Water Cycle Management Plan

Proposed Manufactured Home Estate

40-80 & 82 Chapmans Road, Tuncurry

Prepared on behalf of Allam MHE Development No.2 Pty Ltd

29 November 2024

Document Control Sheet					
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Unless otherwise specified in this report, information and advice received from external parties during the course of this project was not independently verified. However, any such information was, in our opinion, deemed to be current and relevant prior to its use. Whilst all reasonable skill, diligence and care have been taken to provide accurate information and appropriate recommendations, it is not warranted or guaranteed and no responsibility or liability for any information, opinion or commentary contained herein or for any consequences of its use will be accepted by ADW Johnson or by any person involved in the preparation of this assessment and report.

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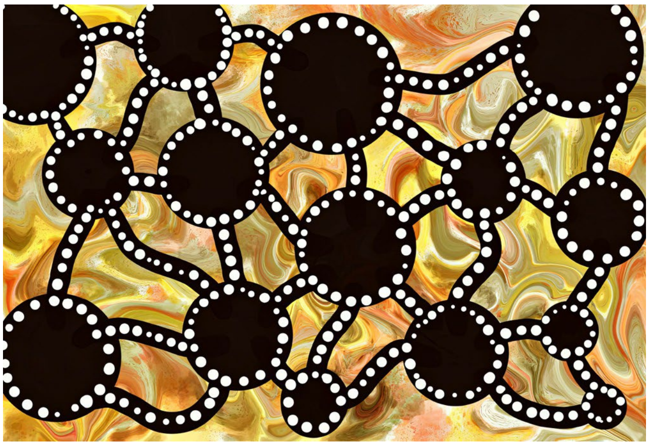
Acknowledgement of Country

We, ADW Johnson, acknowledge the Traditional Custodians of the land where we live and work, the country of Awabakal, Darkinjung and the Eora Nation.

We recognise their continuous connection to the land and waters of our beautiful regions. We pay our respects to Aboriginal and Torres Strait Islanders Elders past, present and emerging.

Artwork created by Joe Griffin, a proud Aboriginal man, descendant of the Awabakal people.



Executive Summary

ADW Johnson has been engaged by Allam MHE Development No.2 Pty Ltd to complete a Water Cycle Management Plan to accompany the development application for a proposed 283 site manufactured home estate and community facilities sited within the lands of Lot 100 DP1286524 and Lot 11 DP615229.

The Water Cycle Management Plan is required under Mid Coast Council's Great Lakes Development Control Plan and is to meet the requirements in relation to stormwater detention, water quality, water sensitive urban design and erosion and sediment control.

The objective of this report is to take a holistic approach to the management of stormwater runoff from the proposed development for both quality and quantity purposes.

This report proposes a water sensitive urban design strategy for both water quality and quantity management to protect the downstream environment and address potential hydrological impacts of the development. The strategy proposes rainwater tanks, bioretention basins and infiltration to sustainably manage stormwater treatment and potable water use for the development. On-site detention basins and level spreaders are proposed to detain and disperse post-development stormwater flows to avoid adverse impacts on the downstream receiving environment.

The industry accepted MUSIC software was used to model the water quality and pollutant reduction performance of the proposed stormwater treatment infrastructure. The modelling results indicated a reduction in pollutant loads to NorBE requirements to comply with the Great Lakes DCP. Furthermore, MUSIC modelling indicated that the development did not exceed an average five (5) runoff events per year to comply with a control outlined in the Great Lakes DCP.

The strategy proposed end of line basins which serve both infiltration and detention stormwater management purposes. Stormwater quantity modelling indicated that the post-development flows from the proposed development were less than the pre-development flows for all durations and storm events up to the 1% AEP event in accordance with Mid Coast Council's Stormwater Drainage Policy. Where discharging through a level spreader to C2 conservation land, results demonstrated that the total post-development discharge through the basin level spreader up to and including the 1% AEP flow did not exceed the 20% AEP pre-development total flow to satisfy Mid Coast Council's level spreader criteria.

The proposed development stormwater management strategy was discussed in regards to the downstream wetland. The proposed detention and water quality treatment facilities adequately cater for the development's surface and subsurface runoff and were found to not adversely impact the downstream wetland to comply with SEPP controls.

A capacity assessment was provided to evaluate the capacity of existing infrastructure within the Chapmans Road reserve to cater for redirected flows from the proposed development. The Chapmans Road reserve was found to safely convey site discharge during the minor storm. A 450mm high x 1200mm wide box culvert was proposed to convey flows from the proposed development to the northern side of Chapmans Road to keep developed runoff within the public road corridor.

An erosion and sedimentation control plan has been prepared for the proposed development and Western Precinct to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the site to downstream waterways during the construction period.

