios have a minimal effect on the size of the required stormwater treatment infrastructure and change the required flood storage volumes by roughly ± 200 m^3. A change of ± 200 m^3 in flood storage should be able to be accommodated within the 1.0 ha drainage reserve allocation.

SWS understand that there is still uncertainty as to the final location of this drainage reserve and advise Peet that as long as the boundary of the gap catchment drainage reserve abuts the location of the existing Mickleham Road culverts, the reserve could be moved north or south as required (roughly within the footprint of the existing dam) given any future development layout. Normally this flexibility regarding the reserve location would not be possible and it is only feasible given the large existing dam onsite.

As provided by Cossill and Webley, the estimate for the construction costs for this asset will be in the order of $1,040,000. Attachment 4 details a full cost breakdown of this estimate. The cost estimate is for planning purposes only and the estimate may vary considerably from ultimate construction costs.

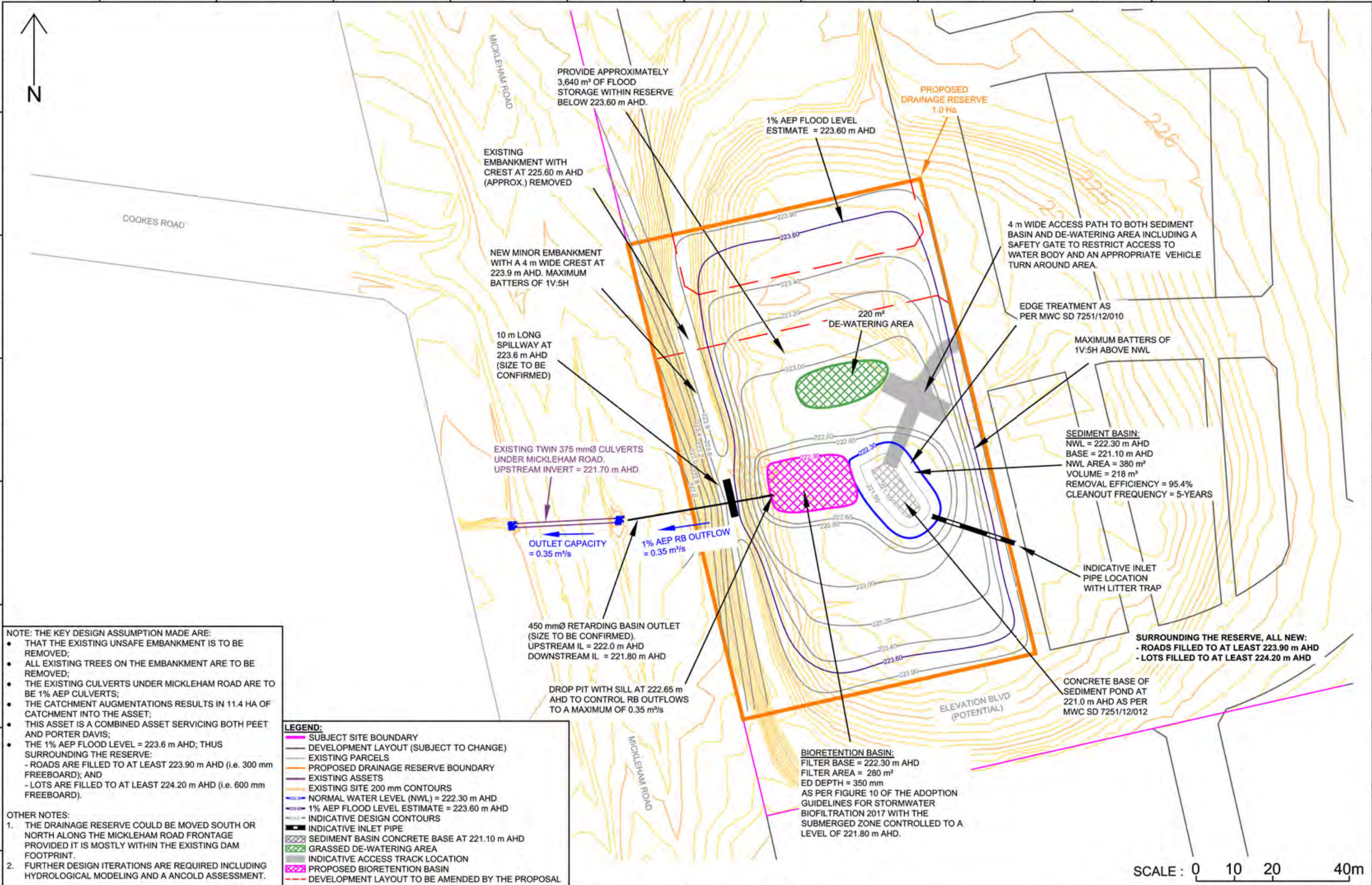
The concept design detailed within this memorandum is to a high level. Once development layouts are known with more certainty, and an agreement has been achieved with Porter Davis, SWS recommends the following further design be completed on the gap catchment drainage reserve (as a minimum):

- Hydrological Modelling (RORB) to:
    - Confirm the required flood storage volumes;
    - Design the outlet system to retard the 1% AEP outflows back to 0.35 m^3/s.
- A ANCOLD investigation on the proposed embankment including setting the spillway size and/or level;
- Surface modelling (12D or similar) to confirm earthwork requirements;
- Confirmation of the stormwater treatment infrastructure proposals including:
    - Confirming sizes; and
    - Development of maintenance management plans.

Regards,

Michael Mag
Stormy Water Solutions
www.stormywater.com.au

Attachment 1 – Combined Gap Catchment Drainage Reserve Concept Design Proposal



NOTE: THE KEY DESIGN ASSUMPTION MADE ARE:

- THAT THE EXISTING UNSAFE EMBANKMENT IS TO BE REMOVED;
- ALL EXISTING TREES ON THE EMBANKMENT ARE TO BE REMOVED;
- THE EXISTING CULVERTS UNDER MICKLEHAM ROAD ARE TO BE 1% AEP CULVERTS;
- THE CATCHMENT AUGMENTATIONS RESULTS IN 11.4 HA OF CATCHMENT INTO THE ASSET;
- THIS ASSET IS A COMBINED ASSET SERVICING BOTH PEET AND PORTER DAVIS;
- THE 1% AEP FLOOD LEVEL = 223.6 m AHD; THUS SURROUNDING THE RESERVE:
  - ROADS ARE FILLED TO AT LEAST 223.90 m AHD (i.e. 300 mm FREEBOARD); AND
  - LOTS ARE FILLED TO AT LEAST 224.20 m AHD (i.e. 600 mm FREEBOARD).

OTHER NOTES:

1. THE DRAINAGE RESERVE COULD BE MOVED SOUTH OR NORTH ALONG THE MICKLEHAM ROAD FRONTAGE PROVIDED IT IS MOSTLY WITHIN THE EXISTING DAM FOOTPRINT.
2. FURTHER DESIGN ITERATIONS ARE REQUIRED INCLUDING HYDROLOGICAL MODELING AND A ANCOLD ASSESSMENT.

LEGEND:

- SUBJECT SITE BOUNDARY
- DEVELOPMENT LAYOUT (SUBJECT TO CHANGE)
- EXISTING PARCELS
- PROPOSED DRAINAGE RESERVE BOUNDARY
- EXISTING ASSETS
- EXISTING SITE 200 mm CONTOURS
- NORMAL WATER LEVEL (NWL) = 222.30 m AHD
- 1% AEP FLOOD LEVEL ESTIMATE = 223.60 m AHD
- INDICATIVE DESIGN CONTOURS
- INDICATIVE INLET PIPE
- SEDIMENT BASIN CONCRETE BASE AT 221.10 m AHD
- GRASSED DE-WATERING AREA
- INDICATIVE ACCESS TRACK LOCATION
- PROPOSED BIORETENTION BASIN
- DEVELOPMENT LAYOUT TO BE AMENDED BY THE PROPOSAL

REVISION	DATE
V2 – MINOR PEET MODIFICATIONS	12/4/21
V1 – COMBINED ASSET – 11.4 HA CATCHMENT	8/4/21

Stormy Water Solutions

DESIGNED	Michael Mag
CHECKED	Valerie Mag
AUTHORISED BY	
PROJECTION	MGA94/Z55

Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998

CRAIGIEBURN WEST
STORMWATER MANAGEMENT STRATEGY
'GAP' CATCHMENT PROPOSAL
COMBINED ASSET

SCALE: AS SHOWN
SHEET 1 OF 1
DRAWING No. 2107/GAP/1

Attachment 2 - Flood Storage Calculations

At this high concept level, flood storage calculations have been completed utilising Boyd's method as shown in Table 2.1. These calculations should be confirmed with a hydrological (RORB) model into the future.

Table 2.1 Boyd's Flood Storage Calculations

Inputs:		
Catchment Area (A) =	11.40	ha
Runoff Coefficient (1% AEP) =	0.90	
100 Year Effective Catchment Area = ∑CA =	10.26	ha
Restricted outflow requirement =	0.35	m^3/s

Boyd's Calculations:

Storm Duration (min)	1% AEP Intensity[1.] (mm/hr)	RB Inflow[2.] (Q_{in}) (m^3/s)	RB Outflow[3.] (Q_{out}) (m^3/s)	Volume of Inflow Hydrograph (V_{in}) (m^3)	Storage required $= V_1(1-Q_{out}/Q_{in})$ (m^3)
10	138.0	3.93	0.35	2360	2150
15	112.0	3.19	0.35	2873	2558
20	94.8	2.70	0.35	3242	2822
25	82.8	2.36	0.35	3540	3015
30	73.8	2.10	0.35	3786	3156
45	56.7	1.62	0.35	4361	3416
60	46.9	1.34	0.35	4812	3552
90	35.9	1.02	0.35	5530	3640
120	29.9	0.85	0.35	6125	3605
180	23.1	0.66	0.35	7120	3340
270	18.0	0.51	0.35	8331	2661
360	15.2	0.43	0.35	9357	1797
540	11.9	0.34	0.35	10978	0

Utilising the reserve proposals shown in Attachment 1, Table 2.2 confirms that the 3,640 m^3 of required flood storage can be provided within the 1.0 ha drainage reserve.

Table 2.2 Flood storage provided within the proposal.

Level (m AHD)	Area (m^2)	Average Area (m^2)	Height Diff (m)	Volume (m^3)	Cumulative Volume (m^3)
222.65	1090				0
222.80	1285	1188	0.15	178	178
223.00	2995	2140	0.2	428	606
223.20	4525	3760	0.2	752	1358
223.40	5750	5138	0.2	1027	2386
223.60	6940	6345	0.2	1269	3655

Attachment 3 – Stormwater Treatment Modelling

The sizing of the sediment basin is shown with Table 3.1.

Table 3.1 Gap Catchment Sediment Basin Sizing

Assumed Asset Properties		
Asset ID =	GAP_SP1	
Normal Water Level = NWL =	222.30	m AHD
NWL Area = (A_{asset}) =	380	m^2
Pond Depth = (d_p) =	1.20	m
Extended Detention Depth = (d_e) =	0.35	m
Volume = (Vol_{TOT}) =	218	m^3
Sump Volume[1.] = (Vol_S) =	117	m^3
4EY Inflow[2.] = (Q_{4EY}) =	0.35	m^3/s
Assumed Hydraulic efficiency[3.] = λ =	0.26	
Upstream Catchment Area = (A_{Catch}) =	11.4	ha
Target Particle Settling Velocity[4.] = (V_s) =	0.011	m/s
Removal Efficiency		
d* = max (d_p, 1) =	1.2	
$\frac{d_e + d_p}{d_e + d^*} =$	1.0	
$\frac{V_s \times A_{asset}}{Q_{4EY}} =$	11.9	
$n = \frac{1}{1 - \lambda} =$	1.35	
$Removal\ efficiency^{5.} = R = 1 - \left[1 + \frac{1}{n} \times \frac{V_s \times A_{asset}}{Q_{4EY}} \times \frac{d_e + d_p}{d_e + d^*}\right]^{-n} =$	**95.4%**	
Cleanout Frequency		
Sediment Load[6.] = (L_S) =	1.6	m^3/ha/year
Gross Pollutant Load[7.] = (L_{GP}) =	0.4	m^3/ha/year
$Cleanout\ Frequency = \frac{R \times (L_S + L_{GP}) \times A_{Catch}}{Vol_S} =$	**5.4**	**years**
Dewatering Area Required ((assuming 500 mm deep layout & 5-year cleanout frequency) =	**218**	m^2

Notes: [1.] *Sump volume taken as the volume below 350mm deep (i.e. below the safety bench).*
[2.] *Flow from Rational Estimate*
[3.] *Hydraulic efficiency estimated from Figure 4.3 of Melbourne Water 2005.*
[4] *Target particle size taken as 125 µm (as per criteria SP3 of Melbourne Water 2018c) with a settling velocity sourced from Table 4.1 of Melbourne Water 2005.*
[5.] *Methodology taken from Chapter 4.3.2 of Melbourne Water 2005.*
[6.] *Load estimate sourced from Willing and Partners 1992.*
[7.] *Load estimate sourced from Allison et. al. 1998.*

A Model for Urban Stormwater Improvement Conceptualisation (**MUSIC**) was developed to size the required bioretention system. The model was simulated with 10-yrs of climate data from gauge 086282 from 1981 until 1991 which during this period received a mean annual rainfall of 522 mm/yr. The model was simulated with node properties as detailed within Table 3.2.

Table 3.2 Gap Catchment MUSIC Modelling Node Details

Node ID:	Node Type	Specific Details
Gap_Catch	Source Node – Mixed	Area = 11.4 ha F_{imp} = 0.80
Gap_SP1	Sediment Basin	Area = 380 m^2 ED = 0.35 m Volume = 215 m^3
Gap_BIO1	Bioretention Basin	Area = 280 m^2 ED = 0.35 m Filter Depth = 0.5 m Hydraulic Conductivity = 100 mm/hr Exfiltration = 0 mm/hr Effective Plants Submerged Zone Present to a depth of 0.45 m

As shown in Table 3.3, the above stormwater treatment train can achieve BPEMG treatment at the outfall from the gap catchment.

Table 3.3 Gap Catchment Stormwater Pollutant Removal

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	7,740	1,270	6,470	83.6%
Total Phosphorus	16.0	8.5	7.5	46.8%
Total Nitrogen	112	61	51	45.5%
Gross Pollutants	1,590	0	1,590	100.0%

Attachment 4 – Cost Estimates

Table 4.1 below details the high level cost estimates for the proposed gap catchment assets. The estimates are as provided by Cossill and Webley.

The cost estimate produced within Table 4.1 is for planning purposes only and the estimate may vary considerably from ultimate construction costs.

Table 4.1 High Level Gap Catchment Asset Cost Estimate from Cossill and Webley

Item	Item Description	Unit	Quantity	Rate	Amount
1	**Site Establishment**				
a	Site Establishment	item	1	$50,000.0	$50,000
b	Dewatering existing dam	item	1	$30,000.0	$30,000
c	Clearing and tree removal	item	1	$25,000.0	$25,000
2	**Cut (excavation and disposal)**				
a	Cut for Sediment Basin (218m^3 storage)	m^3	218	$33.8	$7,400
b	Cut for Bioretention Basin (222.3 to 221.8 @ 280m^2)	m^3	140	$33.8	$4,800
c	Cut for Flood Storage (3640m^3)	m^3	3640	$33.8	$123,100
d	Cut for 300mm Freeboard to Roads (assume 300mm cut for 1.0ha)	m^3	3000	$33.8	$101,400
e	Cut for lowering existing embankment	m^3	1790	$33.8	$60,600
3	**Fill**				
a	Fill (assumed imported) - Rough estimate to be confirmed with future 12D modelling	m^3	2400	$20.5	$49,200
4	**Clay Lining Sediment Basin**				
a	Imported 350 mm Deep to extended detention depth (EDD) level	m^2	380	$20.0	$7,600
5	**Planting**				
a	Site Establishment	item	1	$20,000.0	$20,000
b	Amelioration of site soils	m^2	9330	$3.5	$32,700
c	Ephemeral (6x90cm3 ./m^2)	m^2	38	$16.6	$700
d	Shallow Marsh (2x600cm3 ./m^2)	m^2	38	$14.3	$600
e	Deep Marsh (2x600cm3 ./m^2)	m^2	38	$14.3	$600
f	Submerged Marsh (1x600cm3 ./m^2)	m^2	0	$14.3	$0
g	Topsoil within Planting Zones	m^2	114	$3.3	$400
h	Weed Control Matting	m^2	114	$6.9	$800
i	Topsoil Surrounding Reserve	m^2	9330	$3.3	$30,800
j	Grassing Surrounding Reserve	m^2	9330	$7.4	$69,100
k	Landscaping maintenance (2 years)	weeks	104	$500.0	$52,000
6	**Access Track**				
a	Access Track - Crushed Rock (4 m wide)	m^2	250	$32.7	$8,200
7	**Fencing**				
a	Sediment Basin Access Bollards	item	4	$250.0	$1,000
8	**Structures**				
a	Modified Headwalls	item	1	$3,004.0	$3,100
b	High Flow Outlet Pits	item	1	$6,930.0	$7,000
c	450 mmØ Pipe Length (Outlet system)	m	40	$400.0	$16,000
d	Outlet Weir/Spillway	item	1	$15,000.0	$15,000
e	Weir Separating Sediment Basin and Bioretention	item	1	$15,000.0	$15,000
f	Litter Trap on Inlet to Sediment Basin	item	1	$50,000.0	$50,000
g	Sediment Basin Concrete Base	m^2	106	$120.0	$12,800
9	**Bioretention Basin**				
a	Filter Media	m^2	280	$30.0	$8,400
b	Transition Layers	m^2	280	$15.0	$4,200
c	Drainage Layer	m^2	280	$30.0	$8,400
d	Mulch and Planting	m^2	280	$30.0	$8,400
e	Weed Control Matting	m^2	280	$6.9	$2,000
f	Perforated Pipe	m	80	$125.0	$10,000
g	Plastic inspection openings including bends and risers	no.	20	$150.0	$3,000
h	Welded HDPE liner around filter media	m^2	350	$50.0	$17,500
10	**Contingency**				
a	Contingencies @ 10%				$85,680
	Total Base Estimate				**$942,480**
	Professional Fees (MWC Calculator)				$96,856
	TOTAL COST ESTIMATE				**$1,040,000**

**Estimate for planning purposes only and the estimate may vary considerably from ultimate construction costs.*

Addendum C Peet 2020 SWMS

Craigieburn West

Stormwater Management Strategy

25th September 2020

Report by: **Stormy Water Solutions**

stormywater@optusnet.com.au

www.stormywater.com.au

M 0412 436 021

Document Verification

Project Name	Craigieburn West SWMS
Client Contact	PEET: Barbara Oh
SWS Project Number	2050 (1964)
Document Name	2050_Craigieburn_West_SWS_SWMS_25Sep20

Document History

Issued To	Date	Version	Author	Reviewer
Client	25/9/2020	V6	MM	VM
Client	8/9/2020	V5	MM	VM
Client	18/6/2020	V4	MM	VM

Accreditation

Michael Mag

- Bachelor of Engineering – Civil (Honours) 2016
- Bachelor of Science – Applied Mathematics 2016
- Master of Advanced Civil Engineering (Water) 2020

Valerie Mag

- Bachelor of Engineering (Honours) 1989
- Master of Engineering Science 1993
- Registered as a Professional Engineer (Civil and Environmental Engineering), National Engineering Register (Engineers Australia).

Climate Change Statement

Unless otherwise stated, the information in this report does not take into consideration the current understanding of climate change and its consequences on our current engineering practices. This may lead to a under (or over) estimation of hydrological calculations and as such may result in under (or over) design of aspects of this design compared to a design in which climate change is considered.

Disclaimer

Contents

1 Introduction

Stormy Water Solutions (**SWS**) has been engaged by Peet Craigieburn Pty Ltd (the **Client**) to develop a high-level stormwater management strategy (**SWMS**) for the development of their 'Craigieburn West' project (the **Subject Site**). The subject site is defined as shown in Figure 1 (noting that the internal development layout is subject to change).

Currently, the subject site is zoned either FZ3 or UGZ. It is expected that the land will be rezoned as part of the Craigieburn West Precinct Structure Plan to residential land with an average lot size of in the order of 350 m^2 as shown in Appendix C.3.

The subject site spans three separate catchments as defined in Figure 1, being:

- The Aitken Creek Drainage Scheme (DS 4480);
- The Upper Brodies Creek DS (DS 4381); and
- A small 'Gap' catchment between the above two DS's that drains west across Mickleham Road.

The client has also engaged Cossill & Webley (**C&W**) to provide civil engineering advice and prepare a Servicing Strategy for the project. This SWMS has been developed in close consultation with C&W to ensure that the subdivision design and fill/catchment proposals can accommodate the recommendations of this SWMS.

The deliverables of this SWMS are <u>concept designs</u> of the major stormwater treatment and stormwater retardation infrastructure (if) required for each of the three catchment outfalls from the subject site.

Table 1 and Figure 1 below details the current and proposed areas of the development that drain to each catchment as defined by C&W. The proposed catchment realignments form the key assumptions within this SWMS. The catchment realignments have been proposed predominantly to reduce the Gap catchment area draining across Mickleham Road.

Table 1 Catchment Delineations

Catchment		Original 'Base Case' DS Area	Proposed SWMS DS Area	Change[2.]
Aitken Creek DS 4480		39.8 ha	46.7 ha	+ 6.9 ha
Upper Brodies Creek DS 4381		10.7 ha	11.1 ha	+ 0.4 ha
Gap	**Subject Site**	13.8 ha	6.6 ha	- 7.2 ha
	1360-1370 Mickleham Road[1.]	5.6 ha	5.6 ha	0 ha

Notes: [1.] *Catchment areas include 1360-1370 Mickleham Road (which is outside of the client's control).*

[2.] *Small rounding errors result in the sum of the changes not equalling zero.*

This report assumes a separate SWMS will be developed independently for 1360 – 1370 Mickleham Road (not owned by the client), in line with the requirements detailed within this SWMS.

It is assumed that the reader of this report is familiar with the catchments and drainage schemes affected by the subject site development.

This SWMS addresses the ‘base case’ development option compared with the ‘proposed case’ development option. The ‘base case’ can be seen as what the SWMS would be required to be with the original DS catchment boundaries. The ‘proposed case’ is this SWMS, with the proposed catchment changes as per Table 1 and Figure 1.

It is anticipated that providing a comparison of the ‘base case’ and this proposed SWMS will aid in the approval process of this SWMS by clearly outlining the differences in reserves and assets that the proposed catchment augmentations result in.

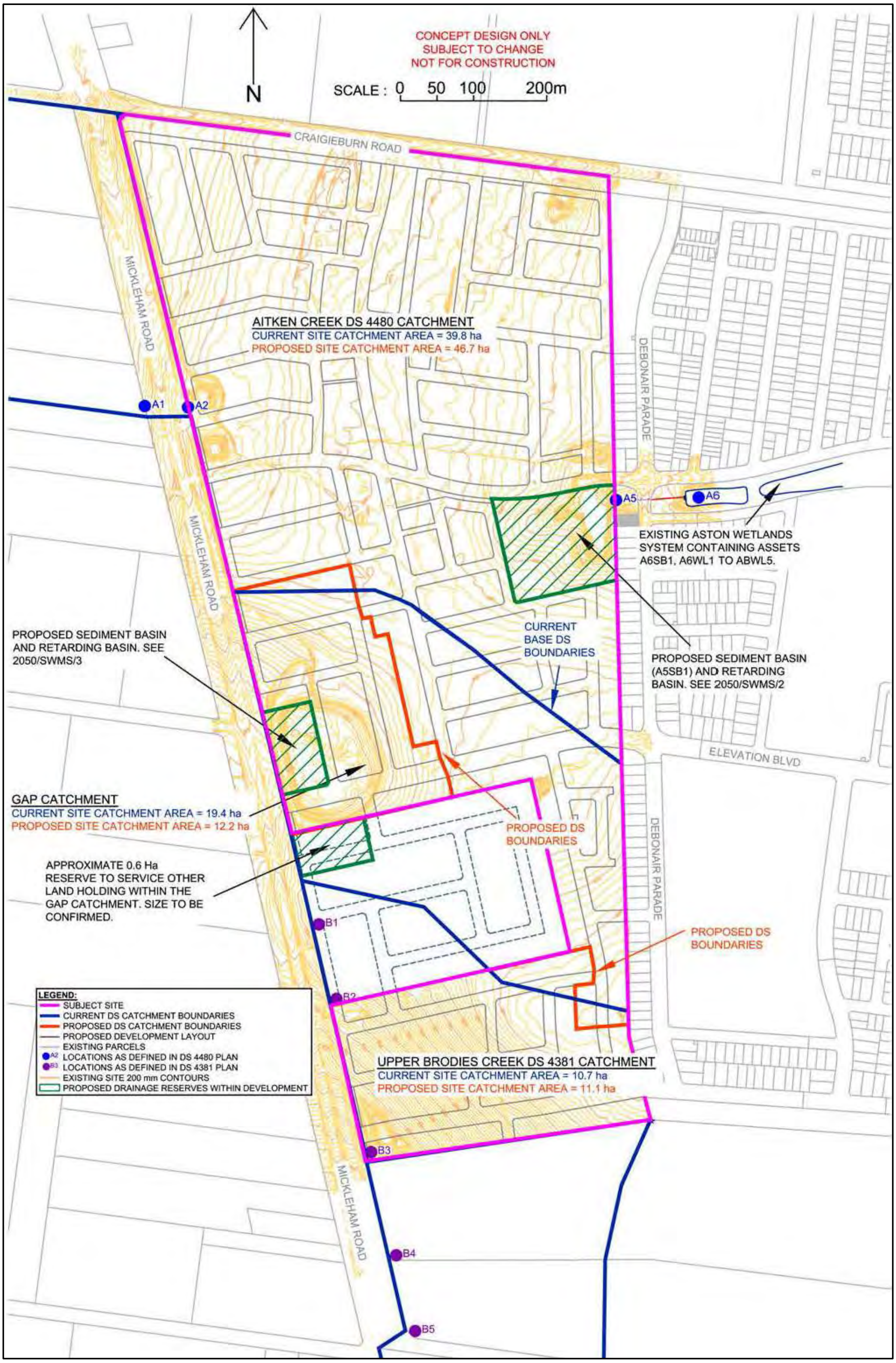


Figure 1 **Craigieburn West - Proposed Catchment changes (development layout subject to change)**

1.1 Background Reports and Information

Aitken Creek DS 4480 Region

The following background report has formed the basis of the understanding of the existing assets which may be affected by the development of the subject site:

- '575 Craigieburn Road, Craigieburn, Wetland Function Design Report, 23/9/2010, Stormy Water Solutions' (the **2010 Report**).

This report relates to the functional design of the series of five wetlands (A6WL1-5) and one sediment basin (A6SB1) within the Aston Estate (east of the subject site) relating to DS 4480. The 2010 Report formed the basis of the design of these downstream systems and these systems have since been constructed following the recommendations of the 2010 Report.

Crucially, the 2010 Report (relating to the design of the downstream Aston Estate systems) accounted for development of the subject site. The 2010 Report assumed a Fraction Impervious ($\mathbf{F_{imp}}$) of 0.50 for the subject site (and the Aston Estate), whereas it will more likely be in the order of 0.80 given the proposed lot densities in the subject site.

The client has provided survey and as-constructed information (see Appendix C) of these assets which have been utilised within this SWMS.

Upper Brodies Creek DS 4381 Region

The 'Amira Estate, Mickleham Road, Greenvale, Stormwater Management Strategy, 4/3/2013, Neil M Craigie Pty Ltd' (the **Neil Craigie 2013 Report**) also relates to this project.

The Neil Craigie 2013 Report relates to the design of Upper Brodies Creek DS 4831 asset WL1 within Peet's Aspect development which treats and retards outflows from the DS 4831 catchment. The design was further developed by SMEC in 2016 generally in accordance with the Neil Craigie 2013 Report. Similar to the 2010 Report, assumptions relating to the F_{imp} of the catchment have been updated within this SWMS compared to within the Neil Craigie 2013 Report.

2 Design Constraints

Given the three separate catchments (and outfalls) from the subject site, the constraints have been separated by catchment. Largely, the constraints are the same for both the 'base case' and the 'proposed SWMS' development options. Where there is a key difference in constraints between the scenarios, it is explicitly stated below.

At this stage, potential constraints such as Aboriginal Cultural Heritage requirements, or retention of native Flora and Fauna etc that are usually determined during the PSP process have not been considered.

2.1 Aitken Creek DS (DS 4480)

2.1.1 DS Layout

It is assumed in development of this SWMS that the Melbourne Water Corporation (**MWC**) DS 4480 layout is generally as per the April 2017 DS plan (see Appendix E), other than the change in catchment boundaries proposed within Figure 1 and the reserve allocation discussed further below. These catchment changes increase the subject site catchment within DS 4480 by approximately 6.9 ha. It should be noted that the total DS 4480 catchment is in the order of 1,715 ha (approx.). As such, this change is negligible for the total DS catchment (but may affect the local catchment).

It is of note that the DS 4480 plan does not call for any stormwater treatment or retarding basin assets (and hence reserve land take) on the subject site (approximately DS4480 location A5). Rather it only calls for a DS pipe from A2 to A5 (as defined in the April 2017 DS plan). However, as discussed below, a reserve is required at A5 in both the 'base case' and 'proposed SWMS'.

2.1.2 Reserve Allocation

The general reserve location for stormwater infrastructure is assumed to be as shown in the revised development layout presented in Appendix C.3. Effort has been made to ensure that the reserve location and allocations are as efficient as possible.

2.1.3 Existing Topography

There is an existing pondage along the west of the A5SB1 reserve, with a Normal Water Level (**NWL**) of approximately 224.40 m AHD. The reserve then generally grades up to the west at a grade of 1V:35H (approx.).

2.1.4 Existing DS 4480 Assets

As part of the downstream Aston wetland system, a connection to the subject site has been partially constructed. A pit containing a 1200 mmØ pipe (Invert Level (**IL**) = 220.64 m AHD) has been constructed 16m east of the A5SB1 reserve boundary. This pipe then enters the downstream existing Aston wetlands system. This 1200 mmØ pipe will form the main outlet of any subject site proposals within the DS 4480 catchment.

The existing 1200 mmØ enters the downstream A6SB1 asset at an invert of 219.90 m AHD. The NWL of A6SB1 is 221.00 m AHD. The existing 1200 mmØ is almost completely drowned and has a limited capacity. Therefore, any outlet designed from the proposed system at location A5 (see DS 4480 plan) is required to be free draining for most events given the tail water constraints from A6SB1.

2.1.5 Design Flows and Retarding Basin Design

The DS 4480 plan does not call for any Retarding Basin (**RB**) at the site discharge location (point A5, DS 4480 plan). However, assumptions relating to the F_{imp} of the catchment have changed over time. Due to these changes, if the flow from the subject site was left to freely drain (i.e. not be retarded) the design capacity of the downstream Aston Wetlands system may be exceeded in the 1% AEP event.

Thus, rather than retard to pre-development flow rates at the subject site boundary (Point A5 in Figure 1), flow rates will be retarded to less than those assumed within the 2010 Report at key locations along the downstream Aston wetlands system (so as to not increase the downstream flood levels from those detailed within the 2010 Report).

All flows will be calculated to Australian Rainfall and Runoff 2019 (**ARR 2019**) standards, accounting for the increase in catchment F_{imp} compared to the 2010 Report assumptions.

The proposed RB will also be designed to ensure that there is at least 600 mm freeboard above the 1% AEP flood level estimate to any of the existing Stage 18 Aston lot levels.

Further, the existing downstream crossing of Debonair Parade has a limited 1% Annual Exceedance Probability (**AEP**) capacity as set by the velocity, depth, and hazard requirements of the MWC Floodway Safety Criteria (2017). As such, an RB is also required to ensure that Debonair Parade is low risk in the post-development scenario.

2.1.6 Stormwater Treatment

At the present time, no stormwater treatment assets are identified at location A5 as part of DS4480. Given an RB is required at the site outfall, it is logical that a sedimentation basin also be provided within the RB base. Sediment basin (**A5SB1**) is proposed within the footprint of the required RB and its treatment accounted for. Any shortfall in treatment is expected to then be met via applicable DS 4480 contributions.

The sediment basin's primary function will be to capture sediment to ensure the existing, constructed 1200 mmØ connection into the downstream A6SB1 is less likely to block. This existing 1200 mmØ pipeline is almost completely drowned. Without an upstream, independent sediment pond it will continue to be prone to blockage due to sedimentation (with or without upstream development).

2.1.7 Summary

In summary, the design constraints for both the 'base case' and 'proposed SWMS' result in an asset being required at the subject site outfall of the Aitken Creek catchment because:

- The existing 1200 mmØ DS pipe under (across) Debonair Parade experiences significant backwater impacts (it is currently approx. 90% drowned);
- The existing 1200 mmØ DS pipe under (across) Debonair Parade has a restricted capacity;
- Given the two points above, the existing 1200 mmØ DS pipe is at a high risk of blockage due to the Craigieburn West PSP catchment's sediment deposition if not captured upstream within the PSP region; and
- The overland flow path allowances across Debonair Parade have a limited 1% AEP capacity (set by velocity and hazard requirements of the MWC Floodway Safety Criteria (2017)) and this results in a retarding basin being required directly upstream of this constructed road at the PSP boundary.

As such, a combined sediment basin and retarding basin is proposed at the Aitken Creek site outfall (labelled A5SB1 herein) for both the 'base case' and 'proposed SWMS' scenarios.

2.2 Upper Brodies Creek DS (DS 4381)

2.2.1 DS Layout

The DS 4381 layout is assumed to be as per the April 2017 DS plan other than the change in catchment boundaries proposed within Figure 1 which increases the subject site catchment within DS 4381 by approximately 0.4 ha. It should be noted that the total DS 4381 catchment is in the order of 165 ha (approx.). As such, this change is negligible for the total DS catchment

2.2.2 Existing Assets

DS 4381's major treatment and retardation asset RB1LA (the Aspect RB) has been constructed. Ensuring that this asset still performs its required flood retardation and stormwater treatment functions (as per the Neil Craigie 2013 Report) with the catchment change proposed is the main consideration for this SWMS relating to DS 4381.

There have also been minor system DS pipes constructed up to point B8 on the DS 4381 plan (see Appendix E). It is also required to show that these existing minor system pipes can accommodate the extra proposed catchment with around the same level of service as they were originally designed for.

2.2.3 Stormwater Treatment

No stormwater treatment is proposed within the DS 4381 catchment on the subject site, rather the applicable DS 4381 contribution rate is expected to be paid. Notwithstanding the above, stormwater treatment will occur within the constructed downstream Aspect RB.

2.3 Gap Catchment

The section below details constraints relating to all landholdings within the Gap catchment, being the Subject Site and 1360 – 1370 Mickleham Road However, this SWMS only details servicing proposals for the Subject Site (not 1360-1370 Mickleham Road).

Both the base case and proposed SWMS's presented allow development of the subject site independent of 1360-1370 Mickleham Road and do not affect the size of the asset required on this property. Thus, either scenario does not prejudice or negatively impact any future development of 1360-1370 Mickleham Road.

2.3.1 DS Layout

The largest change between the two development scenarios ('base case' and 'proposed SWMS') is the catchment areas draining towards the Gap catchment.

In the 'base case' scenario, the DS boundaries result in a total Gap catchment of 19.4 ha comprising:

- 13.8 ha of Subject Site land; and
- 5.6 ha of 1360-1370 Mickleham Road land.

In the 'proposed SWMS' scenario, the DS boundaries result in a total Gap catchment of 12.2 ha comprising:

- 6.6 ha of Subject Site land; and

- 5.6 ha of 1360-1370 Mickleham Road land.

2.3.2 Reserve Allocations

Given that the Gap catchment is not within a current Melbourne Water DS, each landholder within the catchment will be expected to manage the stormwater runoff from their own landholding. As such, within this report (for both development scenarios) it is assumed two Gap catchment reserves will be constructed as shown in Figure 1, being:

- One reserve servicing the Subject Site; and
- One reserve servicing 1360-1370 Mickleham Road.

2.3.3 Existing Assets

An existing farm dam is located on the subject site upstream of the outfall. This dam's embankment is over 3 metres high and has multiple small trees growing on it. It is assumed to be completely removed within this SWMS.

Twin 375 mmØ culverts have recently been constructed under Mickleham Road as part of the road reconstruction (by others). These conduits are significantly undersized for the catchment even in a pre-development situation, i.e. under current farming conditions. Consequently, a key priority of this SWMS is to improve the drainage conditions in the gap catchment. Currently the upstream dam likely retards almost the entire 1% AEP (100-Year ARI) flow from the upstream catchment and the 375 mmØ culverts only pick up the road reserve catchment. As such, properties downstream of the road have in the order of a 1% AEP (100-Year ARI) level of service from the road. The capacity of the existing road culverts is 0.35 m^3/s.

Any proposal within this SWMS will aim to ensure that this culvert system will provide a 1% AEP level of service to Mickleham Road once the 'Gap' catchment is developed. This will be achieved via the catchment changes detailed within Figure 1, and provision of an RB in the proposed reserves.

2.3.4 Hydrologic Targets

As the Gap catchment is not covered by any drainage scheme, a standard target for the outlet across Mickleham Road would be to ensure the 1% AEP post-development outflows are retarded to pre-development flow rates.

However, as the existing dam is proposed to be removed, and there is a restricted capacity of the existing culverts under Mickleham Road, this standard approach is not feasible for this catchment. As such, the hydrological target for the Gap catchment has been taken as:

- 1% AEP post-development outflows are retarded to the capacity of the existing Mickleham Road culverts (0.35 m^3/s) to ensure Mickleham Road has 1% AEP capacity (with 300 mm freeboard to the road crest).

Given the original 'base case' catchment delineations of 13.8 ha (71%) of the Gap catchment being the subject site, and 5.6 ha (29%) of the Gap catchment being 1360-1370 Mickleham Road, the 1% AEP post-development outflow target for:

- the Subject Site is set at 0.25 m³/s; and
- 1360-1370 Mickleham Road is set at 0.10 m³/s.

The above values have been derived by scaling the applicable catchments to the Mickleham Road culvert capacity.

Further, the targets are proposed to be retained across both development scenarios (‘base case’ and ‘proposed case’). The client, in the ‘proposed’ scenario is directing more catchment to the Aitken Creek DS region to reduce the reliance on the Gap catchment. This will not affect the original targets for either landholding.

2.3.5 Stormwater Treatment

Given the RB is required as discussed above, a simple stormwater treatment system is proposed on each landholding (being the subject site and 1360-1370 Mickleham Road) to treat outflows from the Gap catchment to Best Practice Environmental Management Guidelines (**BPEMG**) objectives (CSIRO 1999) for environmental management of stormwater pollutants being:

- Total Suspended Solids (**TSS**) 80% retention of the typical urban annual load;
- Total Phosphorus (**TP**) 45% retention of the typical urban annual load;
- Total Nitrogen (**TN**) 45% retention of the typical urban annual load;
- Gross Pollutants 70% retention of the typical urban annual load; and
- Flows Retardation of the 1.5-year ARI flow to pre-development rates

3 Base Case Indicative SWMS

Drawings 2050/BASE/1-2 (Appendix A.1) detail a ‘mock’ SWMS created assuming the original, unchanged catchment boundaries (see Figure 1 or Table 1).

The section below (and in Appendix A) is not the proposed SWMS, rather it is provided so that at a high level, the benefits of the proposed SWMS catchment changes can be quantified.

3.1 Base Case - Aitken Creek DS (DS 4480)

A combined sediment basin and RB (A5SB1) within a 1.62 ha reserve allocation is required within the Aitken Creek DS region in the ‘base case’ scenario.

In this ‘base case’ condition, at the outlet of A5SB1, the stormwater treatment system attributes can be summarised as:

- PSP development area within the DS 4480 region = 39.8 ha;
- Total Nitrogen generated from PSP development area within the DS 4480 region = 352 kg/yr
- Total Nitrogen retained in A5SB1 = 90 kg/yr

The general ‘look’ of the assets proposed is expected to be similar to that shown in Figure 2.

Figure 2 **Expected look of a Sediment Basin within a Retarding Basin. Source: SWS**

3.2 Base Case - Upper Brodies Creek DS (DS 4381)

The 'base case' scenario proposals would be to follow the existing DS 4381 alignments, directing flows into the DS pipes (B3-B8) east of Mickleham Road and connecting into the downstream Aspect RB.

3.3 Base Case - Gap Catchment

In a 'base case' scenario, it is estimated that:

- A 1.4 ha PSP 'Waterway and Drainage Reserve' allocation would be required on the client's landholding; and
- A 0.6 ha PSP 'Waterway and Drainage Reserve' allocation would be required to service the Other Landholdings in the Gap catchment.

Each of these 'Waterway and Drainage Reserve' allocations would be expected to contain a combined RB, sediment basin and bioretention system to ensure that:

- Mickleham Road is not inundated in the 1% AEP event; and
- BPEMG treatment is achieved.

Note that the 1% AEP outflow restriction requirements (see Section 2.3.4) are in excess of the "usual" predevelopment requirements given the existing capacity of the outlet culverts under Mickleham Road.

The expected look of the Gap Catchment reserves would be as shown in Figure 2.

4 Proposed SWMS

Drawings 2050/SWMS/1-3 (Appendix B.1) detail the SWMS developed. For all catchments, the proposed catchment boundaries as defined in Figure 1 (and drawing 2050/SWMS/1) are assumed. All designs are at the concept design stage and should be further developed during detailed design. Appendix B details the high-level modelling undertaken as part of the proposed SWMS development.

4.1 Proposed SWMS - Aitken Creek DS (DS 4480)

Consistent with the 'base case', asset A5SB1 is proposed as shown in drawing 2050/SWMS/2. In the 'proposed case' (i.e. this SWMS), the size increases to 2.10 ha compared to 1.62 ha in the 'base case'. A5SB1 is a dual function Sediment Basin and RB, again consistent with the 'base case'. Appendix B.2 details the hydrological, hydraulic and stormwater treatment modelling undertaken in the design of A5SB1.

Overall, the asset A5SB1 provides:

- Flow retardation, which reduces the design flows through the downstream Aston wetlands;
- A free draining outfall into the downstream system by setting A5SB1's NWL at 222.40 m AHD;
- 2% AEP (50-year ARI) capacity before the downstream overland flow path is engaged;
- When engaged the overland flow path meets all relevant 1% AEP MWC floodway safety criteria when crossing Debonair Parade (see Appendix B.2.4);
- An approximate 1% AEP level of 223.90 m AHD, providing sufficient freeboard to the existing Aston Stage 18 lots; and
- A sediment basin sized to capture 97% of the pollutants finer than 125 µm in a 4EY event and to have a 7-year cleanout frequency (see Appendix B.2.2).

Appendix B.2.3 shows that in this scenario, the total 46.7 ha PSP catchment generates 422 kg/yr of Total Nitrogen (**TN**), with the proposed A5SB1 asset retaining approximately 109 kg/yr of TN. This retention in TN within the subject site is an opportunity to reduce the DS 4480 water quality contribution for the subject site (subject to Melbourne Water confirmation).

It should be noted that the sediment basin function of this asset is crucial to ensuring the constructed downstream pipe connection to the Aston wetland system does not become blocked with sediment.

4.2 Proposed SWMS - Upper Brodies Creek DS (DS 4381)

The SWMS for the DS 4381 catchment is to generally follow the current DS 4381 proposals (as shown in 2050/SWMS/1). The slight increase in catchment (0.4 ha) due to the revised catchment boundaries results in a negligible change to the DS operation and assumptions. As such, the SWMS for the DS 4381 catchment generally follows the current DS 4381 proposals (as shown in 2050/SWMS/1).

Appendix B.3 details the analysis undertaken for this SWMS, demonstrating that the 0.4 ha increase in catchment has negligible effects on:

- The Aspect RB's flood operation;

- The Aspect RB's stormwater treatment function; and
- The level of service provided by existing constructed DS Pipes.

No stormwater treatment within the DS 4381 subject site catchment is proposed. Rather the applicable contribution rate is proposed to be paid and the subject site serviced in the downstream Aspect RB.

There are no adverse effects on the Aspect RB's function due to the proposed catchment changes.

4.3 Proposed SWMS - Gap Catchment

Given the proposed catchment changes, the Gap catchment area is significantly reduced from 19.4 ha to 12.2 ha. However, despite this reduction in catchment (and thus flows), the existing culverts under Mickleham Road would still not provide 1% AEP protection to the road if the Gap catchment was developed (without an RB) (see Section 2.2.3).

As such, a retardation basin is proposed as shown in 2050/SWMS/3. This will ensure that Mickleham Road has a 1% AEP level of service. Appendix B.4 details the high level calculations performed at this stage to size the RB.

It is proposed to construct a sediment basin within the base of the RB as shown in 2050/SWMS/3. This will provide primary stormwater treatment before flow discharge to the west. This sediment basin will then connect into a small nodal bioretention system which will allow the subject site landholding to achieve BPEMG stormwater pollutant retention.

Appendix B.4 provides details on the sizing of the assets and details the assumptions made regarding the proposals within this catchment.

5 High Level Comparison of the Two Catchment Options

5.1 Aitken Creek DS (DS 4480)

The difference in the two options results in an additional 6.9 ha of catchment contributing to the Aitken Creek DS region. This is increase is negligible when looking at the whole DS (which is approx. 1,715 ha). Importantly though, it provides a significant benefit to the drainage outcomes in the Gap catchment.

Locally, the additional 6.9 ha of catchment slightly increases the 1% AEP inflows into A5, from 9.3 m^3/s to 10.9 m^3/s. However, as an RB is required at A5 in either option (see Section 2.1), the increase in flows can be easily mitigated by providing slightly more flood storage in the proposed SWMS. Overall, this increases the reserve requirements at A5 from 1.62 ha, to 2.10 ha.

The increase in catchment between both options also increases the size of the sediment basin asset required in the base of the RB from 1,700 m^2 (base case) to 2,100 m^2 (proposed SWMS). This is roughly a $260,000 increase in asset construction costs (high level cost estimate to be used for planning purposes only).

As of September 2020, the total DS 4480 rate is $84,850 /ha ($61,854 /ha hydraulic, and $23,043 /ha water quality). Thus, with an extra 6.9 ha of land contributing to DS 4480, the financial effect on the Aitken Creek DS is a net surplus in the order of $250,000 (i.e. funds remaining after deducting the additional $260,000 construction cost) due to the catchment changes proposed (noting that the water quality rate payable will be reduced given the additional TN treatment provided by A5SB1).