This report provides evidence that the proposed development and Western Precinct can be constructed and operated to comply with Mid Coast Council's Drainage and WSUD Guidelines as well as controls stipulated by the Great Lakes DCP.

Contents

Section 1
Introduction

1 Introduction

ADW Johnson was engaged by Allam MHE Development No.2 Pty Ltd to complete a Water Cycle Management Plan (WCMP) to accompany the development application (DA) for a proposed 283 site manufactured home estate and community facilities on 40-80, 82 Chapmans Road, Tuncurry.

This report forms part of the DA, providing assessment of the existing site and hydrology, the proposed development, Mid Coast Council's (herein referred to as 'Council' or 'MCC') stormwater management requirements, the proposed stormwater control facilities, environmental protection works and the erosion and sediment controls required to meet the controls specified by the Great Lakes DCP and Council's stormwater drainage and WSUD guidelines.

The site to which this WCMP is prepared for is illustrated in Figure 1.

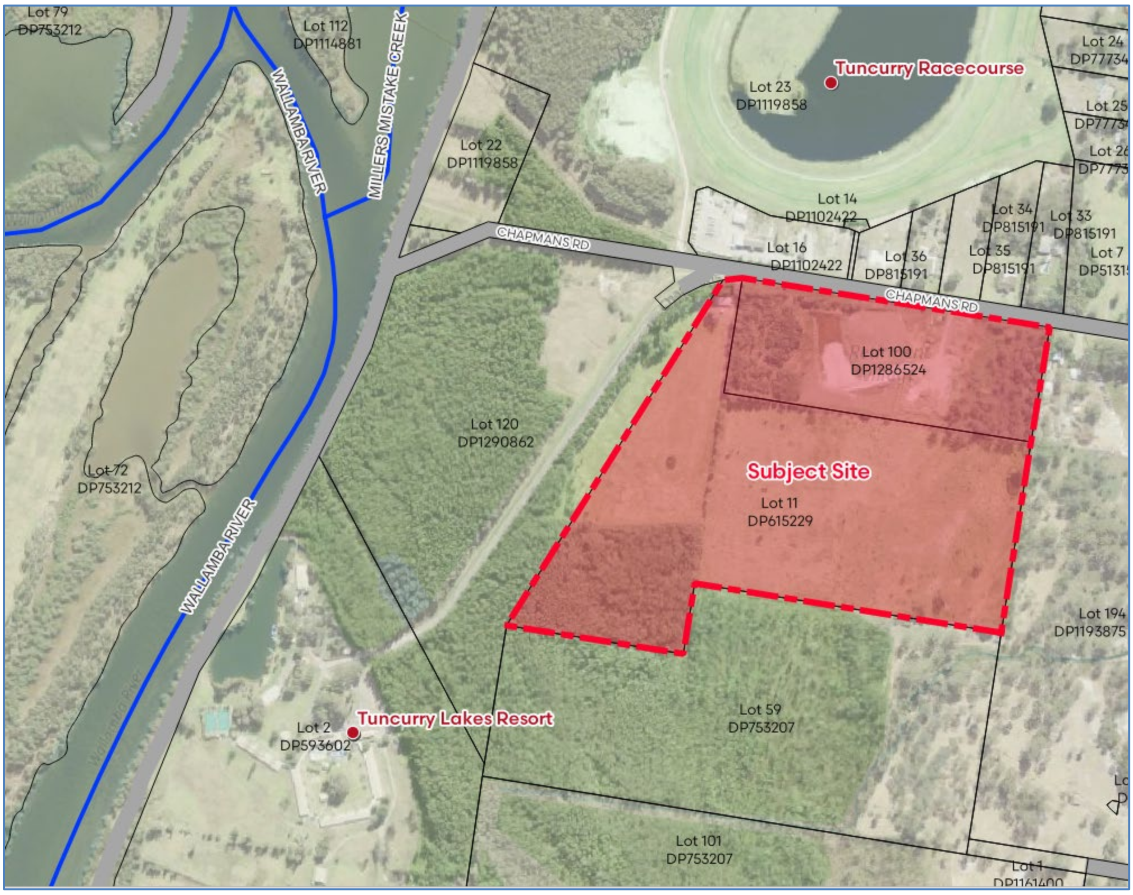


Figure 1: Proposed Development Site Locality (Source: SIXMaps)

1.1 Background

The proposed development is sited within the Western Precinct as defined within the Great Lakes DCP which includes Lot 100 DP1286524 and Lot 11 DP615229. A Stormwater Management Strategy (SWMS) was previously prepared by BMT WBM Pty Ltd for the Western Precinct in March 2010 which informed the stormwater management controls within the current Great Lakes DCP. The report covers aspects related to water quality, wetland health, and habitat protection for the Western Precinct. The report does not address stormwater detention.

A Stormwater Management Plan (SWMP) was previously prepared by Land Dynamics Australia (LDA) to accompany a DA for the development of Lot 100 DP1286524.

Concept engineering plans were also prepared by LDA to support the development proposal. The DA was refused by MCC for the reasons outlined in the Statement of Facts and Contentions (SOFAC) from the subsequent court proceedings pursued by Allam MHE Development No.2 Pty Ltd to object MCC's refusal. A revised SWMP was prepared by ADW Johnson in June 2024 which addressed concerns raised by Council regarding the stormwater management for the site. The revised development application for the proposed design within Lot 100 Do1286524 has been approved by MCC, as part of the Land & Environment Court appeal, this court approved determination was dated 6th August 2024

This WCMP has been prepared to support a Development Application for a 283 site manufactured home estate over the Western Precinct as defined within the Great Lakes DCP (Lot 100 DP1286524 and Lot 11 DP615229).

Section 2
Site Description

2 Site Description

2.1 Existing Site

The subject site is located over Lot 100 DP1286524 and Lot 11 DP615229 Chapmans Road, Tuncurry within the Mid Coast Local Government Area (LGA) and together form the Western Precinct as described within the Great Lakes DCP. This proposed development site has an overall area of approximately 22.4ha.

The developable portion of the site is bound by C2 environmental conservation land to the east, south and north. No works are proposed within the C2 conservation land. The development is proposed over the developable area (zoned as R2 residential) with an approximate area of 16.2Ha. The zoning of the site is shown in Figure 2.