Thus, there should be no detrimental net cost effect to the DS due to the changes. Rather, there is likely to be a net benefit to the Aitken Creek DS due to the proposed catchment changes. In the unlikely event that the proposed changes result in a net deficit to the scheme instead of the anticipated net surplus, Peet Craigieburn Pty Ltd acknowledges that it is Melbourne Water's policy not to reimburse construction cost shortfalls (over and above the construction required to meet the objectives of the DS in the 'base case') arising from "developer initiated" scheme changes such as the changes proposed in this SWMS.

5.2 Upper Brodies Creek DS (DS 4381)

There are negligible effects on the Upper Brodies Creek DS due to the proposed catchment changes, and no adverse effects on the Aspect RB due to the proposed catchment changes.

5.3 Gap Catchment

The main benefits of the catchment changes proposed within this SWMS are seen within the Gap Catchment.

The proposed changes reduce the area draining to the Gap Catchment outfall by 7.2 ha. This reduction approximately halves the size of the required reserve on the Client's land from 1.41 ha (base case) to 0.76 ha (proposed SWMS).

This reduction in asset size significantly reduces the ongoing maintenance liability for Hume City Council.

Furthermore, the proposed catchment changes also avoids the need to upgrade the existing culverts under Mickleham Road to provide a 1% AEP level of service; and the total volume of stormwater conveyed through downstream rural properties is significantly reduced.

6 Concluding Remarks and Further Work Required

The SWMS detailed within this report and associated drawing set (2050/SWMS/1-3) details the concept designs of assets required to service the client's Craigieburn West development through three catchments with modified catchment boundaries. The proposed assets will:

- Ensure that there is no downstream increase in 1% AEP flood effects due to the client's Craigieburn West development in any of the three catchments;
- Supplement the stormwater treatment within each catchment;
- Significantly improve the drainage conditions within the Gap catchment.

The concept designs detailed will need to be developed further as the detailed design progresses and development layouts are finalised. Further work required (in addition to the works detailed in drawing set 2050/SWMS/1-3) to develop the concept designs to a functional design standard should include (but is not limited to):

DS 4480 Catchment:

- DS design of the DS 4480 pipe A2-A5 once development layouts are finalised; and
- Sizing of outlets to meet the 1.5-year ARI retention requirement (if applicable).

DS 4381 Catchment:

- DS design of the DS 4381 pipe B1-B8, including confirmation that the existing pipes downstream of B8 are of a suitable capacity.

Gap Catchment:

- An earthworks model of the proposed removal of the embankment to the contours shown in 2050/SWMS/3 including the effects of filling the existing dam for development; and
- Detailed sizing of RB outlets to meet the 1.5-year ARI retention requirement (if applicable) and the 1% AEP retention requirements.

Notwithstanding the above future work to be completed in due course, the designs and calculations presented in this SWMS (and associated Appendices) clearly demonstrate a practical/sensible/logical servicing proposal for client's Craigieburn West development. It is requested MWC and Council review this SWMS and provide approval in principle for both the proposed assets and the catchment changes within this region.

7 References

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Nearmap 2020. *Areal imagery for locations and dates shown on Figures where applicable*.

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8 Abbreviations, Descriptions and Definitions

The following table lists some common abbreviations and drainage system descriptions and their definitions which are referred to in this report.

Abbreviation / Descriptions	Definition
AHD - Australian Height Datum	Common base for all survey levels in Australia. Height in metres above mean sea level.
ARI - Average Recurrence Interval.	The average length of time in years between two floods of a given size or larger. A 100 Year ARI event has a 1 in 100 chances of occurring in any one year.
AEP – Annual Exceedance Probability	The chance of a storm (flow) of that magnitude (or larger) occurring in a given year. $\boldsymbol{AEP} = \mathbf{1} - \boldsymbol{e}^{\left(\frac{-1}{ARI}\right)}$. i.e. 18.13% AEP = 5 Year ARI
BPEMG	Best Practice Environmental Management Guidelines. See CSIRO (1999)
DSS or DS	Development Services Scheme (DSS) or Drainage Scheme (DS) is a master plan developed my MWC for drainage within a catchment area.
EY – Exceedances per year	The amount of times a storm (flow) of that magnitude is expected to be exceeded per year. i.e. 4 EY = 3 Month ARI
Hectare (ha)	10,000 square metres
HECRAS	A hydraulic software package that enables the calculations of flood levels and velocities along a waterway given a specified flow.
Kilometre (km)	1000 metres
m^3/s -cubic metre/second	Unit of discharge usually referring to a design flood flow along a stormwater conveyance system
Megalitre (ML) (1000 cubic metres)	1,000,000 litres = 1000 cubic metres. Often a unit of water body (e.g. pond) size
MUSIC	Hydrologic computer program used to calculate stormwater pollutant generation in a catchment and the amount of treatment which can be attributed to the WSUD elements placed in that catchment
MWC	Melbourne Water Corporation
Retarding basin	A flood storage dam which is normally empty. May contain a lake or wetland in its base
NWL - Normal Water Level	Water level of a wetland or pond defined by the lowest invert level of the outlet structure
NSL – Natural Surface Level	The surface level of the natural (existing) surface before works.
RORB	Hydrologic computer program used to calculate the design flood flow (in m^3/s) along a stormwater conveyance system (e.g. waterway)
Sedimentation basin (Sediment pond)	A pond that is used to remove coarse sediments from inflowing water mainly by settlement processes.
Swale	A small shallow drainage line designed to convey stormwater discharge. A complementary function to the flood conveyance task is its WSUD role (where the vegetation in the base acts as a treatment swale).
TSS	Total Suspended Solids – a term for a particular stormwater pollutant parameter
TP	Total Phosphorus – a term for a particular stormwater pollutant parameter
TN	Total Nitrogen – a term for a particular stormwater pollutant parameter
WSUD - Water Sensitive Urban Design	Term used to describe the design of drainage systems used to: o Convey stormwater safely o Retain stormwater pollutants o Enhance local ecology o Enhance the local landscape and social amenity of built areas
Wetland	WSUD element which is used to collect TSS, TP and TN. Usually incorporated at normal water level (NWL) below which the system is designed as shallow marsh, marsh, deep marsh and open water areas.

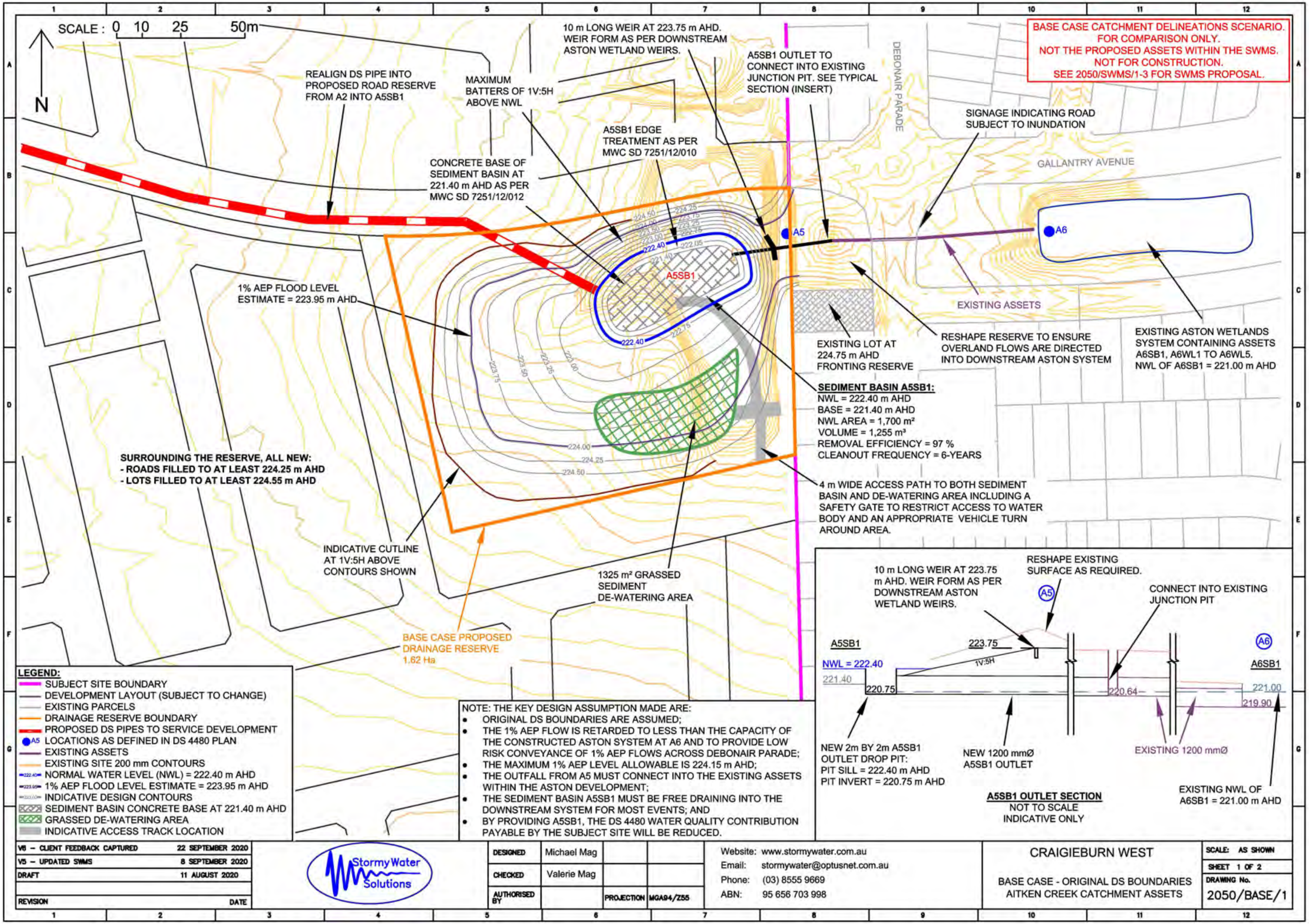
Appendix A 'Base Case' Indicative SWMS Development

The following Appendix is provided so that the referral authorities can have confidence that sufficient analysis has been undertaken to ensure that reasonable estimates of the assets within the 'base case' have been developed.

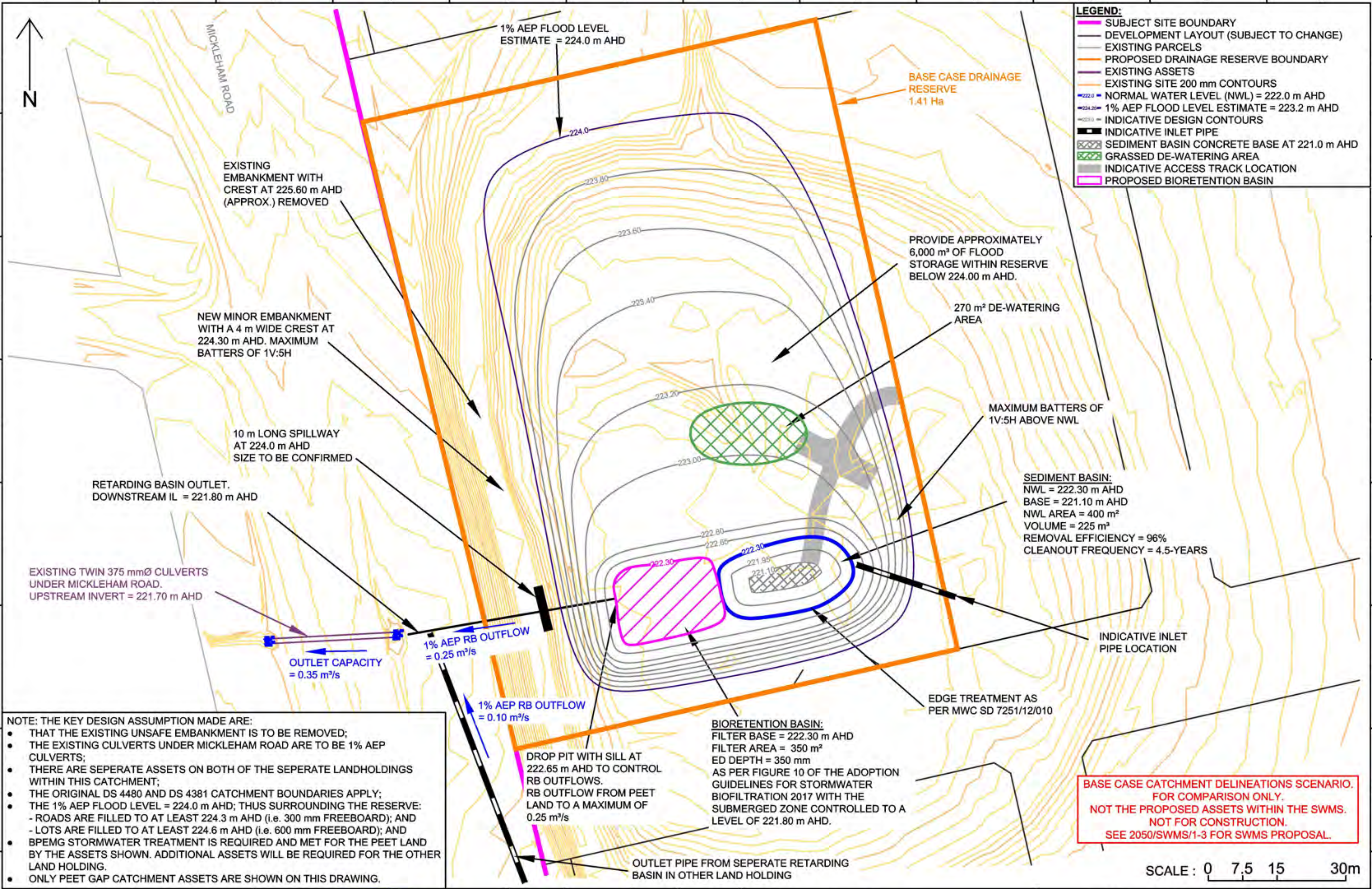
The designs and modelling presented within this Appendix (A) are not the proposed SWMS. Appendix B should be referred to for the calculations relating to the proposed SWMS.

A.1 Base Case - Concept Design Drawings

The following drawings are not the proposed SWMS and are to be used as a high-level reference only when discussing the 'base case'.



SCALE : 0 10 25 50m
N
BASE CASE CATCHMENT DELINEATIONS SCENARIO.
FOR COMPARISON ONLY.
NOT THE PROPOSED ASSETS WITHIN THE SWMS.
NOT FOR CONSTRUCTION.
SEE 2050/SWMS/1-3 FOR SWMS PROPOSAL.
REALIGN DS PIPE INTO PROPOSED ROAD RESERVE FROM A2 INTO A5SB1
MAXIMUM BATTERS OF 1V:5H ABOVE NWL
10 m LONG WEIR AT 223.75 m AHD. WEIR FORM AS PER DOWNSTREAM ASTON WETLAND WEIRS.
A5SB1 OUTLET TO CONNECT INTO EXISTING JUNCTION PIT. SEE TYPICAL SECTION (INSERT)
DEBONAIR PARADE
SIGNAGE INDICATING ROAD SUBJECT TO INUNDATION
GALLANTRY AVENUE
A5SB1 EDGE TREATMENT AS PER MWC SD 7251/12/010
CONCRETE BASE OF SEDIMENT BASIN AT 221.40 m AHD AS PER MWC SD 7251/12/012
A5
A6
A5SB1
1% AEP FLOOD LEVEL ESTIMATE = 223.95 m AHD
EXISTING ASSETS
EXISTING LOT AT 224.75 m AHD FRONTING RESERVE
RESHAPE RESERVE TO ENSURE OVERLAND FLOWS ARE DIRECTED INTO DOWNSTREAM ASTON SYSTEM
EXISTING ASTON WETLANDS SYSTEM CONTAINING ASSETS A6SB1, A6WL1 TO A6WL5. NWL OF A6SB1 = 221.00 m AHD
SEDIMENT BASIN A5SB1:
NWL = 222.40 m AHD
BASE = 221.40 m AHD
NWL AREA = 1,700 m²
VOLUME = 1,255 m³
REMOVAL EFFICIENCY = 97 %
CLEANOUT FREQUENCY = 6-YEARS
SURROUNDING THE RESERVE, ALL NEW:
- ROADS FILLED TO AT LEAST 224.25 m AHD
- LOTS FILLED TO AT LEAST 224.55 m AHD
4 m WIDE ACCESS PATH TO BOTH SEDIMENT BASIN AND DE-WATERING AREA INCLUDING A SAFETY GATE TO RESTRICT ACCESS TO WATER BODY AND AN APPROPRIATE VEHICLE TURN AROUND AREA.
INDICATIVE CUTLINE AT 1V:5H ABOVE CONTOURS SHOWN
1325 m² GRASSED SEDIMENT DE-WATERING AREA
BASE CASE PROPOSED DRAINAGE RESERVE 1.62 Ha
10 m LONG WEIR AT 223.75 m AHD. WEIR FORM AS PER DOWNSTREAM ASTON WETLAND WEIRS.
RESHAPE EXISTING SURFACE AS REQUIRED.
CONNECT INTO EXISTING JUNCTION PIT
A5SB1
NWL = 222.40
221.40
220.75
223.75
1V:5H
220.64
A6SB1
221.00
219.90
NEW 2m BY 2m A5SB1 OUTLET DROP PIT:
PIT SILL = 222.40 m AHD
PIT INVERT = 220.75 m AHD
NEW 1200 mmØ A5SB1 OUTLET
EXISTING 1200 mmØ
EXISTING NWL OF A6SB1 = 221.00 m AHD
A5SB1 OUTLET SECTION
NOT TO SCALE
INDICATIVE ONLY
LEGEND:
SUBJECT SITE BOUNDARY
DEVELOPMENT LAYOUT (SUBJECT TO CHANGE)
EXISTING PARCELS
DRAINAGE RESERVE BOUNDARY
PROPOSED DS PIPES TO SERVICE DEVELOPMENT
A5 LOCATIONS AS DEFINED IN DS 4480 PLAN
EXISTING ASSETS
EXISTING SITE 200 mm CONTOURS
NORMAL WATER LEVEL (NWL) = 222.40 m AHD
1% AEP FLOOD LEVEL ESTIMATE = 223.95 m AHD
INDICATIVE DESIGN CONTOURS
SEDIMENT BASIN CONCRETE BASE AT 221.40 m AHD
GRASSED DE-WATERING AREA
INDICATIVE ACCESS TRACK LOCATION
NOTE: THE KEY DESIGN ASSUMPTION MADE ARE:
• ORIGINAL DS BOUNDARIES ARE ASSUMED;
• THE 1% AEP FLOW IS RETARDED TO LESS THAN THE CAPACITY OF THE CONSTRUCTED ASTON SYSTEM AT A6 AND TO PROVIDE LOW RISK CONVEYANCE OF 1% AEP FLOWS ACROSS DEBONAIR PARADE;
• THE MAXIMUM 1% AEP LEVEL ALLOWABLE IS 224.15 m AHD;
• THE OUTFALL FROM A5 MUST CONNECT INTO THE EXISTING ASSETS WITHIN THE ASTON DEVELOPMENT;
• THE SEDIMENT BASIN A5SB1 MUST BE FREE DRAINING INTO THE DOWNSTREAM SYSTEM FOR MOST EVENTS; AND
• BY PROVIDING A5SB1, THE DS 4480 WATER QUALITY CONTRIBUTION PAYABLE BY THE SUBJECT SITE WILL BE REDUCED.
V6 – CLIENT FEEDBACK CAPTURED 22 SEPTEMBER 2020
V5 – UPDATED SWMS 8 SEPTEMBER 2020
DRAFT 11 AUGUST 2020
REVISION DATE
Stormy Water Solutions
DESIGNED Michael Mag
CHECKED Valerie Mag
AUTHORISED BY
PROJECTION MGA94/Z55
Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998
CRAIGIEBURN WEST
BASE CASE - ORIGINAL DS BOUNDARIES AITKEN CREEK CATCHMENT ASSETS
SCALE: AS SHOWN
SHEET 1 OF 2
DRAWING No. 2050/BASE/1



NOTE: THE KEY DESIGN ASSUMPTION MADE ARE:

- THAT THE EXISTING UNSAFE EMBANKMENT IS TO BE REMOVED;
- THE EXISTING CULVERTS UNDER MICKLEHAM ROAD ARE TO BE 1% AEP CULVERTS;
- THERE ARE SEPERATE ASSETS ON BOTH OF THE SEPERATE LANDHOLDINGS WITHIN THIS CATCHMENT;
- THE ORIGINAL DS 4480 AND DS 4381 CATCHMENT BOUNDARIES APPLY;
- THE 1% AEP FLOOD LEVEL = 224.0 m AHD; THUS SURROUNDING THE RESERVE:
  - ROADS ARE FILLED TO AT LEAST 224.3 m AHD (i.e. 300 mm FREEBOARD); AND
  - LOTS ARE FILLED TO AT LEAST 224.6 m AHD (i.e. 600 mm FREEBOARD); AND
- BPEMG STORMWATER TREATMENT IS REQUIRED AND MET FOR THE PEET LAND BY THE ASSETS SHOWN. ADDITIONAL ASSETS WILL BE REQUIRED FOR THE OTHER LAND HOLDING.
- ONLY PEET GAP CATCHMENT ASSETS ARE SHOWN ON THIS DRAWING.

REVISION	DATE
V6 – CLIENT FEEDBACK CAPTURED	22 SEPTEMBER 2020
V5 – UPDATED SWMS	8 SEPTEMBER 2020
DRAFT	11 AUGUST 2020

Stormy Water Solutions

DESIGNED	Michael Mag
CHECKED	Valerie Mag
AUTHORISED BY	
PROJECTION	MGA94/Z55

Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998

CRAIGIEBURN WEST

BASE CASE - ORIGINAL DS BOUNDARIES GAP CATCHMENT ASSETS

SCALE: AS SHOWN

SHEET 2 OF 2

DRAWING No. 2050/BASE/2

A.2 Base Case - Aitken Creek DS (DS 4480)

Note: Significantly more reporting detail has been provided for the Aitken Creek DS catchment compared to the other catchments as the majority of the catchment changes proposed in the SWMS affect Aitken Creek DS catchment.

A.2.1 Hydrological Modelling

The RORB Runoff Routing Program (Version 6.45) was used to determine the 4 EY, 18%, 10% and 1% AEP (3-month, 5-year, 10-year and 100-year ARI) post-development design flows originating from the DS4480 catchment (upstream of the Aston Eastern Outfall) including the effects of the proposed new retarding basin (asset A5SB1). RORB is a general runoff and stream flow routing program used to calculate flood hydrographs from rainfall and other channel inputs. It subtracts losses from rainfall to produce rainfall excess and routes this through catchment storage to produce the hydrograph.

The RORB model has been developed primarily:

- To ensure that the flows within the Aston Wetlands systems are at or below those assumed within the 2010 Report;
- To ensure flows are retarded so that the overland flow connection to the downstream wetland system can be designed to current safety standards; and
- To quantify the benefits of the proposed retarding basin A5SB1.

A.2.1.1 Model Description

Catchment delineations have been based on the following sources:

- As Constructed plans for Aston Stages 1-30 and 32 (for catchments within the existing Aston Estate);
- The existing DS 4480 plan (for external catchment boundaries).