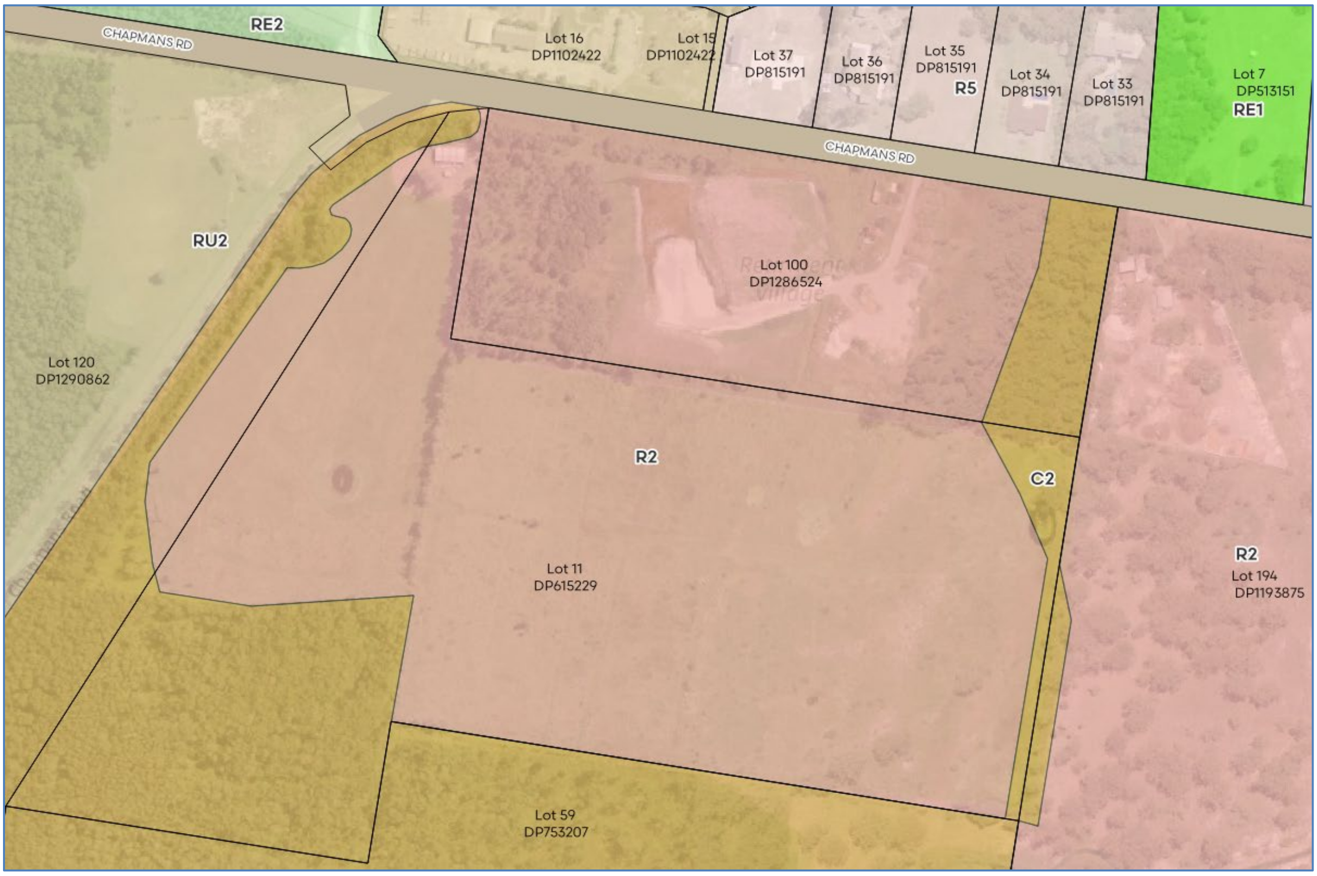


Figure 2: Proposed Development Site Zoning

The development site is bound to the north by Chapmans Road, to the east, south and west by rural land. The land to the east of the site which is zoned as R2 low density residential is located within the Eastern Precinct as defined in the Great Lakes DCP.

The existing site contains approximately 20,000m^3 of imported sandy material which was stockpiled after the development received bulk earthworks approval in 2022. There are existing gravel access tracks and dilapidated farm sheds in close proximity to the current property entrance intersecting with Chapmans Road. Chapmans Road is classified as a local road and is drained by roadside swales and culverts as kerb and gutter drainage infrastructure is not currently present. The existing property is primarily rural pasture and pervious grassland. Figure 3 exhibits the existing site in its most current state from an aerial perspective.

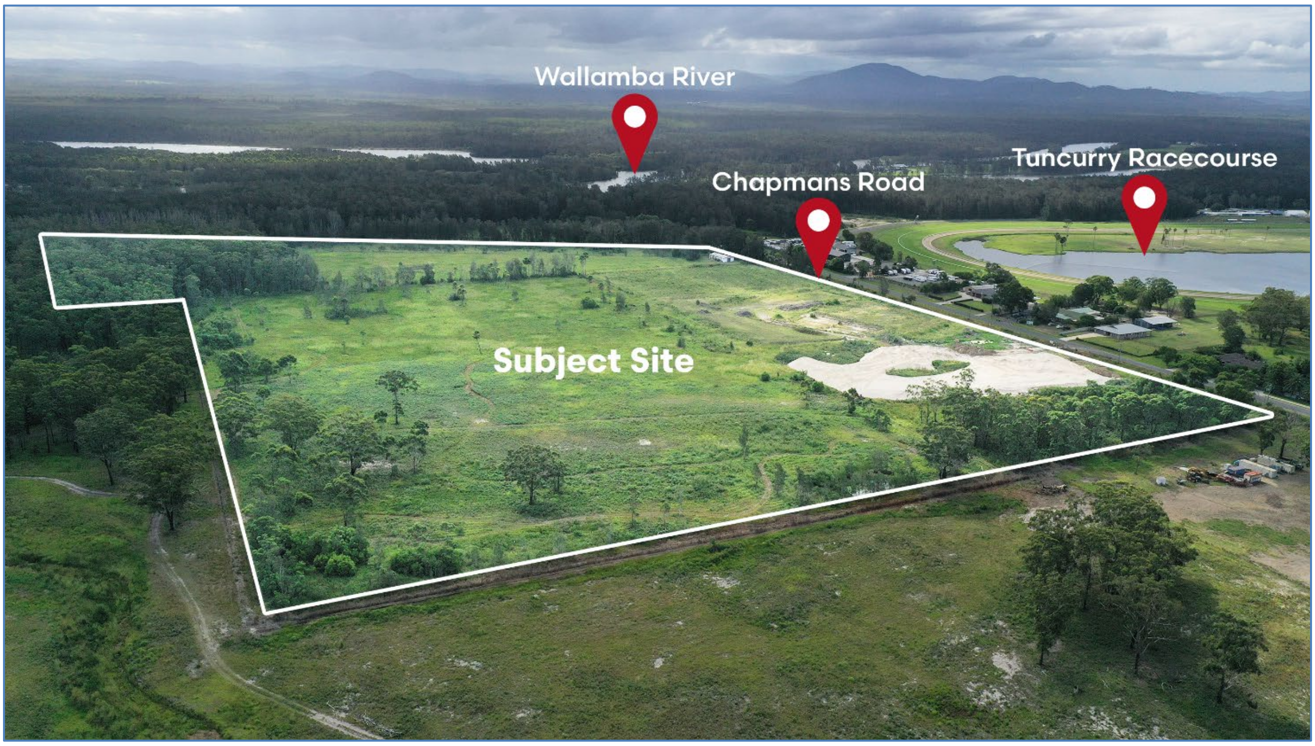


Figure 3: Aerial Site Photo
(Photographed by Drone on 16/02/2024 facing west towards Wallamba River)

The existing site is located approximately 500m east of the Wallamba River, a major fourth order watercourse according to the Strahler stream classification system. All runoff from the development site, either through infiltration or direct runoff, is received by the Wallamba River ecosystem. The existing site is located within the Wallamba River floodplain and hence, experiences regional flooding during infrequent and rare storm events.