Figure A.1 details the RORB model for the post-development conditions and Tables A.1 and A.2 detail the tabulation of the RORB model setup (i.e. catchment area, fraction imperviousness, reach lengths, etc).

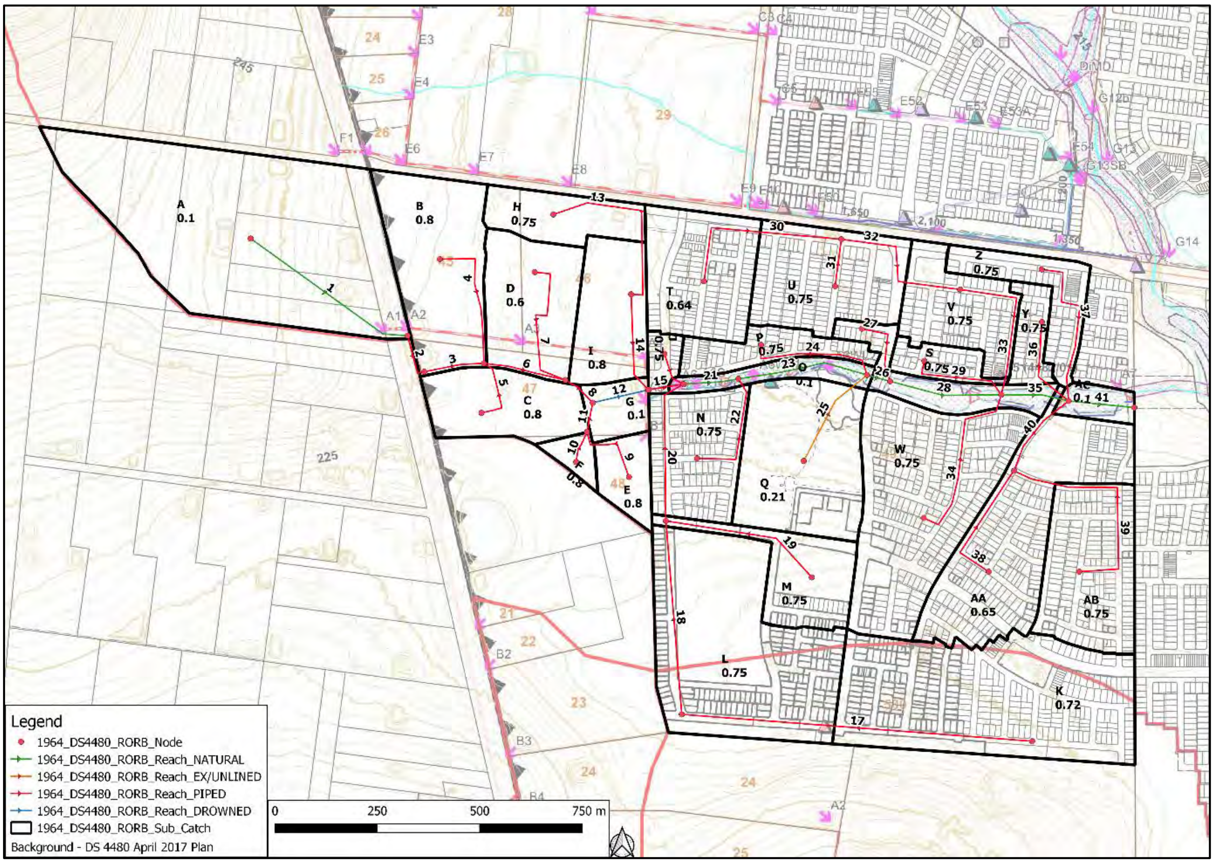


Figure A.1 'Base Case' RORB Model Layout (Existing DS Catchments)

Table A.1 RORB Sub-Catchment Details

Sub Area	Area (ha)	Area (km^2)	Fraction Imperviousness
A	28.5	0.285	0.10
B	10.4	0.104	0.80
C	6.0	0.060	0.80
D	7.5	0.075	0.60
E	2.5	0.025	0.80
F	1.1	0.011	0.80
G	2.1	0.021	0.10
H	4.2	0.042	0.75
I	5.9	0.059	0.80
J	1.1	0.011	0.75
K	20.0	0.200	0.72
L	18.4	0.184	0.75
M	5.5	0.055	0.75
N	6.9	0.069	0.75
O	2.4	0.024	0.10

Sub Area	Area (ha)	Area (km^2)	Fraction Imperviousness
P	3.4	0.034	0.75
Q	11.0	0.110	0.21
R	1.0	0.010	0.75
S	1.9	0.019	0.75
T	8.1	0.081	0.64
U	8.8	0.088	0.75
V	6.0	0.060	0.75
W	16.0	0.160	0.75
X	3.0	0.030	0.10
Y	2.1	0.021	0.75
Z	4.2	0.042	0.75
AA	13.5	0.135	0.65
AB	8.8	0.088	0.75
AC	1.5	0.015	0.10
Total	**211.7**	**2.117**	**0.59**

Note: A significantly higher F_{imp} has been utilised within this modelling (0.80 for new development and 0.75 for existing development) compared to the F_{imp} of 0.50 assumed within the 2010 Report.

Table A.2 RORB Reach Details

Reach	Reach Type	Length (km)	Slope (%)	Reach	Reach Type	Length (km)	Slope (%)
1	1	0.459		**22**	3	0.299	1.67%
2	3	0.112	0.33%	**23**	1	0.323	
3	3	0.147	1.02%	**24**	3	0.322	1.24%
4	3	0.344	0.44%	**25**	2	0.266	1.88%
5	3	0.174	0.33%	**26**	1	0.058	
6	3	0.204	0.61%	**27**	3	0.183	2.19%
7	3	0.370	0.33%	**28**	1	0.276	
8	3	0.087	0.33%	**29**	3	0.245	1.51%
9	3	0.184	0.71%	**30**	3	0.451	0.33%
10	3	0.079	1.07%	**31**	3	0.116	1.38%
11	3	0.073	0.76%	**32**	3	0.373	0.54%
12	4	0.140		**33**	3	0.379	0.79%
13	3	0.456	0.33%	**34**	3	0.430	2.33%
14	3	0.247	0.33%	**35**	1	0.166	
15	3	0.087	0.92%	**36**	3	0.229	1.31%
16	3	0.094	3.74%	**37**	3	0.407	0.98%
17	3	0.858	0.33%	**38**	3	0.324	3.39%
18	3	0.474	0.55%	**39**	3	0.554	2.17%
19	3	0.402	0.87%	**40**	3	0.222	2.71%
20	3	0.362	1.94%	**41**	1	0.161	
21	1	0.134					

Note: RORB reach type numbers correspond to:

1 = Natural Reach

2 = Ex/Unlined Reach

3 = Piped Reach

4 = Drowned Reach

A.2.1.2 Model Parameters

The model has been simulated with the following parameters:

K_c = 1.84 m = 0.8 IL = 15 mm $RoC_{1\%AEP}$ = 0.6

Data hub location: (37.595 S, 144.888 E), accessed 8/10/2019

Where the K_c value has been derived by utilising approximately a constant K_c to d_{av} ratio from the ‘proposed’ scenario modelling in Appendix B.

No pre-burst from the ARR 2019 datahub has been used in the modelling. The MWC regional parameter set has been determined using ARR 1987 practices. In ARR 1987, the temporal patterns available represented bursts (see Section 3.2 of ARR 1987), not complete storms. In addition, the MWC parameter sets were determined by fitting parameters to observed storm bursts. Therefore, it can be assumed that the IL value determined by MWC accounts for pre-burst effects. As such, the regional parameter set IL values are deemed applicable for use on the burst temporal patterns download from the ARR 2019 datahub without consideration of pre-burst effects.

Further, the effective impervious area (**EIA**) and indirectly connected area (**ICA**) surface type splitting's recommended in ARR 2019 have not been used. These splitting's rely on the information being estimated from GIS sources, which is not entirely available given this modelling is for design of new development, not only existing land uses. Further, the EIA and ICA concepts introduce an additional complexity into the modelling, which given the many uncertainties with these estimates, may not produce better final design outcomes. Modelling without EIA and ICA will likely produce conservative results (i.e. higher flows and volumes) (Chapter 5.3.4.1.2, Book 5, ARR 2019).

A.2.1.3 Model Verification

It is required to check the estimated flows against other flow calculation methods to ensure the RORB model developed is valid for application.

Table A.3 shows the verification of the 18% AEP and 1% AEP flows at the proposed retarding basin location with the Probabilistic Rational Method. Overall, the estimates are similar (with RORB being slightly higher).

Table A.3 'Base Case' RORB Model Verification at FP3

Method	FP3	
	$Q_{1\%AEP}$ (m^3/s)	$Q_{18\%AEP}$ (m^3/s)
RORB[1.]	9.30	3.50
Regression Curve (Urban)[2.]	7.85	N/A
Rational[3.]	9.90	3.80

Notes: [1.] *No SSD included in the model for verification purposes.*

[2.] *Urban Nikoloau/vont Steen equation from p11, of Melbourne Water (2018a).*

[3.] *Rational Assumptions:* $C_5 = 0.50$, $t_c = 25$ *min*

A.2.1.4 Base Case Retarding Basin Concept

A RB is proposed in the void space above the future sediment pond asset (A5SB1) at approximately FP3 as defined within Figure A.1.

The A5SB1 asset is proposed to:

- Ensure that the design flows assumed within the 2010 Report through the existing Aston wetlands are not exceeded;
- Ensure flows are retarded so that the overland flow connection to the downstream wetland system can be designed to current safety standards;
- Enable some stormwater treatment to complement the downstream wetland systems; and
- To protect the downstream pipe connection (constructed) between this asset and the existing Aston wetland system from sediment blockage.

The RB has not been designed to meet pre-development flows at FP3, as the 2010 Report designed the downstream system assuming development of the subject site. However, among other reasons, the assumed increase in F_{imp} of the development, and the change in ARR practices has resulted in the need for a RB at FP3.

The NWL of A5SB1 has been set at 222.40 m AHD to allow 'independence' from the downstream A6SB1 sediment basin system (which has an NWL of 221.00 m AHD). A concept for the outlet from A5SB1 is as shown in drawing 2050/BASE/1 and is proposed to connect into the existing 1200 mmØ inlet into the downstream system. A 10 m long high-flow spillway is proposed along the east of the asset (at a level of 223.75 m AHD) to ensure that the local 1% AEP flood level is below 224.15 m AHD (to provide at least 600 mm freeboard to existing Aston Stage 18 lot 1801, which has a RL of 224.75 m AHD fronting the proposed asset (see Appendix C).

The flood storage (above 222.40 m AHD) has been estimated from the design contours shown in drawing 2050/BASE/1.

The resultant Stage, (Flood) Storage, Discharge (**SSD**) relationship for the reading basin is provided in Table A.4 below.

Table A.4 Base Case A5SB1 Retarding Basin SSD relationship

Stage (m AHD)	Storage (m^3)	Q[2.] (m^3/s)
222.40[1.]	0	0.0
222.50	175	0.5
222.75	650	2.1
223.00	1,290	2.3
223.25	2,220	2.5
223.50	3,400	2.7
223.75[3.]	8,940	2.8
224.00	6,895	5.5
224.25	9,265	10.3
224.50	11,980	16.3

Notes: [1.] *Base of the retarding basin set as the Sediment Basin Normal Water Level set to achieve a free draining outflow.*

[2.] *Outflow calculated using an hydraulic grade line analysis utilising the a HECRAS model of the downstream wetland system to generate tail water levels for various flow rates, and accounting for the increase in flow rates from the other DS pipe that discharges into A6SB1 from the south.*

[3.] *Spillway level at which the Debonair Parade overland flow path is engaged (approximately at the local 5% AEP level)*

There may be scope in future design iterations to reduce the ultimate size of this asset.

A.2.1.5 Model Results

The model has been simulated for the major (1% AEP) and minor (18% AEP) storm events using the full ensembles of 240 temporal patterns as required in ARR 2019. The results from these simulations are provided in Table A.5.

Note, the 18% AEP storm events have been used instead of the 20% AEP storm events for the minor system design flows to produce slightly conservative estimates of minor system flows.

Table A.5 ‘Base Case’ RORB Model Results at A5SB1 (Existing DS Catchment)

Location ID[1.]	Output	1% AEP		10% AEP		18% AEP	
FP3 - RB INFLOW	Flow[2.]	9.3	m^3/s	4.4	m^3/s	3.5	m^3/s
	Critical Duration	20	minute	20	minute	20	minute
FP3 - RB OUTFLOW	Flow[2.]	4.7	m^3/s	2.40	m^3/s	2.20	m^3/s
	Critical Duration	1	hour	30	minute	20	minute
	Flood Storage[3.]	8,800	m^3	2,400	m^3	1,300	m^3
	Flood Level Estimate[4.]	223.95	m AHD	223.15	m AHD	222.90	m AHD

Notes: [1.] *See Figure A.1 for locations*

[2.] *Peak Average flow for the 10 temporal patterns analysed for the critical duration*

[3.] *Rounded up to the nearest 50* m^3

[4.] *Rounded to the nearest 50 mm*

A.2.2 *Sediment Basin Calculations*

A.2.2.1 Sediment Basin Size

Table A.6 below details the sizing of asset A5SB1 in the base case scenario.

Table A.6 Asset A5SB1 Sediment Basin Sizing Calculations – Base Case

Assumed Asset Properties		
Asset ID =	A5SB1	
Normal Water Level = NWL =	222.4	m AHD
NWL Area = (A_{asset}) =	1700	m^2
Pond Depth = (d_p) =	1.00	m
Extended Detention Depth = (d_e) =	0.00	m
Volume = (Vol_{TOT}) =	1255	m^3
Sump Volume[1.] = (Vol_S) =	735	m^3
4EY Inflow[2.] = (Q_{4EY}) =	1.0	m^3/s
Assumed Hydraulic efficiency[3.] = λ =	0.26	
Upstream Catchment Area = (A_{Catch}) =	68.3	ha
Target Particle Settling Velocity[4.] = (V_s) =	0.011	m/s
Removal Efficiency		
d* = max (d_p, 1) =	1.0	
$\frac{d_e + d_p}{d_e + d^*} =$	1.0	
$\frac{V_s \times A_{asset}}{Q_{4EY}} =$	11.0	
$n = \frac{1}{1 - \lambda} =$	1.35	
$Removal\ efficiency^{5.} = R = 1 - \left[1 + \frac{1}{n} \times \frac{V_s \times A_{asset}}{Q_{4EY}} \times \frac{d_e + d_p}{d_e + d^*}\right]^{-n} =$	**97%**	
Cleanout Frequency		
Sediment Load[6.] = (L_s) =	1.6	m^3/ha/year
Gross Pollutant Load[7.] = (L_{GP}) =	0.4	m^3/ha/year
$Cleanout\ Frequency = \frac{R \times (L_S + L_{GP}) \times A_{Catch}}{Vol_S} =$	**6**	**years**
Dewatering Area Required ((assuming 500 mm deep layout & 5-year cleanout frequency) =	**1330**	m^2

Notes: [1.] *Sump volume taken as the volume below 350mm deep (i.e. below the safety bench).*

[2.] *Flow from RORB Model*

[3.] *Hydraulic efficiency estimated from Figure 4.3 of Melbourne Water 2005.*

[4] *Target particle size taken as 125 μm (as per criteria SP3 of Melbourne Water 2018c) with a settling velocity sourced from Table 4.1 of Melbourne Water 2005.*

[5.] *Methodology taken from Chapter 4.3.2 of Melbourne Water 2005.*

[6.] *Load estimate sourced from Willing and Partners 1992.*

[7.] *Load estimate sourced from Allison et. al. 1998.*

A.2.2.2 Sediment Basin Velocity Check – Base Case

The Melbourne Water "Wetland Design Manual, Part A2: Deemed to Comply Criteria" (2018c) criteria SP3 requires:

> "*that velocity through the sediment pond during the peak 100 year ARI event is ≤ 0.5 m/s.*"

Note: SP3 states the 100-year ARI velocity should be calculated using TED, while the methodology in Part D of the Manual states the 10-year ARI level should be used. The 10-year ARI (10% AEP) level has been used going forward.

Table A.7 below shows how this condition is met for the western sediment pond (SPW).

Table A.7 A5SB1 1% AEP Velocity Check

Step	Description	Label	Value	Unit
1a	1% AEP Flow through Sediment Pond (FP3)	Q	9.3	m^3/s
2 (i)	NWL	NWL	222.40	m AHD
2 (ii)	10% AEP Level Estimation[1.]	FL	223.15	m AHD
3 (i)	Narrowest Width at NWL[2.]	W_{NWL}	21.0	m
3 (ii)	Narrowest Width at 10% AEP Level	$W_{10\%AEP}$	30.0	m
4	Flow Area = $\frac{W_{10\%AEP}-W_{NWL}}{2} \times (FL - NWL) =$	A	19.1	m^2
5	Flow Velocity = $\frac{Q}{A}$ =	**V**	**0.50**	**m/s**
Check	SP3 Requirement, V <		0.50	m/s
	Requirement Met?		**YES**	

Notes: 1. See RORB Modelling

2. This is the narrowest width able to meet the requirement. A width larger than this value will be provided.

A.2.3 Continuous Simulation Modelling

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.3.0) has been used to assess the proposed design and to quantify the stormwater retention benefits of the proposed treatment train.

A.2.3.1 Model Description

A.2.3.1.1 Catchments

Subareas and fraction imperviousness used in the MUSIC modelling are as detailed in the RORB model. However, for quicker simulation times, groups of catchments have been condensed within MUSIC as shown in Table A.8.

Table A.8 Base Case MUSIC Source Nodes

RORB Catchments and MUSIC Node ID	Area (ha)	F_{imp}
A	28.4	0.10
B-I	39.8	0.72
J-M	44.9	0.74
N	6.9	0.75
O	2.4	0.10
P-R	15.4	0.36
S-W	40.8	0.73
X	3.0	0.10
Y-AB	28.6	0.70
AC	1.5	0.10

Sub areas are subject to change given the final development layout, however, provided the criteria of directing as much catchment as possible to (or close to) the defined inlet locations is adhered to, the final MUSIC results are not expected to change significantly.

As per MWC's Guidelines for the Use of MUSIC (Melbourne Water, 2018b), "Mixed" source node typing has been used to model the pollutants generated from the catchment.

Rainfall-Runoff parameters as recommended in the Melbourne Water Guidelines for the Use of MUSIC (2018b) have been utilised.

It should be noted, the assumptions regarding catchment delineations, specifically the inlets into the Aston wetland system, made in the 2010 Report have not completely been captured within the Aston development. As such, the modelling detailed herein is based on the constructed pipe alignments within Aston.

A.2.3.1.2 Climate Data

MWC's Guidelines for the Use of MUSIC (Melbourne Water, 2018b) recommends a 10-year rainfall and evapotranspiration reference period at 6-minute time intervals be used in the continuous simulation modelling. For this region of Melbourne, MWC recommend using 10-years of Melbourne Airport Rainfall from 1971 to 1980 with a mean annual rainfall of 575 mm/year.

This recommended gauge is however not appropriate for use has it has a large gap from approximately January 1980 until June 1980 where data is missing. Analysis of the daily data for this gauge (086282) shows that it indeed did rain during this period. Thus, the reference gauge is not appropriate for use.

As such, SWS has used the same gauge but from 1981 until 1991 which during this period received a mean annual rainfall of 522 mm/yr. This period is a complete data set with no gaps.

The nearby Greenvale Reservoir rainfall gauge (Gauge number: 086305) has a mean annual rainfall of 612.5 mm/yr. As such, the period used by SWS is representative of a drier period in the region.

A.2.3.1.3 Treatment Element Modelling

The Sediment Basin detailed in Appendix A.2.2 has been modelled. Further, the existing Aston wetland system has also been modelled as per the details in the 2010 Report (which have been confirmed to be relatively representative of the constructed assets). Table A.9 below details all treatment elements modelled.

Table A.9 Treatment Element Details within the MUSIC Model

Asset Type	Asset ID	NWL Area (m^2)	Permanent Pool Volume (m^3)	Inlet Pond Volume (m^3)	ED Depth (m)	ED Time (hrs)	Overflow Weir Length (m)
Proposed Sediment Basin	A5SB1	1,700	1,250	N/A	0	0	10
Existing Sediment Basin	A6SB1	1,700	2,550	N/A	0	0	22.8
Existing Wetland	A6WL1	4,200	1,260	0	0.35	48	30
Existing Wetland	A6WL2	5,330	1,600	0	0.35	48	5
Existing Wetland	A6WL3	9,050	2,700	0	0.35	48	30
Existing Wetland	A6WL4	6,000	1,800	0	0.35	48	5
Existing Wetland	A6WL5	7,225	2,150	0	0.5	48	24

A.2.3.1.4 Hydrologic Routing

No routing has been utilised within the MUSIC modelling undertaken.

A.2.3.1.5 Model Schematic

Figure A.2 below details the model schematic.

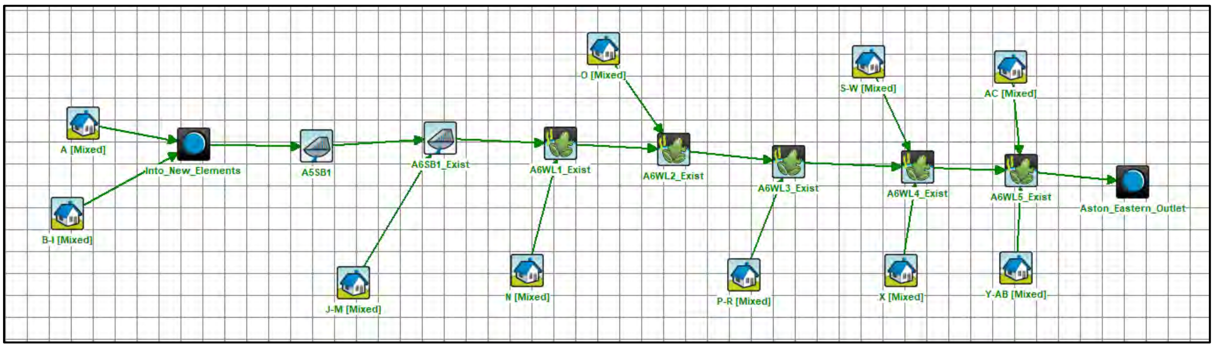


Figure A.2 MUSIC Model Schematic

Note that the model assumes the external DS catchment (west of Mickleham Road) receives no treatment before the subject site treatment elements.

A.2.3.2 Stormwater Pollutant Retention Results

Clause 56.07-4 of the Victorian State Planning provisions states that urban stormwater management systems must be designed to meet current best practice management performance objectives for stormwater quality management in the Urban Stormwater – Best Practice Environmental Management Guidelines (CSIRO 1999).

The Best Practice Environmental Management Guidelines (**BPEMG**) objectives for environmental management of stormwater pollutants are:

- Total Suspended Solids (TSS) 80% retention of the typical urban annual load;
- Total Phosphorus (TP) 45% retention of the typical urban annual load;
- Total Nitrogen (TN) 45% retention of the typical urban annual load; and
- Gross Pollutants 70% retention of the typical urban annual load.

Table A.10 details the pollutant retention results at the inlet to the existing wetland system (FP3 outlet, see Figure B.1) and Table A.11 details the pollutant retention results at the eastern outlet of the catchment (i.e. the eastern boundary of Aston, FP5 in Figure B.1).

Table A.10 Stormwater Pollutant Removal at Sediment Basin A5SB1

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	27,300	10,200	21,300	62.5%
Total Phosphorus	57	31	26	45.5%
Total Nitrogen	411	321	90	21.7%
Gross Pollutants	5,650	0	5,650	100.0%

Table A.11 Stormwater Pollutant Removal of Entire Aston System (with A5SB1 included)

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	110,000	31,800	78,200	71.0%
Total Phosphorus	225	88	137	60.9%
Total Nitrogen	1,590	968	622	39.2%
Gross Pollutants	22,800	0	22,800	100.0%

The 2010 Report indicated that at FP5, BPEMG could be met for the entire DS catchment upstream of this location due to the combined effect of the series of wetlands. However due to following reasons, the results from the 2010 Report are no longer valid (though they were at the time):

- A change in F_{imp} assumption from 0.50 to 0.75-0.80 for the catchment;
- A change in MUSIC modelling ‘best practice’ being:
  - The use of 10-years of climate data, not 1-year;
  - A change in ‘Pervious Area Properties’ due to updated MUSIC guidelines (Melbourne Water 2018b);

- A more detailed catchment model of the Aston Estate based on as constructed drawings, which now directs a large part of the catchment (which was assumed to enter A6WL3), to now enter the downstream A6WL4; and
- The assumption that at FP3 (point A5 in the 2010 Report) that the upstream catchment would be treated to best practice before discharge into the Aston Wetlands (though this was not ultimately captured within the DS 4480 proposals).

It should be noted, if BPEMG treatment occurred at FP3 (rather than just the proposed A5SB1 asset), with the current modelling, the DS would still not be able to meet BPEMG at FP5 due to the changes detailed above.

As such, it is proposed that to meet the BPEMG requirements for the development, the developers of the subject site would pay a reduced water quality DS 4480 rate.

A.2.4 Debonair Parade Hydraulic Modelling

As per Appendix A.2.1, in the 1% AEP event it is expected that 1.9 m^3/s will be required to be conveyed overland across (perpendicular) to Debonair Parade from the west to the east.

It must be shown that the crossing meets the relevant Melbourne Water floodway safety criteria as defined within Figure A.3.

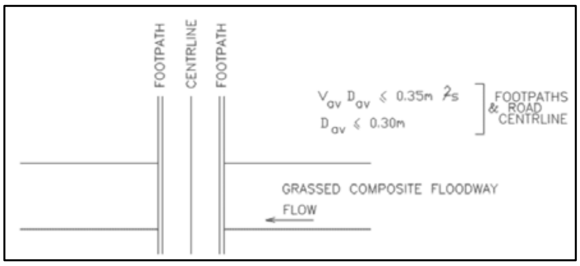


Figure A.3 Relevant Floodway Safety Conditions (Source: Figure A7, Melbourne Water 2017)

A preliminary HECRAS model between the proposed A5SB1 and existing A6SB1 has been developed including the crossing of Debonair Parade utilising site survey (from Appendix C.4).

The model indicates that when crossing Debonair Parade, the 1% AEP flow profile has:

- A maximum depth = D_{max} = 290 mm;
- An average depth = D_{ave} = 235 mm;
- An average velocity = V_{ave} = 0.17 m/s; and
- A 1% AEP hazard = Hazard = 0.04 m^2/s (= $D_{ave} \times V_{ave}$).

As such, the crossing meets both the velocity and hazard requirements of Melbourne Water (2017).

It is also recommended to erect signage adjacent to the cobble stone section of Debonair Parade where the crossing occurs indicating that the road may be subject to inundation.

In terms of alternative access; there are multiple other north to south crossings (Vintage Boulevard and Champion Parade) which would allow crossings from the south to the north of the existing Aston stages.

A.3 Base Case - Upper Brodies Creek DS (DS 4381)

The base case scenario development of the Upper Brodies Creek DS region is to follow the DS proposals. That is, directing flows south adjacent to Mickleham Road into the constructed wetland/retarding basin at 1110 Mickleham Road, Greenvale, 3059 (hereby referred to as the Aspect RB).

A.3.1 Potential Flood Impacts

The Aspect RB was originally designed by Neil Craigie in 2013 utilising ARR1987 practices. This design set the critical 1% AEP (100-year ARI) outflow from the Aspect RB at 2.9 m^3/s, at a flood level of 188.46 (say 188.50) m AHD.

Subsequently, the design was developed by SMEC and constructed in the middle of 2016. The as constructed design largely replicates the Neil Craigie 2013 Report, with the only major variation being in the location of the 20 m long high flow spillway, which now fronts Mickleham Road (following the recommendations of SMEC's ANCOLD assessment).

SWS has assessed the as constructed outflow arrangement of the Aspect RB and found that it mostly replicates that assumed by the Neil Craigie 2013 Report. As such, the Neil Craigie 2013 design stage/storage/discharge (SSD) relationship will be utilised herein for all modelling proposals.

However, it appears as though the catchment delineations have slightly changed since the development of the Neil Craigie 2013 modelling. Hence, a revised model reflecting the current DS layout has been created by SWS.

Since the Neil Craigie 2013 Report there have been major changes in methodology and assumptions within the catchment, specifically:

- A general increase in the assumed F_{imp} (as captured in Table C.1)
  - from 0.60 for the Aspect estate to 0.75; and
  - from 0.60 for the future developments in the region to 0.80 for the future development,

  both of which result in the catchment generating more runoff than assumed within the Neil Craigie 2013 modelling;
- A change in ARR practices from ARR 1987 to ARR 2019, particularly
  - A change in rainfall depths;
  - A change in temporal patterns; and
  - A change in hydrological modelling simulation framework.

Table A.12 details the effects of the above on the Aspect RB. Overall, the Aspect RB is generally expected to operate as originally designed.

Table A.12 Aspect RB hydrological model results

ARR Methodology	Model Output	Scenario: Neil Craigie 2013	Scenario: Base Case DS Layout - SWS
1987	Aspect RB $Q_{1\%AEP}$ Inflow (m^3/s)	20.8	21.6
	Critical Duration	20-minute	20-minute
	Aspect RB $Q_{1\%AEP}$ Outflow (m^3/s)	2.9	3.5
	Critical Duration	2-hour	2-hour
	Aspect RB 1% AEP Flood Level (m AHD)[1,]	188.46	188.52
2019	Aspect RB $Q_{1\%AEP}$ Inflow (m^3/s)	19.6	20.0
	Critical Duration	20-minute	20-minute
	Aspect RB $Q_{1\%AEP}$ Outflow (m^3/s)	3.8	4.4
	Critical Duration	2-hour	2-hour
	Aspect RB 1% AEP Flood Level (m AHD)[1.]	188.53	188.56

Notes: [1.] Flood levels have been exactly reproduced from the RORB models within the Table. However, in practice, all levels should be rounded to the next highest 100 mm, resulting in essentially the same flood level between the scenarios.

From Table A.12 it can be seen that the change in ARR practices results in an increase in outflows from the Aspect RB for all scenarios. For retarding basins, this change is predominantly due to the changes in model simulation framework from single to ensemble events (see ARR 2019 Book 4, Chapter 3.2). This variance does not mean that the Neil Craigie 2013 Report was incorrect, or that the as constructed asset is not working. This is an effect that will be present in all assets of this age due to the change in ARR methodology.

A.3.2 Potential Stormwater Treatment Impacts

The DS 4381 proposes two treatment assets, a wetland within the Aspect RB base and a bioretention system on property 28 of the DS. Flows from the subject site bypass the bioretention system, and as such, only effect the stormwater treatment of the wetland.

Neil Craigie 2013 Report's original MUSIC model has not been used for the comparison as it only used 1-year of climate data and utilised non-current runoff generation parameters. Rather, a new model has been developed utilising the current DS layouts, with current MWC's Guidelines for the Use of MUSIC (Melbourne Water, 2018b) datasets and an increased F_{imp} for the catchment. The new model does however utilise Neil Craigie 2013 Report's original wetland node.

It should be noted, that (primarily) due to the increased in assumed F_{imp}, the current DSS proposals cannot treat the catchment to best practice. Table A.13 summarises the model results at the outlet of the Aspect RB system.

Table A.13 Expected on Aspect wetland performance

Proposal:		Current DS Boundary
TSS	Source (kg/yr)	53,500
	Residual (kg/yr)	15,300
	Retained (kg/yr)	38,200
	% reduction	**71.4%**
TP	Source (kg/yr)	108
	Residual (kg/yr)	43
	Retained (kg/yr)	65
	% reduction	**60.0%**
TN	Source (kg/yr)	763
	Residual (kg/yr)	468
	Retained (kg/yr)	295
	% reduction	**38.7%**

A.4 Gap Catchment

A.4.1 Performance Targets

Usual practice is to provide 1% AEP post-development flow retardation to pre-development levels. However, in existing conditions, immediately upstream, and downstream of the gap catchment outfall there are various aspects as described below and in Figure A.4.

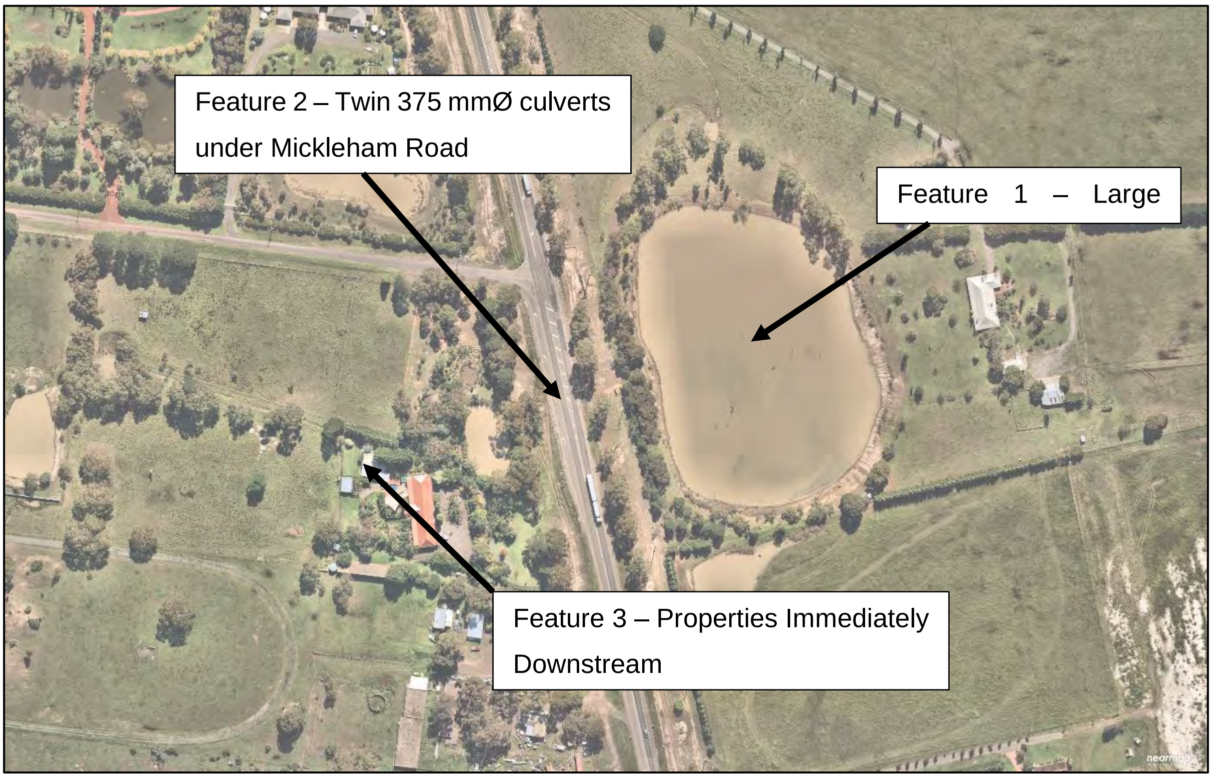


Figure A.4 Annotated Existing conditions of the Gap catchment Outlet. Source: Nearmap Image Captured on 9/4/20

<u>Feature 1 – Large Dam</u>

Preliminary calculations show that this dam (above a typical normal water level) has enough void volume to capture the entire 1% AEP pre-development runoff volume without spillage.

As such, in the existing conditions, there would be minimal runoff from the gap catchment crossing Mickleham Road.

However, the embankment of the Dam is not expected to be to an appropriate structural standard. The embankment is an informal, high spoil mound with trees located on the crest and batters. In addition, the waterbody is significantly too large for its catchment which probably results in it being prone to turnover and water quality issues. Thus, it is recommended that the existing dam be decommissioned during the development process.

<u>Feature 2 – Twin 375 mmØ culverts under Mickleham Road</u>

Survey provided by Peet indicate that these culverts have a capacity of 0.35 m^3/s before Mickleham Road (giving 300 mm freeboard to Mickleham Road). Given Mickleham Road is a major road, it is assumed that the existing culverts will be required to have a 1% AEP level of service once development of the upstream catchment occurs.

<u>Feature 3 – Properties Immediately Downstream (West of Mickleham Road)</u>

It appears that buildings are placed close to drainage lines and may be subject to inundation if flows are significantly increased crossing Mickleham Road.

Given the discussions on each of the three aspects above, SWS propose that, rather than retarding to 1% AEP pre-development flow rates (which is approximately 1.4 m^3/s if there was no dam), the following hydrological targets be proposed for the PSP Gap catchment outfall:

- Removal of the existing dam;
- Construction of retarding basin(s) to retard 1% AEP outflows from the Gap catchment PSP region to a maximum of 0.35 m^3/s (the capacity of the existing Mickleham Road culverts); thus
- Providing Mickleham Road with a 1% AEP level of service; and which
- Should not adversely affect the flood effect west of Mickleham Road (to be confirmed).

As the Gap catchment is not within a Melbourne Water drainage scheme, it is also proposed to treat the stormwater runoff from the Gap catchment to BPEMG standards.

A.4.2 Preliminary Hydrological Modelling

The Gap catchment is serviced via two assets - one on the Subject Site and one on 1360-1370 Mickleham Road (i.e. two drainage reserves, one for each landholding in the Gap catchment).

The outflow requirements for each of these assets has been determined by apportioning the total 0.35 m^3/s target by the contributing catchments. This results in a 0.25 m^3/s target for the Subject Site (71% of the Gap catchment area), and a 0.10 m^3/s 1% AEP outflow target for 1360-1370 Mickleham Road (29% of the Gap catchment area).

Initial sizing (Rational and Boyd's Method with 2016 IFD's as shown in Table A.14) indicates that in the order of 6,000 m^3 of 1% AEP flood storage is required on the Subject Site.

Table A.14 Preliminary RB sizing on the Subject Site using Boyd's Method (to be updated as design progresses)

Storm Duration	1% AEP Intensity[1.]	RB Inflow[2.] (Q_{in})	RB Outflow[3.] (Q_{out})	Volume of Inflow Hydrograph (V_{in})	Storage required = $V_{in}(1-Q_{out}/Q_{in})$
(min)	(mm/hr)	(m^3/s)	(m^3/s)	(m^3)	(m^3)
10	138.0	4.68	0.25	2806	2656
15	112.0	3.80	0.25	3417	3192
20	94.8	3.21	0.25	3856	3556
25	82.8	2.81	0.25	4210	3835
30	73.8	2.50	0.25	4503	4053
45	56.7	1.92	0.25	5186	4511
60	46.9	1.59	0.25	5723	4823
90	35.9	1.22	0.25	6577	5227
120	29.9	1.01	0.25	7285	5485
180	23.1	0.78	0.25	8468	5768
270	18.0	0.61	0.25	9908	5858
360	15.2	0.52	0.25	11128	5728

Notes: [1.] IFD location = 37.5875 S, 144.8875 E.

[2.] Inflow calculated using the Rational Method with a $C_{1\%AEP}$ of 0.88 (i.e. $C_{18\%AEP}$ = 0.7).

[3.] Scaled Outflow as Discussed

A.4.3 Preliminary Stormwater Treatment Asset Modelling

A treatment train containing the elements detailed A 400 m^2, 240 m^3 sediment basin and a 350 m^2 nodal bioretention system (both located within the base of the retarding basin) are proposed within the subject site to meet the BPEMG stormwater treatment targets applicable to its 13.9 ha catchment area.

The levels detailed on 2050/BASE/2 detail a proposed system. The bioretention basin levels are based on Figure 10 of Payne et al. (2015) (with a submerged zone).

The above configuration has been modelled in MUSIC utilising many of the same parameters as described within Appendix 2.2.3 (climate data, etc). Table A.15 details the modelling undertaken and Figure A.5 provides a model schematic.

Table A.15 Gap Catchment MUSIC Modelling Details – Base Case

Node ID:	Node Type	Specific Details
Gap_Catch	Source Node – Mixed	Area = 13.8 ha F_{imp} = 0.80
Gap_SP1	Sediment Basin	Area = 400 m^2 ED = 0.35 m Volume = 240 m^3
Gap_BIO1	Bioretention Basin	Area = 350 m^2 ED = 0.35 m Filter Depth = 0.5 m Hydraulic Conductivity = 100 mm/hr Exfiltration = 0 mm/hr Effective Plants Submerged Zone Present to a depth of 0.45 m

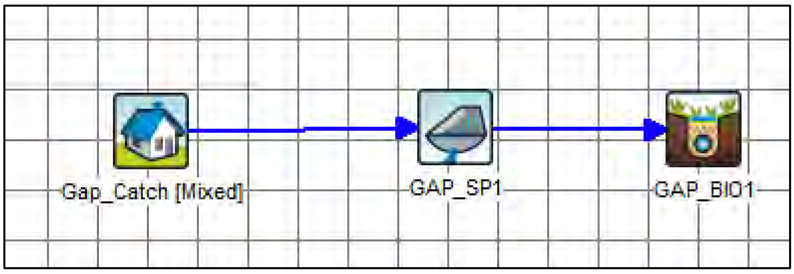


Figure A.5 Gap Catchment MUSIC Model Schematic

Table A.16 below details the results of the modelling showing that the 13.9 ha of the Subject Site within the Gap catchment can meet BPEMG pollutant retention results.

Table A.16 Subject Site – Base Case Gap Catchment Stormwater Pollutant Removal

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	9,550	1,600	7,950	83.2%
Total Phosphorus	19.6	10.5	9.1	46.4%
Total Nitrogen	138.0	74.5	63.5	46.0%
Gross Pollutants	1,940	0	1,940	100.0%

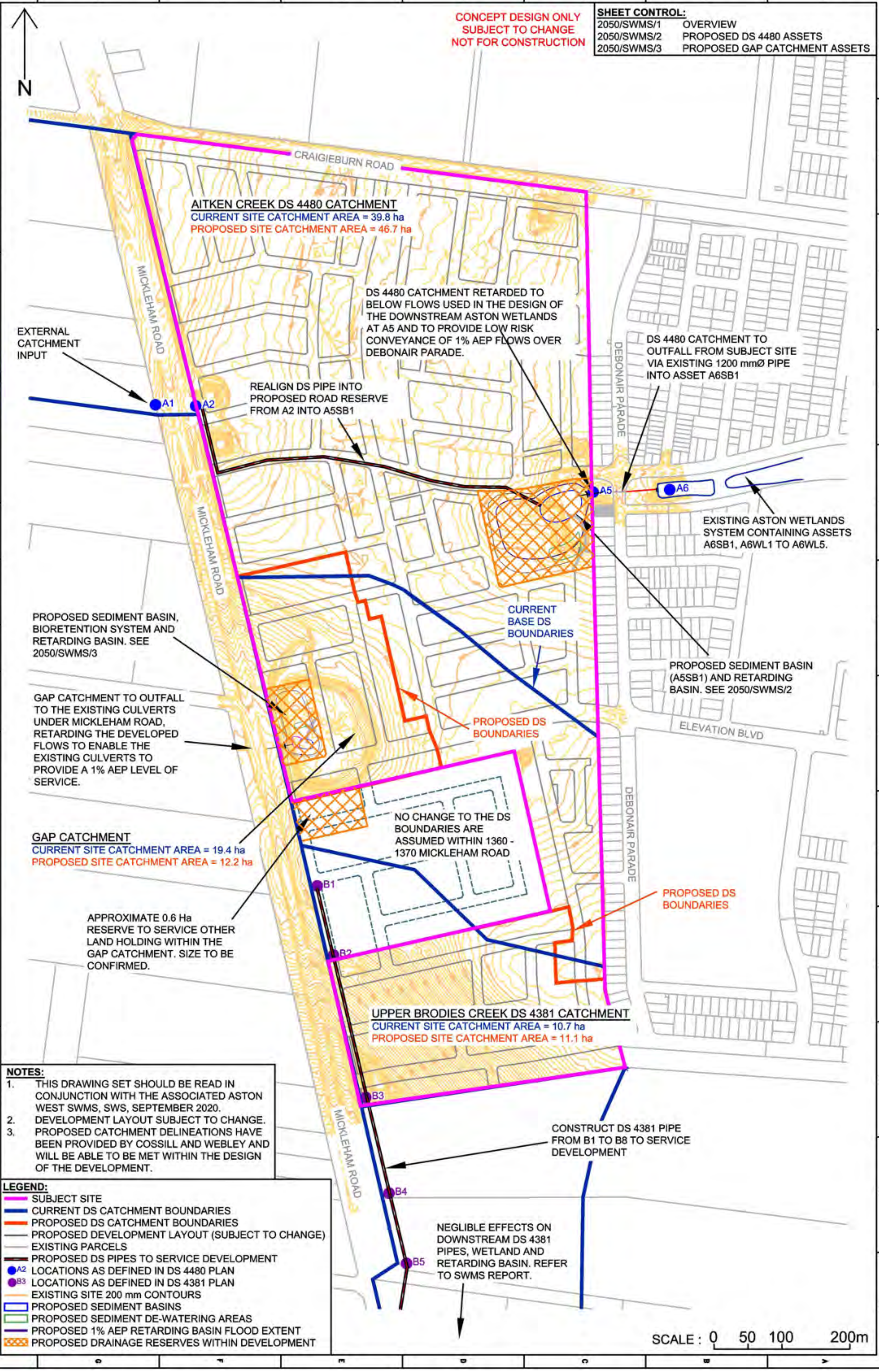
Similar stormwater treatment assets would be required to meet the treatment targets on 1360-1370 Mickleham Road. The drainage reserve allocation on 1360-1370 Mickleham Road has been determined (in a preliminary sense) by apportioning the Subject Site's reserve (Drawing 2050/BASE/2) by the contributing catchment area to this separate asset.

Appendix B Proposed SWMS Development

The following Appendix details the preliminary sizing and modelling undertaken for the proposed Peet Craigieburn Limited SWMS.

B.1 Concept Design Drawings

The following drawings detail the proposed SWMS.