The existing site topography can be identified as being low-lying and flat with grades between 0.3% and 0.5% in the north-east to south-west direction. The maximum and minimum natural surface elevations within the site are RL 1.8m and RL 0.65m respectively. Currently, stormwater runoff experiences localised ponding in low-lying areas of the site where the natural surface undulates.

The existing site properties and catchments are summarised in Exhibit 1.

2.2 Site Geotechnical Conditions

The geotechnical conditions of the existing site have been identified through site investigations for potential issues such as groundwater, acid sulphate soils, and contamination. The investigations have been carried out by external consultants, the findings of which are discussed within this section.

The existing site is underlain by three (3) different soil categories: quaternary aged coastal deposits (sand) in the eastern portion of the site (zone 1), tidal delta flat deposits in the middle (zone 2), and Holocene floodplain deposits in the western portion of the site (zone 3; Regional Geotechnical Solutions, 2023; Figure 4). In total, 88 test pits have been carried out by Regional Geotechnical Solutions over Lot 100 DP1286524 and Lot 11 DP615229 from November 2022 to September 2023.

Therefore, it is likely that the proposed development will be constructed on clayey sand representing the 'type B' soil hydrological group. Rock was not encountered in any geotechnical site testing.

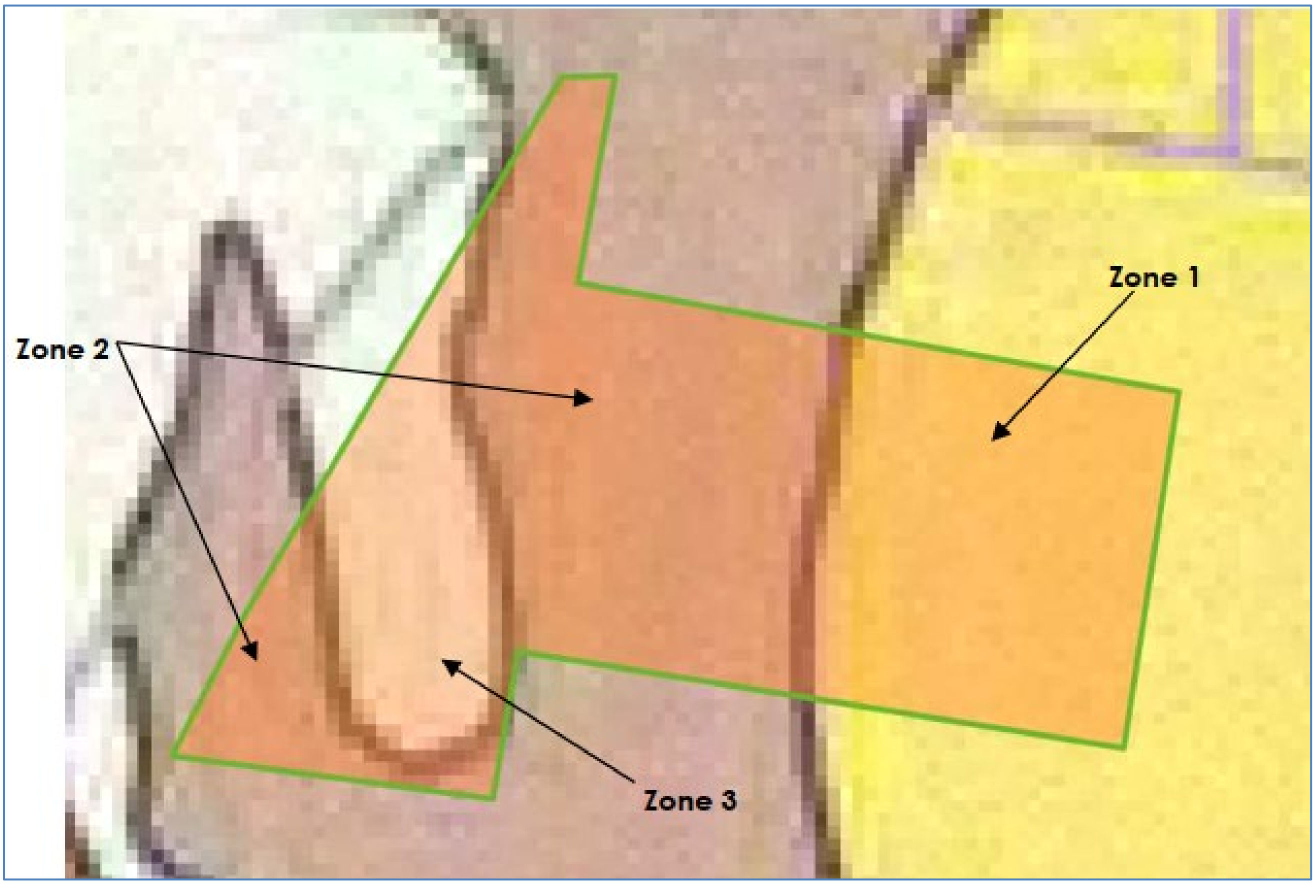


Figure 4: Site Soil Mapping (Regional Geotechnical Solutions, 2023)

The site has been identified as being located within a high probability Acid Sulphate Soil (ASS) region. The property straddles two (2) regions where ASS are located within 1m and 1m-3m of the natural surface respectively by the Coolongolook 1:25,000 ASS Risk Map. As the site is intended to be filled as part of the proposed development, the presence of ASS is unlikely to impact the development. The proposed development will also not contain groundwater bores which can be exposed to contaminated groundwater from ASS.

Groundwater has been identified and classified in the site subsurface by various hydrogeological testing and reports by Douglas Partners. A preliminary groundwater study was conducted in January 2023 with a conceptual hydrogeological model for the existing site (Douglas Partners, 2023a). A more detailed groundwater report was published by Douglas Partners in July 2023 (Douglas Partners, 2023b). Fifteen (15) months of groundwater monitoring well logging data was provided to Allam MHE Development No.2 Pty Ltd by Douglas Partners in August 2024 (Douglas Partners, 2024b).

The existing site has a groundwater level which varies seasonally and is shallow relative to the existing natural surface based on the abovementioned groundwater studies. The groundwater level raises following larger rainfall events and lowers while recharging over long dry periods. The observed monitoring well logging data indicates that the groundwater level generally at or slightly higher than the existing natural surface during the wetter months (Douglas Partners, 2024b). According to the modelling conducted by Douglas Partners, groundwater is expected to flow from east to west across the site towards the Wallamba River with a profile which generally matches the natural surface (Douglas Partners, 2023b) as indicated in Figure 5.