REVISION		DATE
V6	CLIENT FEEDBACK CAPTURED	22 SEPTEMBER 2020
V5	UPDATED SWMS	8 SEPTEMBER 2020
REV B	REVISED DS4480 FLOOD LEVELS	18 JUNE 2020
REV A	RESERVE BOUNDARIES REVISED	20 DECEMBER 2019

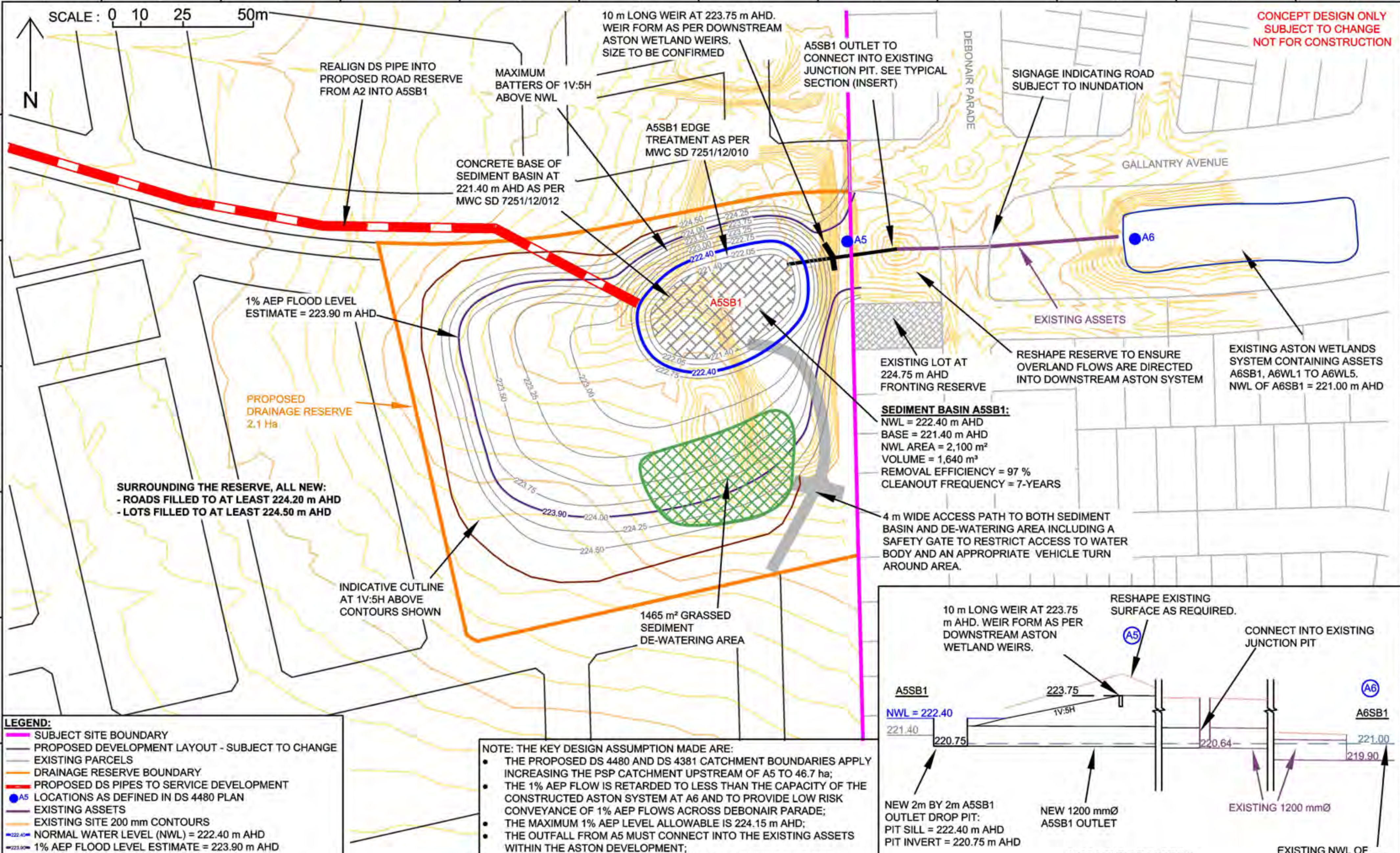
Stormy Water Solutions

DESIGNED: Michael Mag
CHECKED: Valerie Mag
AUTHORISED BY:
PROJECTION: MGA94/Z55

Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998

CRAIGIEBURN WEST
STORMWATER MANAGEMENT STRATEGY
OVERVIEW

SCALE: AS SHOWN
SHEET 1 OF 3
DRAWING No. 2050/SWMS/1



A5SB1 OUTLET SECTION
NOT TO SCALE
INDICATIVE ONLY

LEGEND:

- SUBJECT SITE BOUNDARY
- PROPOSED DEVELOPMENT LAYOUT - SUBJECT TO CHANGE
- EXISTING PARCELS
- DRAINAGE RESERVE BOUNDARY
- PROPOSED DS PIPES TO SERVICE DEVELOPMENT
- A5 LOCATIONS AS DEFINED IN DS 4480 PLAN
- EXISTING ASSETS
- EXISTING SITE 200 mm CONTOURS
- 222.40 NORMAL WATER LEVEL (NWL) = 222.40 m AHD
- 223.90 1% AEP FLOOD LEVEL ESTIMATE = 223.90 m AHD
- INDICATIVE DESIGN CONTOURS
- SEDIMENT BASIN CONCRETE BASE AT 221.40 m AHD
- GRASSED DE-WATERING AREA
- INDICATIVE ACCESS TRACK LOCATION

NOTE: THE KEY DESIGN ASSUMPTION MADE ARE:

- THE PROPOSED DS 4480 AND DS 4381 CATCHMENT BOUNDARIES APPLY INCREASING THE PSP CATCHMENT UPSTREAM OF A5 TO 46.7 ha;
- THE 1% AEP FLOW IS RETARDED TO LESS THAN THE CAPACITY OF THE CONSTRUCTED ASTON SYSTEM AT A6 AND TO PROVIDE LOW RISK CONVEYANCE OF 1% AEP FLOWS ACROSS DEBONAIR PARADE;
- THE MAXIMUM 1% AEP LEVEL ALLOWABLE IS 224.15 m AHD;
- THE OUTFALL FROM A5 MUST CONNECT INTO THE EXISTING ASSETS WITHIN THE ASTON DEVELOPMENT;
- THE SEDIMENT BASIN A5SB1 MUST BE FREE DRAINING INTO THE DOWNSTREAM SYSTEM FOR MOST EVENTS; AND
- BY PROVIDING A5SB1, THE DS 4480 WATER QUALITY CONTRIBUTION PAYABLE BY THE SUBJECT SITE WILL BE REDUCED.

REVISION	DATE
V6 – CLIENT FEEDBACK CAPTURED	22 SEPTEMBER 2020
V5 – UPDATED SWMS	8 SEPTEMBER 2020
REV B – REVISED DS4480 FLOOD LEVELS	18 JUNE 2020
REV A – RESERVE BOUNDARIES REVISED	20 DECEMBER 2019

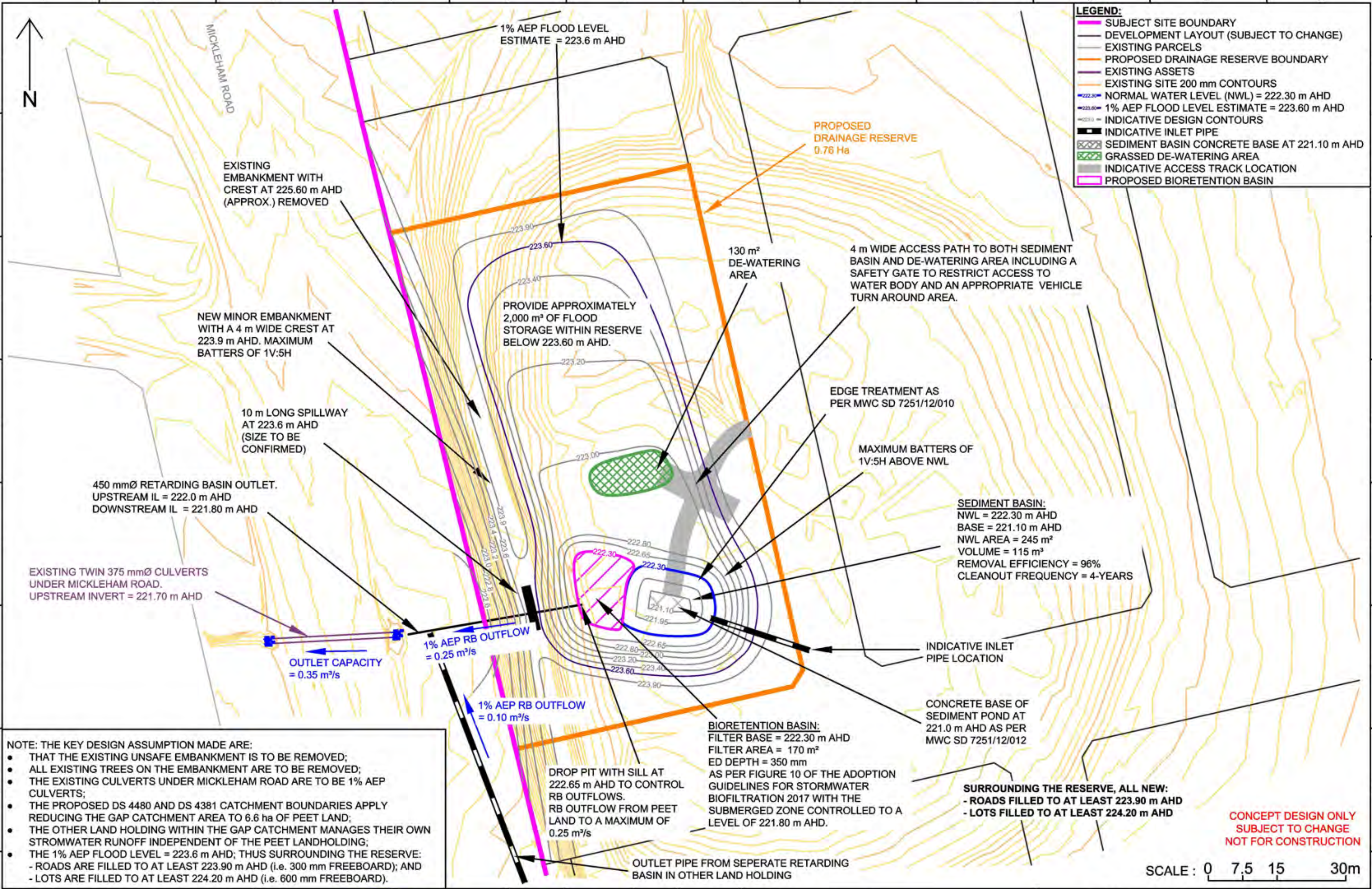
Stormy Water Solutions

DESIGNED	Michael Mag
CHECKED	Valerie Mag
AUTHORISED BY	
PROJECTION	MGA94/Z55

Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998

CRAIGIEBURN WEST
STORMWATER MANAGEMENT STRATEGY
DS 4480 PROPOSED ASSETS

SCALE: AS SHOWN
SHEET 2 OF 3
DRAWING No. 2050/SWMS/2



NOTE: THE KEY DESIGN ASSUMPTION MADE ARE:

- THAT THE EXISTING UNSAFE EMBANKMENT IS TO BE REMOVED;
- ALL EXISTING TREES ON THE EMBANKMENT ARE TO BE REMOVED;
- THE EXISTING CULVERTS UNDER MICKLEHAM ROAD ARE TO BE 1% AEP CULVERTS;
- THE PROPOSED DS 4480 AND DS 4381 CATCHMENT BOUNDARIES APPLY REDUCING THE GAP CATCHMENT AREA TO 6.6 ha OF PEET LAND;
- THE OTHER LAND HOLDING WITHIN THE GAP CATCHMENT MANAGES THEIR OWN STROMWATER RUNOFF INDEPENDENT OF THE PEET LANDHOLDING;
- THE 1% AEP FLOOD LEVEL = 223.6 m AHD; THUS SURROUNDING THE RESERVE:
  - ROADS ARE FILLED TO AT LEAST 223.90 m AHD (i.e. 300 mm FREEBOARD); AND
  - LOTS ARE FILLED TO AT LEAST 224.20 m AHD (i.e. 600 mm FREEBOARD).

REVISION	DATE
V6 – CLIENT FEEDBACK CAPTURED	22 SEPTEMBER 2020
V5 – UPDATED SWMS	8 SEPTEMBER 2020
REV B – REVISED DS4480 FLOOD LEVELS	18 JUNE 2020
REV A – RESERVE BOUNDARIES REVISED	20 DECEMBER 2019

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Website: www.stormywater.com.au
Email: stormywater@optusnet.com.au
Phone: (03) 8555 9669
ABN: 95 656 703 998

CRAIGIEBURN WEST
STORMWATER MANAGEMENT STRATEGY
'GAP' CATCHMENT PROPOSAL

SCALE: AS SHOWN
SHEET 3 OF 3
DRAWING No. 2050/SWMS/3

B.2 Aitken Creek DS (DS 4480)

B.2.1 Hydrological Modelling

As per Appendix A.2.1, RORB (v6.45) has been utilised.

The RORB model has been developed primarily:

- To ensure that the flows within the Aston Wetlands systems are at or below those assumed within the 2010 Report;
- To ensure flows are retarded so that the overland flow connection to the downstream wetland system can be designed to current safety standards; and
- To quantify the benefits of the proposed retarding basin A5SB1.

B.2.1.1 Model Description

Catchment delineations have been based on the following sources:

- As Constructed plans for Aston Stages 1-30 and 32 (for catchments within the existing Aston Estate);
- The proposed DS realignment boundaries as shown in Appendix E.3 and approximate catchment boundaries from Cossill & Webley site proposals; and
- The existing DS 4480 plan (for external catchment boundaries).

Provided general catchment delineation, lot densities and flow paths are retained as the design progresses, no significant changes to the model results are expected.

Figure B.1 details the RORB model for the post-development conditions and Tables B.1 and B.2 detail the tabulation of the RORB model setup (i.e. catchment area, fraction imperviousness, reach lengths, etc).

No pre-development model has been formulated given the target is not the pre-development flows. Rather, ensuring the flows through the Aston Wetland cells are less than those assumed within the 2010 Report is the retardation requirement in this case.

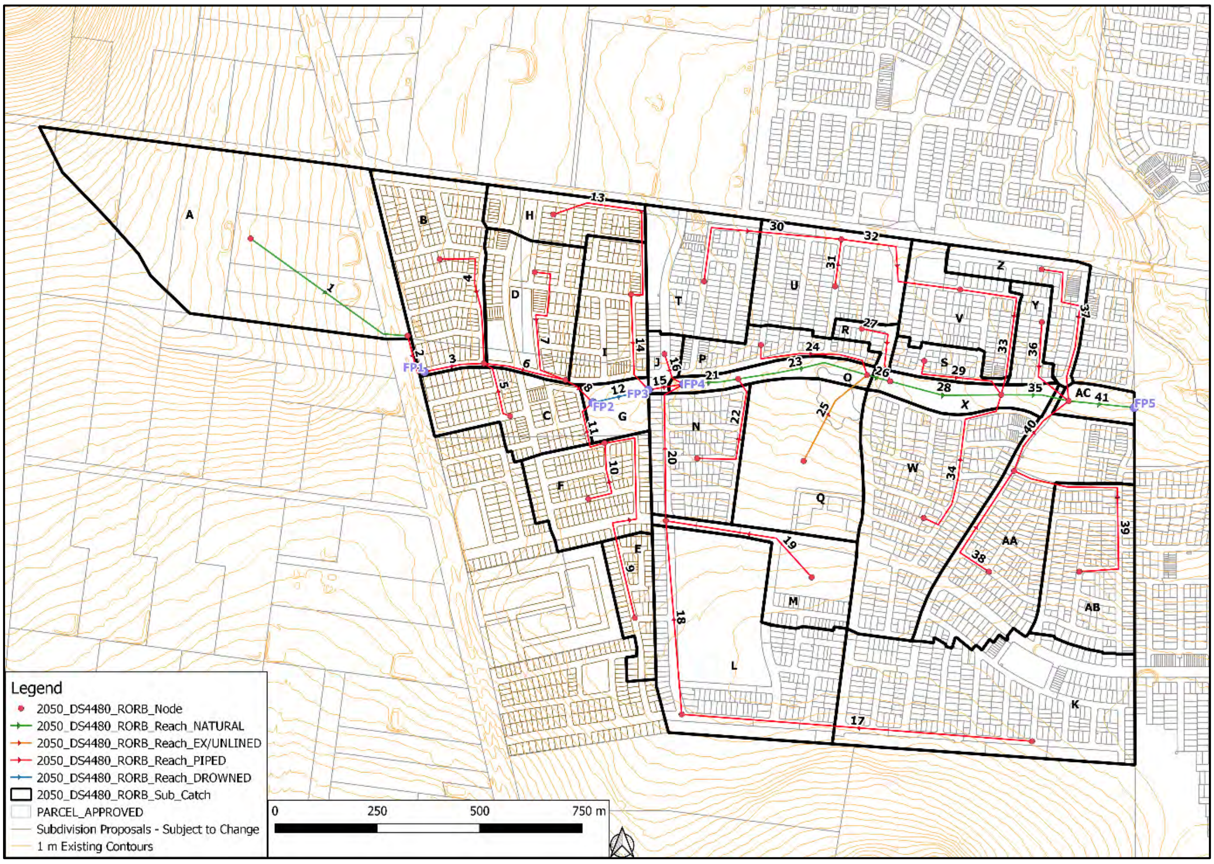


Figure B.1 Proposed SWMS RORB Model Layout

Table B.1 Proposed SWMS RORB Sub-Catchment Details

Sub Area	Area (ha)	Area (km^2)	Fraction Imperviousness	Sub Area	Area (ha)	Area (km^2)	Fraction Imperviousness
A	28.5	0.285	0.10	**P**	3.4	0.034	0.75
B	10.4	0.104	0.80	**Q**	11.0	0.110	0.21
C	6.4	0.064	0.80	**R**	1.0	0.010	0.75
D	7.5	0.075	0.59	**S**	1.9	0.019	0.75
E	3.2	0.032	0.80	**T**	8.1	0.081	0.64
F	6.9	0.069	0.80	**U**	8.8	0.088	0.75
G	2.1	0.021	0.10	**V**	6.0	0.060	0.75
H	4.2	0.042	0.72	**W**	16.0	0.160	0.75
I	5.9	0.059	0.80	**X**	3.0	0.030	0.10
J	1.1	0.011	0.75	**Y**	2.1	0.021	0.75
K	20.0	0.200	0.72	**Z**	4.2	0.042	0.75
L	18.4	0.184	0.75	**AA**	13.6	0.136	0.65
M	5.5	0.055	0.75	**AB**	8.8	0.088	0.75
N	6.9	0.069	0.75	**AC**	1.5	0.015	0.10
O	2.4	0.024	0.10	**Total**	**218.8**	**2.188**	**0.60**

Note: A significantly higher F_{imp} has been utilised within this modelling (0.80 for new development and 0.75 for existing development) compared to the F_{imp} of 0.50 assumed within the 2010 Report.

Table B.2 Proposed SWMS RORB Reach Details

Reach	Reach Type	Length (km)	Slope (%)
1	1	0.459	
2	3	0.112	0.33%
3	3	0.147	1.02%
4	3	0.344	0.44%
5	3	0.155	0.33%
6	3	0.204	0.61%
7	3	0.370	0.33%
8	3	0.087	0.33%
9	3	0.571	0.70%
10	3	0.183	0.55%
11	3	0.158	0.35%
12	4	0.140	
13	3	0.456	0.33%
14	3	0.247	0.33%
15	3	0.087	0.92%
16	3	0.094	3.74%
17	3	0.858	0.33%
18	3	0.474	0.55%
19	3	0.402	0.87%
20	3	0.362	1.94%
21	1	0.134	

Reach	Reach Type	Length (km)	Slope (%)
22	3	0.299	1.67%
23	1	0.323	
24	3	0.322	1.24%
25	2	0.266	1.88%
26	1	0.058	
27	3	0.183	2.19%
28	1	0.276	
29	3	0.245	1.51%
30	3	0.451	0.33%
31	3	0.116	1.38%
32	3	0.373	0.54%
33	3	0.379	0.79%
34	3	0.430	2.33%
35	1	0.166	
36	3	0.229	1.31%
37	3	0.407	0.98%
38	3	0.324	3.39%
39	3	0.554	2.17%
40	3	0.222	2.71%
41	1	0.161	

B.2.1.2 Model Parameters

The model has been simulated with the following parameters:

$K_c = 1.84$ $m = 0.8$ $IL = 15$ mm $RoC_{1\%AEP} = 0.6$

Data hub location: (37.595 S, 144.888 E), accessed 8/10/2019

The K_c value has been sourced from the empirical equation recommended by MWC for the Yarra and Maribyrnong Areas (No. 5, Table 4.1 of Melbourne Water 2018a).

No pre-burst or EIA/ICA splitting have been modelled as per the discussion presented in Appendix A.2.1.2.

B.2.1.3 Model Verification

It is required to check the estimated flows against other flow calculation methods to ensure the RORB model developed is valid for application.

Table B.3 shows the verification of the 18% AEP and 1% AEP flows at the proposed retarding basin location with the Probabilistic Rational Method. Overall, the estimates are similar.

Table B.3 'Proposed SWMS' RORB Model Verification at FP3

Method	FP3	
	$Q_{1\%AEP}$ (m^3/s)	$Q_{18\%AEP}$ (m^3/s)
RORB[1.]	11.20	4.10
Regression Curve (Urban)[2.]	8.40	N/A
Rational[3.]	11.25	4.20

Notes: [1.] *No SSD included in the model for verification purposes.*

[2.] *Urban Nikoloau/vont Steen equation from p11, of Melbourne Water (2018a).*

[3.] *Rational Assumptions: C_5 = 0.50, t_c = 25 min*

B.2.1.4 Proposed SWMS Retarding Basin Concept

A retarding basin (**RB**) is proposed in the void space above the future sediment pond asset (A5SB1) at approximately FP3 as defined within Figure B.1.

The A5SB1 asset is proposed to:

- Ensure that the design flows assumed within the 2010 Report through the existing Aston wetlands are not exceeded;
- Ensure flows are retarded so that the overland flow connection to the downstream wetland system can be designed to current safety standards;
- Enable some stormwater treatment to compliment the downstream wetland systems; and
- To protect the downstream pipe connection (constructed) between this asset and the existing Aston wetland system from sediment blockage.

The RB has not been designed to meet pre-development flows at FP3, as the 2010 Report designed the downstream system assuming development of the subject site. However, the assumed increase in F_{imp} of the development, and the change in ARR practices has resulted in the need for the RB at FP3.

The NWL of A5SB1 has been set at 222.40 m AHD to allow 'independence' from the downstream A6SB1 sediment basin system (which has an NWL of 221.00 m AHD). The outlet from A5SB1 is as shown in drawing 2050/SWMS/2 and is proposed to connect into the existing 1200 mmØ inlet into the downstream system. A 10 m long high-flow spillway is proposed along the east of the asset (at a level of 223.75 m AHD) to ensure that the local 1% AEP flood level is below 224.15 m AHD (to provide at least 600 mm freeboard to existing Aston Stage 18 lot 1801, which has a RL of 224.75 m AHD fronting the proposed asset (see Appendix E).

The flood storage (above 222.40 m AHD) has been estimated from the design contours shown in drawing 2050/SWMS/2.

The resultant Stage, (Flood) Storage, Discharge (**SSD**) relationship for the reading basin is provided in Table B.4 below.

Table B.4 Proposed SWMS A5SB1 Retarding Basin SSD relationship

Stage (m AHD)	Storage (m^3)	Q[1.] (m^3/s)
222.40	0	0.0
222.50	215	0.5
222.75	800	2.1
223.00	1,630	2.3
223.25	2,910	2.5
223.50	4,665	2.7
223.75	6,855	2.8
224.00	9,430	5.5
224.25	12,330	10.3
224.50	15,570	16.3

Notes: 1. Outflow calculated using an HGL analysis utilising the 2010 Report HECRAS model to generate tail water levels for various flow rates.

There may be scope in future functional design iterations to reduce the ultimate size of this asset.

B.2.1.5 Model Results

The model has been simulated for the major (1% AEP) and minor (18% AEP) storm events using the full ensembles of 240 temporal patterns as required in ARR 2019. The results from these simulations are provided in Table B.5.

Note, the 18% AEP storm events have been used instead of the 20% AEP storm events for the minor system design flows to produce slightly conservative estimates.

Table B.5 RORB Model Results

Location ID[1.]	1% AEP Peak Average Flow for Critical Duration[2.]		18% AEP Peak Average Flow for Critical Duration[2]	
	Q (m^3/s)	Critical Duration	Q (m^3/s)	Critical Duration
FP1	1.9	1.5-hour	0.3	2-hour
FP2	8.4	20-minute	3.2	20-minute
FP3 - RB INFLOW	10.9	20-minute	4.1	20-minute
FP3 - RB OUTFLOW	4.7	1.5-hour	2.3	45-minute
FP4	11.1	20-minute	5.2	20-minute
FP5	13.8	1.5-hour	5.2	1.5-hour

Notes: 1. See Figure B.1 for locations

2. For the 10 temporal patterns analysed for the critical duration

The model was also simulated for the 4EY event and a flow estimate of 1.2 m^3/s was obtained as the 4 EY inflow into A5SB1.

The results relevant to the RB storage and flood level are presented in Table B.6 below.

Table B.6 RORB Model Results for proposed RB

Location ID[1.]	Output	1% AEP		10% AEP		18% AEP	
FP3 - RB INFLOW	Flow[2.]	10.9	m^3/s	5.2	m^3/s	4.1	m^3/s
	Critical Duration	20	minute	20	minute	20	minute
FP3 - RB OUTFLOW	Flow[2.]	4.7	m^3/s	2.4	m^3/s	2.3	m^3/s
	Critical Duration	45	minute	30	minute	45	minute
	Flood Storage[3.]	8,650	m^3	2,450	m^3	1,630	m^3
	Flood Level Estimate[4.]	223.90	m AHD	223.15	m AHD	223.00	m AHD

Notes: [1.] *See Figure B.1 for locations*

[2.] *Peak Average flow for the 10 temporal patterns analysed for the critical duration*

[3.] *Rounded up to the nearest 50 m^3*

[4.] *Rounded to the nearest 50 mm*

B.2.1.6 Discussion of Results

Table B.6 above shows that the 1% AEP flood level estimate within the RB is 223.90 m AHD. As such, the RB design allows for greater than 600 mm of freeboard above the 1% AEP level to the existing Aston Stage 18 Lot 1801 at a level of 224.75 m AHD.

It should also be noted, the proposed RB has approximately a 2% AEP (50-year ARI) capacity before engaging the spillway (at 223.75 m AHD). As such, in the 1% AEP event, it is expected that, of the 4.7 m^3/s outflow, approximately 2.0 m^3/s is expected over the spillway (and thus having to be conveyed across Debonair Parade as overland flow). The flow of 2.0 m^3/s can be safely conveyed in reserves and across a road as gap flow from A5 (new RB) to A6 (Existing downstream Aston West Sediment Pond) as shown in Appendix B.2.4.

B.2.1.7 Climate Change Considerations

ARR 2019 allows the modeller/designer to simulate IFD's for various climate change scenarios. To assess how the proposed retarding basin could potentially operate in the future, the most conservative (worst in regard to increase in flood flow) year 2090 RCP 8.5 IFD values have been simulated as a 16.3% increase of the 2016 IFD values.

When simulated under this potential future climate condition, the 1% AEP flood level estimate within the retarding basin increases to 224.05 m AHD (6.55 m^3/s outflow with flood level estimate rounded up to the nearest 50 mm). This level would not inundate existing lots and still provides at least 600 mm freeboard to existing lots.

B.2.1.8 Extreme Flow Considerations

A preliminary analysis on the 1 in 2000 AEP event has been completed to provide a preliminary assessment of the 10 m long spillway at 223.75 m AHD. In the 1 in 2000 AEP event, preliminary modelling indicates that the expected RB outflow is 12.30 m AHD with an associated flood level of 224.35 m AHD.

The embankment crest at an assumed (Aston Stage 18 Lot 1801) level of 224.75 m AHD would still provide in excess of 300 mm freeboard in the 1 in 2000 AEP event based on this preliminary analysis.

B.2.2 *Sediment Basin/Pond Design Calculations*

B.2.2.1 Sediment Basin Size

Table B.7 below details the sizing of asset A5SB1 in the proposed SWMS.

Table B.7 Asset A5SB1 Sediment Basin Sizing Calculations – Proposed SWMS

Assumed Asset Properties		
Asset ID =	A5SB1	
Normal Water Level = NWL =	222.4	m AHD
NWL Area = (A_{asset}) =	2100	m^2
Pond Depth = (d_p) =	1.00	m
Extended Detention Depth = (d_e) =	0.00	m
Volume = (Vol_{TOT}) =	1640	m^3
Sump Volume[1.] = (Vol_S) =	985	m^3
4EY Inflow[2.] = (Q_{4EY}) =	1.2	m^3/s
Assumed Hydraulic efficiency[3.] = λ =	0.26	
Upstream Catchment Area = (A_{Catch}) =	75.1	ha
Target Particle Settling Velocity[4.] = (V_s) =	0.011	m/s
Removal Efficiency		
d* = max (d_p, 1) =	1.0	
$\frac{d_e + d_p}{d_e + d^*} =$	1.0	
$\frac{V_s \times A_{asset}}{Q_{4EY}} =$	11.0	
$n = \frac{1}{1-\lambda} =$	1.35	
$Removal\ efficiency^{5.} = R = 1 - \left[1 + \frac{1}{n} \times \frac{V_s \times A_{asset}}{Q_{4EY}} \times \frac{d_e + d_p}{d_e + d^*}\right]^{-n} =$	**97%**	
Cleanout Frequency		
Sediment Load[6.] = (L_s) =	1.6	m^3/ha/year
Gross Pollutant Load[7.] = (L_{GP}) =	0.4	m^3/ha/year
$Cleanout\ Frequency = \frac{R \times (L_S + L_{GP}) \times A_{Catch}}{Vol_S} =$	**7**	**years**
Dewatering Area Required ((assuming 500 mm deep layout & 5-year cleanout frequency) =	**1465**	m^2

Notes: [1.] *Sump volume taken as the volume below 350mm deep (i.e. below the safety bench).*

[2.] *Flow from RORB Model*

[3.] *Hydraulic efficiency estimated from Figure 4.3 of Melbourne Water 2005.*

[4] *Target particle size taken as 125 μm (as per criteria SP3 of Melbourne Water 2018c) with a settling velocity sourced from Table 4.1 of Melbourne Water 2005.*

[5.] *Methodology taken from Chapter 4.3.2 of Melbourne Water 2005.*

[6.] *Load estimate sourced from Willing and Partners 1992.*

[7.] *Load estimate sourced from Allison et. al. 1998.*

<u>*B.2.2.2 Sediment Basin Velocity Check – Proposed SWMS*</u>

The Melbourne Water "Wetland Design Manual, Part A2: Deemed to Comply Criteria" (2018c) criteria SP3 requires:

> "*that velocity through the sediment pond during the peak 100 year ARI event is ≤ 0.5 m/s.*"

Note: SP3 states the 100-year ARI velocity should be calculated using TED, while the methodology in Part D of the Manual states the 10-year ARI level should be used. The 10-year ARI (10% AEP) level has been used going forward.

Table B.8 below shows how this condition is met for the western sediment pond (SPW).

Table B.8 A5SB1 1% AEP Velocity Check – Proposed SWMS

Step	Description	Label	Value	Unit
1a	1% AEP Flow through Sediment Pond (FP3)	Q	10.9	m^3/s
2 (i)	NWL	NWL	222.40	m AHD
2 (ii)	10% AEP Level Estimation[1.]	FL	223.15	m AHD
3 (i)	Narrowest Width at NWL[2.]	W_{NWL}	25.0	m
3 (ii)	Narrowest Width at 10% AEP Level	$W_{10\%AEP}$	34	m
4	Flow Area = $\frac{W_{10\%AEP}-W_{NWL}}{2} \times (FL - NWL) =$	A	22.1	m^2
5	Flow Velocity = $\frac{Q}{A}$ =	**V**	**0.49**	**m/s**
Check	SP3 Requirement, V <		0.50	m/s
	Requirement Met?		**YES**	

Notes: [1.] *See RORB Modelling*

[2.] *This is the narrowest width able to meet the requirement. A width larger than this value will be provided.*

B.2.3 Continuous Simulation Modelling

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC, Version 6.3.0) has been used to assess the proposed design and to quantify the stormwater retention benefits of the proposed treatment train.

<u>*B.2.3.1 Model Description*</u>

B.2.3.1.1 Catchments

Subareas and fraction imperviousness used in the MUSIC modelling are as detailed in the RORB model. However, for quicker simulation times, groups of catchments have been condensed within MUSIC as shown in Table B.9.

Table B.9 MUSIC Source Nodes

RORB Catchments and MUSIC Node ID	Area (ha)	F_{imp}
A	28.5	0.10
B-I	46.7	0.73
J-M	44.9	0.74
N	6.9	0.75
O	2.4	0.10
P-R	15.4	0.36
S-W	40.8	0.73
X	3.0	0.10
Y-AB	28.6	0.70
AC	1.5	0.10

Sub areas are subject to change given the final development layout, however, provided the criteria of directing as much catchment as possible to (or close to) the defined inlet locations is adhered to, the final MUSIC results are not expected to change significantly.

Other catchment assumptions are as per Appendix A.2.3.

B.2.3.1.2 Climate Data

Identical climate data as per Appendix A.2.3 has been utilised.

B.2.3.1.3 Treatment Element Modelling

The Sediment Basin detailed in Appendix B.2.2 has been modelled. Further, the existing Aston wetland System has also been modelled as per the details in the 2010 Report (which have been confirmed to be relatively representative of the constructed assets). Table B.10 below details all treatment elements modelled.

Table B.10 Treatment Element Details within the MUSIC Model

Asset Type	Asset ID	NWL Area (m^2)	Permanent Pool Volume (m^3)	Inlet Pond Volume (m^3)	ED Depth (m)	ED Time (hrs)	Overflow Weir Length (m)
Proposed Sediment Basin	A5SB1	2,100	1,640	N/A	0	0	10
Existing Sediment Basin	A6SB1	1,700	2,550	N/A	0	0	22.8
Existing Wetland	A6WL1	4,200	1,260	0	0.35	48	30
Existing Wetland	A6WL2	5,330	1,600	0	0.35	48	5
Existing Wetland	A6WL3	9,050	2,700	0	0.35	48	30
Existing Wetland	A6WL4	6,000	1,800	0	0.35	48	5
Existing Wetland	A6WL5	7,225	2,150	0	0.5	48	24

B.2.3.1.4 Hydrologic Routing

No routing has been utilised within the MUSIC modelling undertaken.

B.2.3.1.5 Model Schematic

The model schematic is identical to that shown in Figure A.2, with the only changes being in the Source Node 'B-I' and the A5SB1 sediment basin Node.

B.2.3.2 Stormwater Pollutant Retention Results

Clause 56.07-4 of the Victorian State Planning provisions states that urban stormwater management systems must be designed to meet current best practice management performance objectives for stormwater quality management in the Urban Stormwater – Best Practice Environmental Management Guidelines (CSIRO 1999).

The Best Practice Environmental Management Guidelines (BPEMG) objectives for environmental management of stormwater pollutants are:

- Total Suspended Solids (TSS) 80% retention of the typical urban annual load;
- Total Phosphorus (TP) 45% retention of the typical urban annual load;
- Total Nitrogen (TN) 45% retention of the typical urban annual load; and
- Gross Pollutants 70% retention of the typical urban annual load.

Table B.11 details the pollutant retention results at the inlet to the existing wetland system (FP3 outlet, see Figure B.1) and Table B.12 details the pollutant retention results at the eastern outlet of the catchment (i.e. the eastern boundary of Aston, FP5 in Figure B.1).

Table B.11 Stormwater Pollutant Removal at Sediment Basin A5SB1

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	32,100	11,500	20,600	64.3%
Total Phosphorus	66.7	35.9	30.8	46.1%
Total Nitrogen	480	371	109	22.9%
Gross Pollutants	6,600	0	6,600	100.0%

Table B.12 Stormwater Pollutant Removal of Entire Aston System (with A5SB1 included)

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	113,000	32,500	80,500	71.3%
Total Phosphorus	234	93	141	60.2%
Total Nitrogen	1,660	1,020	640	38.6%
Gross Pollutants	23,800	0	23,800	100.0%

The 2010 Report indicated that at FP5, BPEMG could be met for the entire DS catchment upstream of this location due to the combined effect of the series of wetlands. However due to following reasons, the results from the 2010 Report are no longer valid (though they were at the time):

- A change in F_{imp} assumption from 0.50 to 0.75-0.80 for the catchment;
- A change in MUSIC modelling ‘best practice’ being:
    - The use of 10-years of climate data, not 1-year;
    - A change in ‘Pervious Area Properties’ due to updated MUSIC guidelines (Melbourne Water 2018b);

- A more detailed catchment model of the Aston Estate based on as constructed drawings, which now directs a large part of the catchment (which was assumed to enter A6WL3), to now enter the downstream A6WL4; and
- The assumption that at FP3 (point A5 in the 2010 Report) that the upstream catchment would be treated to best practice before discharge into the Aston Wetlands (though this was not ultimately captured within the DS 4480 proposals).

It should be noted, if BPEMG treatment occurred at FP3 (rather than just the proposed A5SB1 asset), with the current modelling, the DS would still not be able to meet BPEMG at FP5 due to the changes detailed above.

As such, it is proposed that to meet the BPEMG requirements for the development, the developers of the subject site pay the water quality DS 4480 rate.

B.2.4 Debonair Parade Hydraulic Modelling

As per Appendix B.2.1.6, in the 1% AEP event it is expected that 2.0 m^3/s will be required to be conveyed overland across (perpendicular) to Debonair Parade from the west to the east.

A preliminary HECRAS model between the proposed A5SB1 and existing A6SB1 has been developed including the crossing of Debonair Parade utilising site survey (from Appendix E.4).

The model indicates that when crossing Debonair Parade, the 1% AEP flow profile has:

- A maximum depth = D_{max} = 300 mm;
- An average depth = D_{ave} = 235 mm;
- An average velocity = V_{ave} = 0.17 m/s; and
- A 1% AEP hazard = Hazard = 0.04 m^2/s (= $D_{ave} \times V_{ave}$).

As such, the crossing meets both the velocity and hazard requirements of Melbourne Water (2017).

It is also recommended to erect signage adjacent to the cobble stone section of Debonair Parade where the crossing occurs indicating that the road may be subject to inundation.

In terms of alternative access; there are multiple other north to south crossings (Vintage Boulevard and Champion Parade) which would allow crossings from the south to the north of the existing Aston stages.

B.3 Upper Brodies Creek DS (DS 4381)

It is proposed to realign the Upper Brodies Creek DS (DS 4381) catchment to direct an additional 0.4 ha of catchment towards the constructed wetland/retarding basin at 1110 Mickleham Road, Greenvale, 3059 (hereby referred to as the Aspect RB).

The same analysis as undertaken within Appendix A.3 has been undertaken with an additional 0.4 ha of catchment as detailed in Table B.13.

Table B.13 Assumed Catchment Details for each Scenario

Model Scenario	Total DS 4381 Catchment Area (ha)	Equivalent Catchment F_{imp}
Neil Craigie 2013	84.3	0.63[1.]
Base Case DS Layout -SWS	80.9	0.77[2.]
Proposed DS Layout -SWS	81.3	0.77[2.]

Notes: [1.] Neil Craigie 2013 predominantly assumed a F_{imp} of 0.60 for the entire DS.

[2.] Current and proposed DS layouts assume a F_{imp} of 0.75 for existing development and 0.80 for future development.

B.3.1 Potential Flood Impacts

Each of the three scenarios has been simulated utilising both ARR 1987 and ARR 2019 practices as shown in Table B14

Overall, the change in the expected 1% AEP flood level due to increasing the DS 4381 catchment area is expected to be negligible, and as such, there are no adverse effects on the Aspect RB due to the proposed catchment changes.

Table B.14 Aspect RB hydrological model results for the various scenarios.

ARR Methodology	Model Output	Scenario		
		Neil Craigie 2013	Base Case DS Layout - SWS	Proposed DS Layout -SWS
1987	Aspect RB $Q_{1\%AEP}$ Inflow (m^3/s)	20.8	21.6	21.7
	Critical Duration	20-minute	20-minute	20-minute
	Aspect RB $Q_{1\%AEP}$ Outflow (m^3/s)	2.9	3.5	3.6
	Critical Duration	2-hour	2-hour	2-hour
	Aspect RB 1% AEP Flood Level (m AHD)[1.]	188.46	188.52	188.53
2016	Aspect RB $Q_{1\%AEP}$ Inflow (m^3/s)	19.6	20.0	20.1
	Critical Duration	20-minute	20-minute	20-minute
	Aspect RB $Q_{1\%AEP}$ Outflow (m^3/s)	3.8	4.4	4.5
	Critical Duration	2-hour	2-hour	2-hour
	Aspect RB 1% AEP Flood Level (m AHD)[1.]	188.53	188.56	188.57

Notes: [1.] Flood levels have been exactly reproduced from the RORB models within the Table. However, in practice, all levels should be rounded to the next highest 100 mm, resulting in essentially the same flood level between the scenarios.

From Table C.2 it can be seen that the change in ARR practices results in an increase in outflows from the Aspect RB for all scenarios. For retarding basins, this change is predominantly due to the changes in model simulation framework from single to ensemble events (see ARR 2019 Book 4, Chapter 3.2). This variance does not mean that the Neil Craigie 2013 Report was incorrect, or that the as constructed asset is not working. This is an effect that will be present in all assets of this age due to the change in ARR methodology.

B.3.2 Potential Stormwater Treatment Impacts

The DS 4381 proposes two treatment assets, a wetland within the Aspect RB base and a bioretention system on property 28 of the DS. Flows from the proposed catchment change bypass the bioretention system, and as such, only effect the stormwater treatment of the wetland.

Neil Craigie 2013 Report's original MUSIC model has not been used for the comparison as it only used 1-year of climate data and utilised non-current runoff generation parameters. Rather, two new models have been developed utilising the current and proposed DS layouts (as per Table B.13), with current MWC's Guidelines for the Use of MUSIC (Melbourne Water, 2018b) datasets and an increased F_{imp} for the catchment. The new models do however utilise Neil Craigie 2013 Report's original wetland node.

It should be noted, that (primarily) due to the increased in assumed F_{imp}, the current DSS proposals cannot treat the catchment to best practice.

Table B.15 summarises the model results. Overall, the extra 0.4 ha of catchment results in more total treatment, but at a slightly less efficiency than with the current DS boundary. However, given the large uncertainties associated with stormwater pollutant modelling, the effect of the boundary change can be considered negligible.

Table B.15 Effects on Aspect wetland performance given DS boundary change

Proposal:		**Base Case DS Boundary**	**Proposed SWMS DS Boundary**
TSS	Source (kg/yr)	53,500	54,800
	Residual (kg/yr)	15,300	15,600
	Retained (kg/yr)	38,200	39,200
	% reduction	**71.4%**	**71.5%**
TP	Source (kg/yr)	108	109
	Residual (kg/yr)	43	44
	Retained (kg/yr)	65	65
	% reduction	**60.0%**	**60.0%**
TN	Source (kg/yr)	763	767
	Residual (kg/yr)	468	471
	Retained (kg/yr)	295	296
	% reduction	**38.7%**	**38.6%**

B.3.3 DS Pipe Sizing

The proposed catchment change could also potentially affect the already constructed DS pipe along the west of the 'Aspect' development. The 'Aspect' development, Stage 4 plans has the most upstream

DS pipe as a 1050 mmØ. At approximately the natural surface slope this 1050 mmØ pipe has a capacity of 4 m^3/s.

The current DS boundary has the 18% AEP flow at this location of 3.95 m^3/s. The proposed DS boundary would increase the flow at the pipe to 4.00 m^3/s. For hydrology, 3.95 m^3/s and 4.00 m^3/s are essentially the same number, especially given the rough RORB estimates used to estimate the flow.

There would need to be a design review of the future scheme pipe B1 to B8 upstream of the constructed assets to ensure that they capture the proposed DS boundary realignment in their design.

B.4 Gap Catchment

The proposed catchment changes for the Gap Catchment are as detailed in Table B.16.

Table B.16 Proposed Gap Catchment Changes

Scenario	Base Case	Proposed SWMS
Subject Site	13.8 ha	6.6 ha
1360-1370 Mickleham Rod	5.6 ha	5.6 ha
Total Gap Catchment	19.4 ha	12.2 ha

B.4.1 Performance Targets

Identical targets to the 'base case' scenario (see Appendix A.4.1) are retained in the 'proposed SWMS' scenario being:

- 1% AEP retardation on the Subject Site to 0.25 m^3/s; and
- BPEMG stormwater pollutant treatment.

B.4.2 Preliminary Hydrological Modelling

Initial sizing (Rational and Boyd's Method with 2016 IFD's as shown in Table B.17) indicates that in the order of 2,000 m^3 of 1% AEP flood storage is required on the Subject Site.

Table B.17 Preliminary RB sizing on the Subject Site using Boyd's Method (to be updated as design progresses)

Storm Duration	1% AEP Intensity[1.]	RB Inflow[2.] (Q_{in})	RB Outflow[3.] (Q_{out})	Volume of Inflow Hydrograph (V_{in})	Storage required = $V_{in}(1-Q_{out}/Q_{in})$
(min)	**(mm/hr)**	**(m^3/s)**	**(m^3/s)**	**(m^3)**	**(m^3)**
10	138.0	2.24	0.25	1342	1192
15	112.0	1.82	0.25	1634	1409
20	94.8	1.54	0.25	1844	1544
25	82.8	1.34	0.25	2013	1638
30	73.8	1.20	0.25	2153	1703
45	56.7	0.92	0.25	2480	1805
60	46.9	0.76	0.25	2737	1837
90	35.9	0.58	0.25	3145	1795
120	29.9	0.48	0.25	3484	1684

Notes: [1.] *IFD location = 37.5875 S, 144.8875 E.*

[2.] *Inflow calculated using the Rational Method with a $C_{1\%AEP}$ of 0.88 (i.e. $C_{18\%AEP}$ = 0.7).*

[3.] *Scaled Outflow as Discussed*

B.4.3 Preliminary Stormwater Treatment Asset Modelling

A treatment train containing the elements detailed A 245 m^2, 115 m^3 sediment basin and a 170 m^2 nodal bioretention system (both located within the base of the retarding basin) are proposed within the subject site to meet the BPEMG stormwater treatment targets applicable to its 6.6 ha of catchment area.