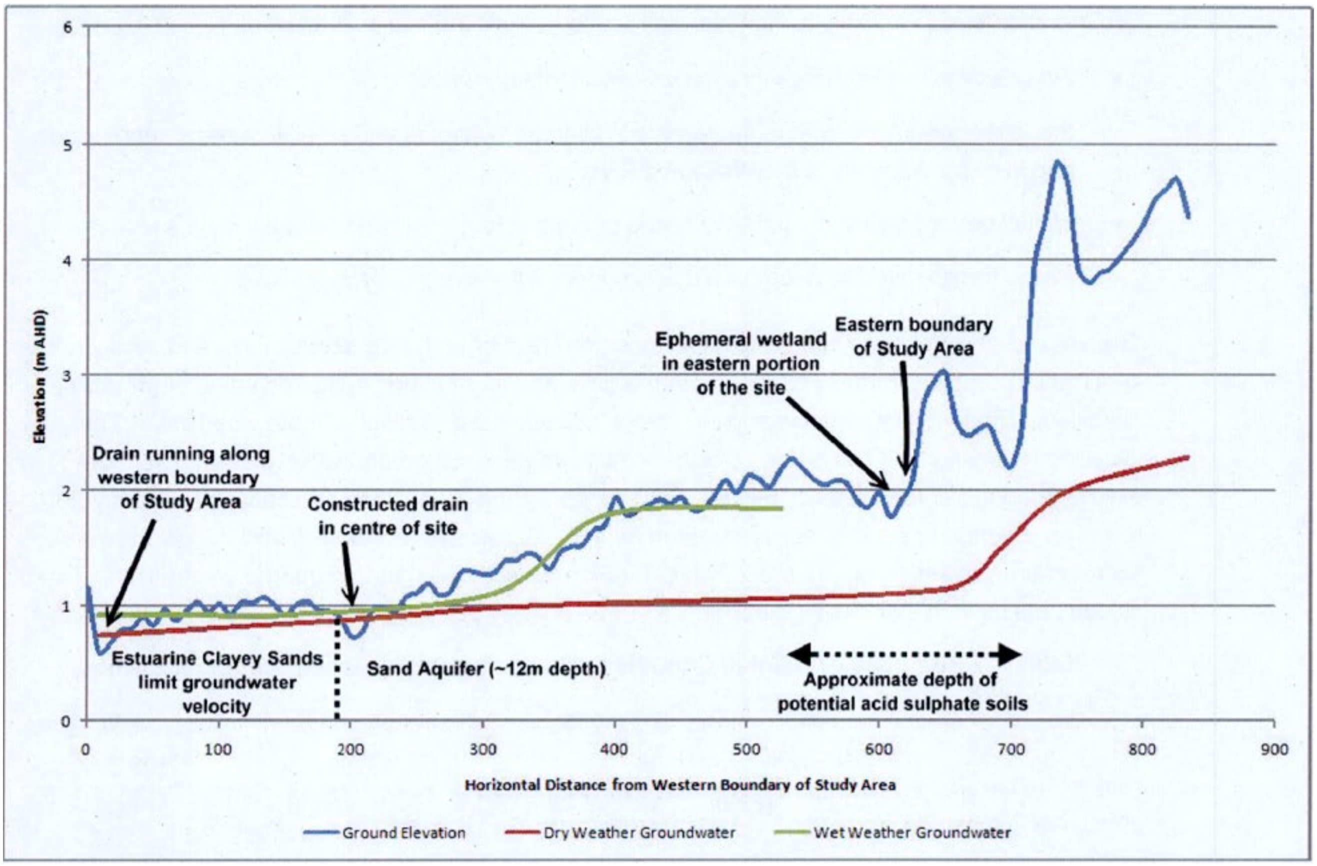


Figure 5: Indicative Wet and Dry Weather Groundwater Profiles (BMT WBM Pty Ltd, 2010)

A shallow unconfined acquifer approximately 12m and 14m in depth is located beneath the existing site and is underlain by clay (BMT WBM Pty Ltd, 2010). The SWMS carried out by BMT WBM in 2010 found that groundwater velocities across the aquifer were relatively low and water table levels increase quickly following rainfall events.

Groundwater Dependant Ecosystems (GDEs) pertaining to the Wallamba Froglet have been identified within the C2 zoned eastern portion of the site and around the Wallamba River (Douglas Partners, 2023b). Therefore, infiltrated stormwater from the site is likely to be received by GDEs.

Infiltration testing has been carried out by Douglas Partners on numerous testing locations around the proposed development site (Douglas Partners, 2024a). The existing soil was found to have variable infiltration characteristics based on the elevation and location of the testing. Double ring infiltrometer testing recorded infiltration rates within sandy fill on site to be between 449mm/hr and 3412mm/hr. Given the recorded infiltration rates for sandy fill on site, an infiltration rate of 100mm/hr would be conservative provided that sandy fill was placed beneath infiltration facilities.

2.3 Proposed Development

The proposed development will comprise 283 MHE sites. The development also includes a community facility, open space and parking facilities. Typical urban residential elements such as roads, drainage infrastructure, services, and landscaping will also be incorporated.

The development will require earthworks and imported fill material to be raised above the regional flood level and to adequately drain runoff through stormwater infrastructure.

The stormwater catchments for the proposed development are influenced by the general earthworks strategy for the site to minimise imported fill material. The design incorporates a peak through the middle of the development to minimise the length of drainage lines. The development is designed to grade radially in all directions towards the boundary of the site to create multiple catchments and drainage reserves to distribute end-of-line stormwater controls.

As such, the proposed stormwater catchments for the development drain to the extremities of the site. Catchments are proposed to drain to Chapmans Road where possible and where there is capacity within the road reserve to cater for flows from the proposed development.

There is an area in the northern extent of the site, including the landscaped buffer along the development frontage and lead-in collector road, which cannot feasibly drain to either drainage reserve for treatment or detention. This portion of the site has its own separate catchment and has been modelled as such.

A grass-lined roadside swale has been proposed along Chapmans Road to assist in the conveyance of stormwater from the proposed developments landscape buffer to the downstream drainage network.

Stormwater infrastructure for the development will involve a combination of at source and end of line treatment and on-site detention facilities. The following water sensitive urban design (WSUD) treatment and detention facilities are proposed:

- **Rainwater Tanks:** At source stormwater reuse and detention.
- **Grass-lined Swale:** Proposed to convey runoff through Chapmans Road reserve.
- **Pit and Pipe Network:** Stormwater conveyance under road reserve.
- **Sediment Forebay and Sump Pit:** Pre-treatment of gross pollutants and suspended solids.
- **Bioretention Swales:** Treatment of boulevard road runoff and catchment 6 runoff.
- **Bioretention Raingardens:** Secondary/tertiary treatment and infiltration.
- **Detention/Infiltration Basins:** Peak flow attenuation and infiltration.
- **Level Spreader and Riprap:** Dispersion of flows to environmental land as required.

Infiltration will also form a major part of the proposed stormwater strategy for the development to support GDEs and the natural water balance of the site.