The levels detailed on 2050/SWMS/3 detail the proposed system. The bioretention basin levels are based on Figure 10 of Payne et al. 2015 (with a submerged zone).

The sediment basin size has been determined as shown in Table B.18.

The above configuration has been modelled in MUSIC utilising many of the same parameters as described within Appendix A.2.2.3 (climate data, etc). Table B.19 details the modelling undertaken and Figure A.5 provides a general model schematic.

Table B.18 Gap Catchment Sediment Basin Sizing – Proposed SWMS

Assumed Asset Properties		
Asset ID =	GAP_SP1	
Normal Water Level = NWL =	222.30	m AHD
NWL Area = (A_{asset}) =	245	m^2
Pond Depth = (d_p) =	1.20	m
Extended Detention Depth = (d_e) =	0.35	m
Volume = (Vol_{TOT}) =	115	m^3
Sump Volume[1.] = (Vol_S) =	53	m^3
4EY Inflow[2.] = (Q_{4EY}) =	0.2	m^3/s
Assumed Hydraulic efficiency[3.] = λ =	0.26	
Upstream Catchment Area = (A_{Catch}) =	6.6	ha
Target Particle Settling Velocity[4.] = (V_s) =	0.011	m/s
Removal Efficiency		
d* = max (d_p, 1) =	1.2	
$\frac{d_e + d_p}{d_e + d^*} =$	1.0	
$\frac{V_s \times A_{asset}}{Q_{4EY}} =$	11.0	
$n = \frac{1}{1-\lambda} =$	1.35	
$Removal\ efficiency^{5.} = R = 1 - \left[1 + \frac{1}{n} \times \frac{V_s \times A_{asset}}{Q_{4EY}} \times \frac{d_e + d_p}{d_e + d^*}\right]^{-n} =$	**96%**	
Cleanout Frequency		
Sediment Load[6.] = (L_s) =	1.6	m^3/ha/year
Gross Pollutant Load[7.] = (L_{GP}) =	0.4	m^3/ha/year
$Cleanout\ Frequency = \frac{R \times (L_S + L_{GP}) \times A_{Catch}}{Vol_S} =$	**4**	**years**
Dewatering Area Required ((assuming 500 mm deep layout & 5-year cleanout frequency) =	**130**	m^2

Notes: [1.] *Sump volume taken as the volume below 350mm deep (i.e. below the safety bench).*

[2.] *Flow from Rational Estimate*

[3.] *Hydraulic efficiency estimated from Figure 4.3 of Melbourne Water 2005.*

[4] *Target particle size taken as 125 μm (as per criteria SP3 of Melbourne Water 2018c) with a settling velocity sourced from Table 4.1 of Melbourne Water 2005.*

[5.] *Methodology taken from Chapter 4.3.2 of Melbourne Water 2005.*

[6.] *Load estimate sourced from Willing and Partners 1992.*

[7.] *Load estimate sourced from Allison et. al. 1998.*

Table B.19 Gap Catchment MUSIC Modelling Details – Proposed SWMS

Node ID:	Node Type	Specific Details
Gap_Catch	Source Node – Mixed	Area = 6.6 ha F_{imp} = 0.80
Gap_SP1	Sediment Basin	Area = 245 m^2 ED = 0.35 m Volume = 115 m^3
Gap_BIO1	Bioretention Basin	Area = 170 m^2 ED = 0.35 m Filter Depth = 0.5 m Hydraulic Conductivity = 100 mm/hr Exfiltration = 0 mm/hr Effective Plants Submerged Zone Present to a depth of 0.45 m

Table B.20 below details the results of the modelling showing that the 6.6 ha of the Subject Site within the Gap catchment can meet BPEMG pollutant retention results.

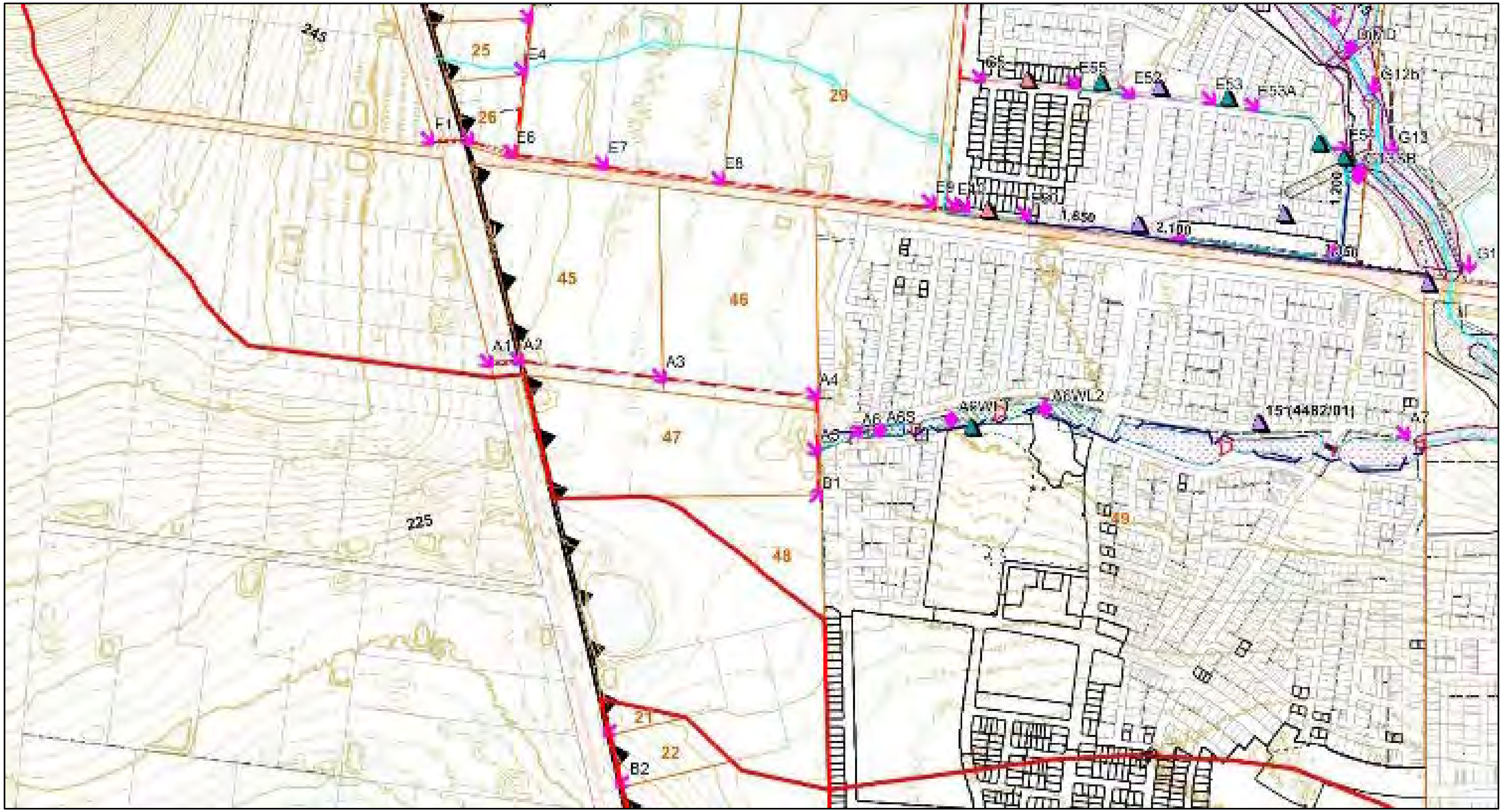
Table B.20 Subject Site – Base Case Gap Catchment Stormwater Pollutant Removal

Pollutant	Sources (kg/yr)	Residual Load (kg/yr)	Retention (kg/yr)	Reduction (%)
Total Suspended Solids	4,530	734	3,796	83.8%
Total Phosphorus	9.25	4.86	4.39	47.5%
Total Nitrogen	64.1	34.6	29.5	45.9%
Gross Pollutants	921	0	921	100.0%

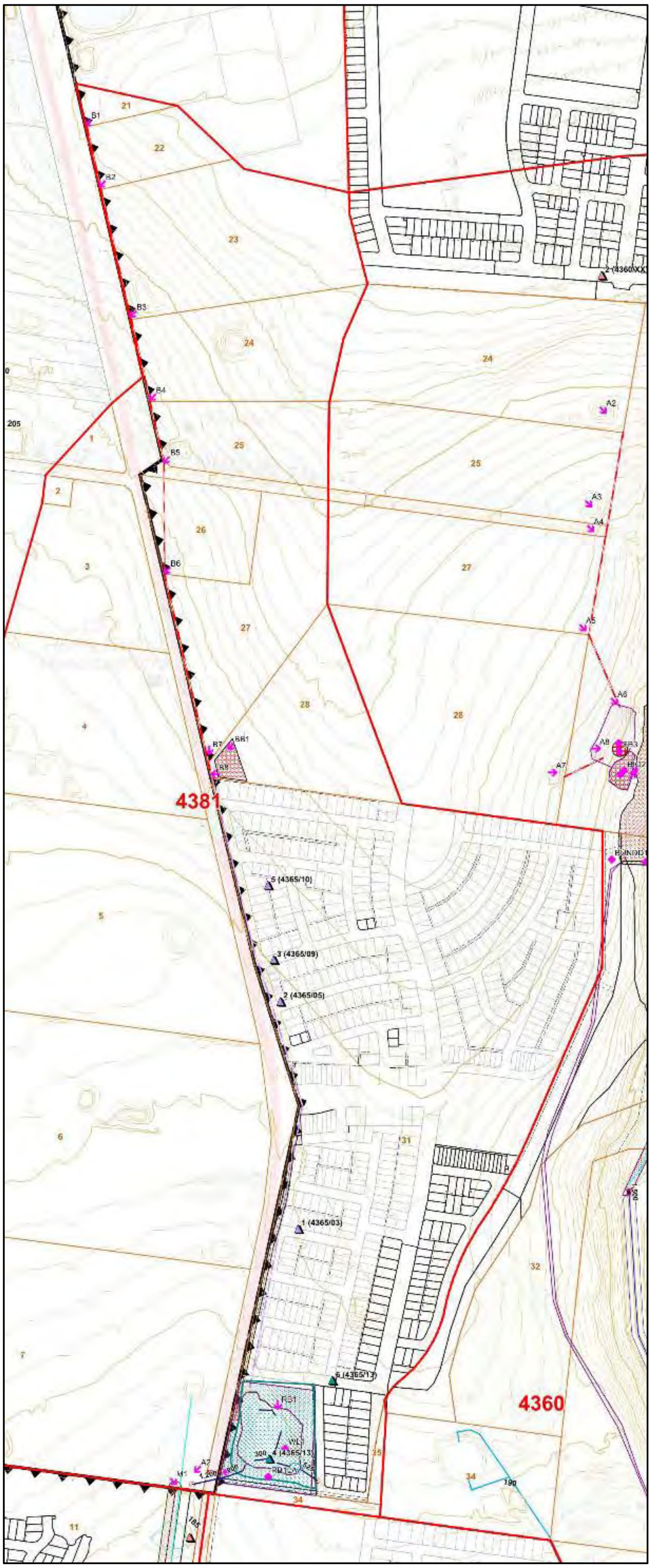
Similar stormwater treatment assets would be required to meet the treatment targets on 1360-1370 Mickleham Road.

Appendix C Background Information & Plans

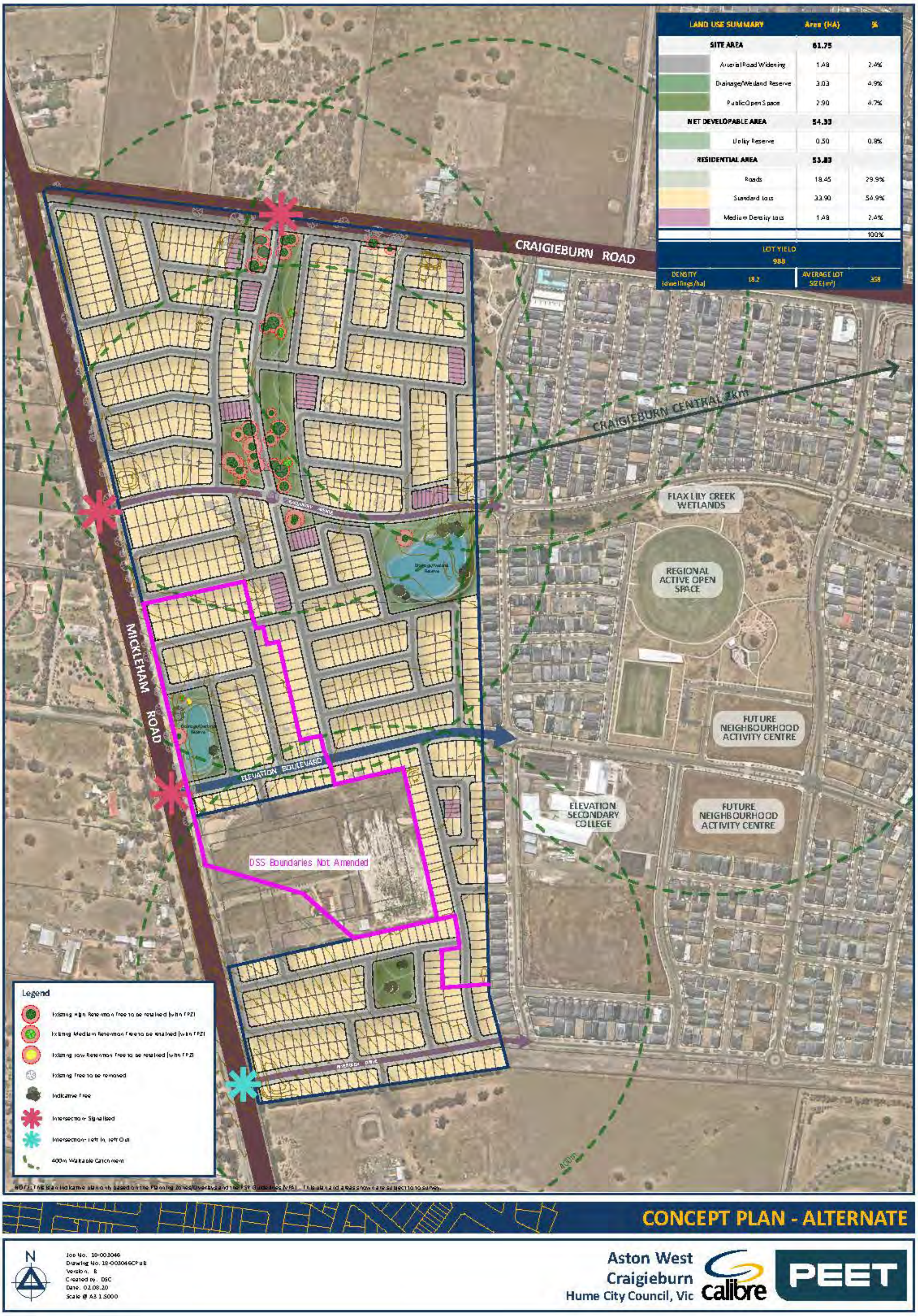
C.1 Extract of DS 4480 Plan (April 2017)



C.2 Extract of DS 4381 Plan (April 2017)

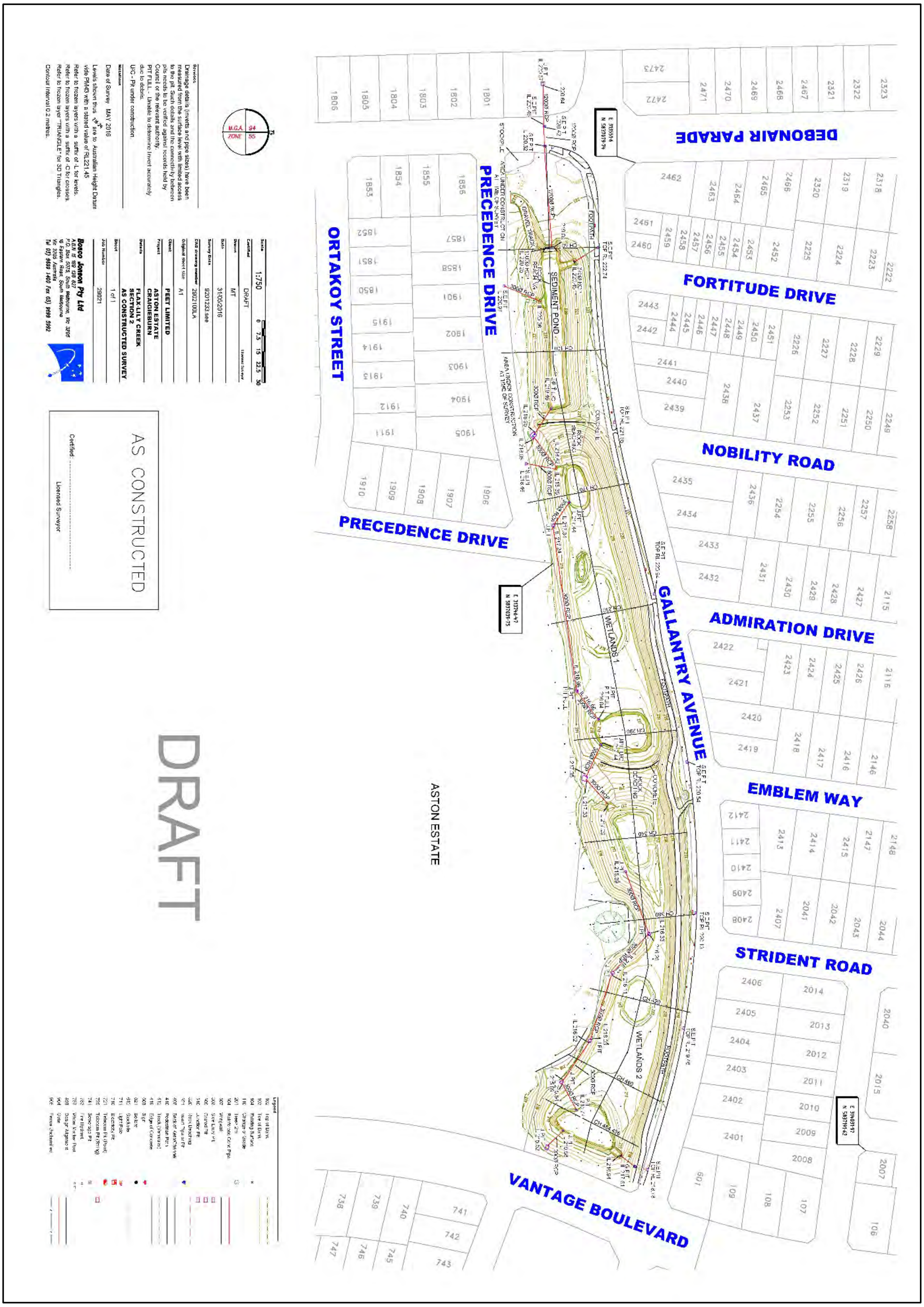


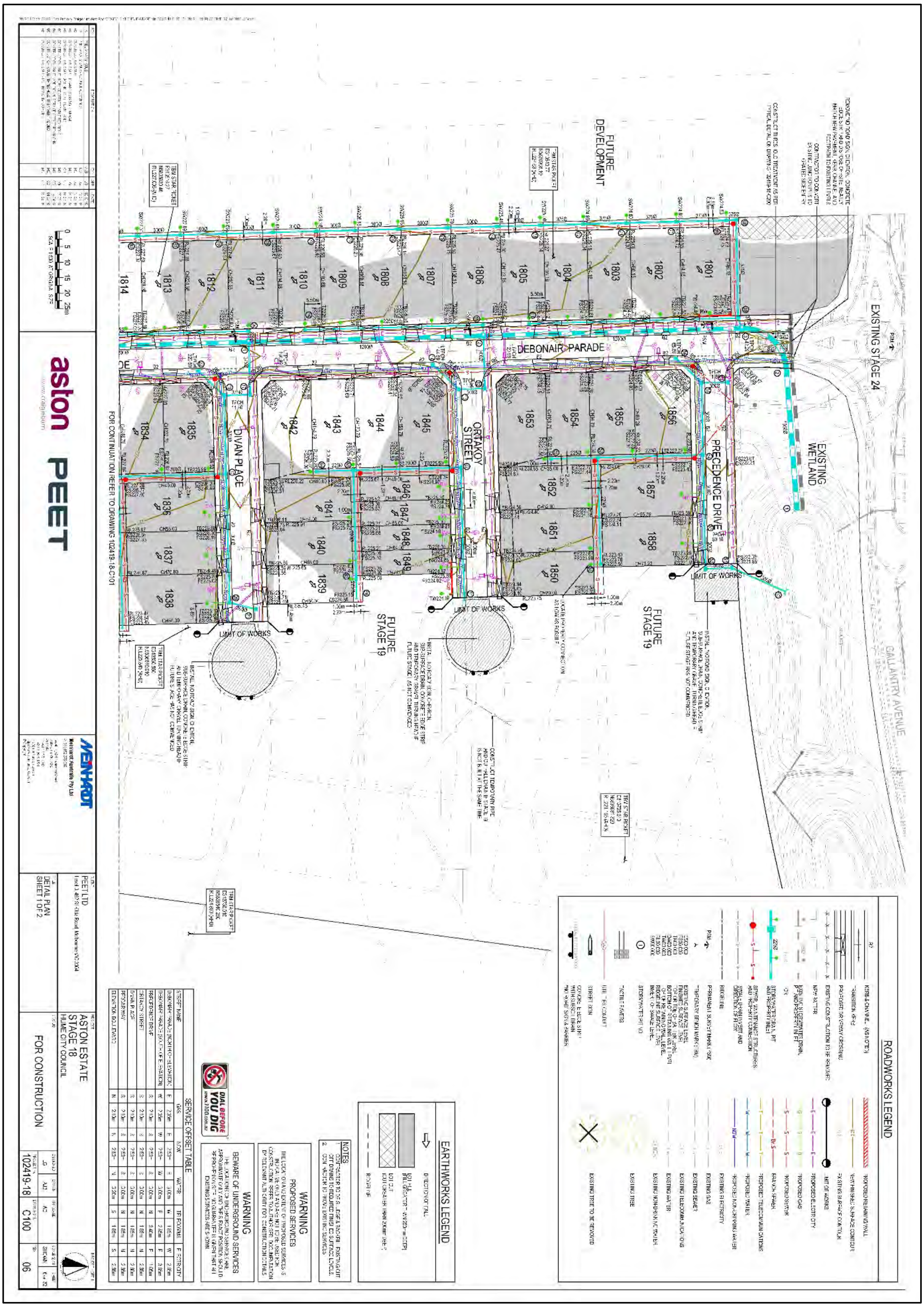
C.3 Proposed Subject Site Development Proposal – Subject to Change



C.4 Feature Survey

C.5 Relevant Aston Plans




EXISTING STAGE 24
EXISTING WETLAND
FUTURE DEVELOPMENT
DEBONAIR PARADE
PRECEDENCE DRIVE
ORTAKOY STREET
DIVAN PLACE
FUTURE STAGE 19
LIMIT OF WORKS
GALLANTRY AVENUE
ROADWORKS LEGEND
EARTHWORKS LEGEND
SERVICE OFFSET TABLE
aston
PEET
ASTON ESTATE STAGE 18
HUME CITY COUNCIL
FOR CONSTRUCTION
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