Frequent flows (at least less than the 3 month ARI) from impervious surfaces are proposed to be treated through the treatment train and biofiltration raingarden prior to infiltration at an end of line OSD basin. The treatment capacity of the system will be equal to the storage in the raingarden up to the top of the extended detention depth (EDD).

Infrequent flows (greater than 3 month ARI) which result in a water level higher than the raingarden EDD will bypass the bioretention raingardens and be stored, infiltrated, and discharged from the OSD basin in a controlled and dispersed manner or via infiltration.

Details regarding the detention and water quality treatment facilities proposed for the development are summarised in the **Exhibit 2**.

Section 3 Objectives & Requirements

3 Objectives & Requirements

Stormwater management within the proposed development is designed to comply with the following documents and guidelines:

2004 Landcom 'Blue Book'.
2014 Great Lakes Local Environmental Plan
2019 Great Lakes Development Control Plan: Section 11 – Water Sensitive Design;
2019 Great Lakes Development Control Plan: Section 16 – Site Specific Development Controls;
2019 Great Lakes Development Control Plan: Section 17 – Manufactured Home Estates and Caravan Parks;
2019 Mid Coast Council Guidelines for Water Sensitive Design Strategies;
2021 State Environmental Planning Policy (Resilience and Hazards)
2022 Mid Coast Council Site Stormwater Drainage Guidelines;

3.1 Stormwater Detention

Stormwater detention and hydrological requirements relevant for the proposed development are determined by the 2024 Mid Coast Council Site Specific Stormwater Drainage Guidelines and are summarised as follows:

- Developments on previously undeveloped catchments are to have the pre-developed catchment assumed as 0% impervious.
- Each site is to be assumed as 60% impervious as part of post development flow and detention calculations.
- Discharge is to be equivalent to pre-development runoff rate for all storm events up to and including the 1% AEP storm event.
- Stormwater flows from the whole site are to be restricted to the 20% AEP predevelopment storm event for all storm events up to and including the 1% AEP storm event where a level spreader is used to discharge stormwater. This requirement is covered in Appendix C of the drainage guideline.

3.2 Water Sensitive Urban Design

The stormwater drainage system must effectively remove the nutrients and gross pollutants from the site prior to runoff entering the existing receiving environment.

The stormwater strategy for the proposed development is to adopt WSUD principles throughout the development to promote sustainable and integrated land and water resource management.

The guidelines for stormwater quality treatment objectives are outlined in the Great Lakes DCP (Section 11 – Water Sensitive Design) and the quality targets relevant for the proposed development are provided in Section 11.4.2.1. The stormwater quality targets are presented for reference in
Table 1.

Table 1: Stormwater Treatment Targets

Pollutant	Stormwater Treatment Targets
Gross Pollutants	90% retention of the average annual load
Suspended Solids	Neutral or Beneficial Effect on Water Quality
Total Phosphorus	Neutral or Beneficial Effect on Water Quality
Total Nitrogen	Neutral or Beneficial Effect on Water Quality

3.3 Erosion and Sedimentation Control

Erosion and sedimentation control measures need to be implemented during any construction activities on the proposed development to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to downstream drainage. Erosion and sedimentation control facilities are to be designed and constructed in accordance with the Blue Book (Landcom, 2004), a widely accepted industry guideline for the management of erosion during construction. Refer to Section 8.0 for further details.

3.4 Groundwater

The proposed development must ensure that the presence of the groundwater table must not impact the performance of WSUD facilities in accordance with the 2019 MCC Guidelines for Water Sensitive Design Strategies. It is therefore required that the underside of bioretention filter media and base of infiltration basins can freely discharge and have clearance to the highest predicted groundwater table to prevent blockage and lowered treatment efficiency prior to infiltration. In accordance with the site specific DCP, a minimum clearance of 1.0m from the base of an infiltration facility to the highest predicted groundwater level is required.

Untreated stormwater from developments should not infiltrate directly to the groundwater table and underlying unconfined aquifer in accordance with Section 16.5.7 of the Great Lakes DCP. As such, stormwater runoff should be treated according to the required treatment targets in Table 1 prior to infiltration to prevent the development from adversely impacting receiving GDEs and the North Tuncurry unconfined aquifer.

3.5 Flooding

In accordance with the relevant Council standards previously mentioned, the following flooding controls apply to the proposed development:

- Habitable dwellings are to have 500mm freeboard from finished floor level (FFL) to:
  - The 1% AEP water level within OSD facilities.
  - The 1% AEP regional flood level.
  - Overland flow paths.

3.6 Proximity to Coastal Wetlands

The subject site has been identified as being located within the proximity buffer to an existing wetland as identified by the 2021 State Environmental Planning Policy (Resilience and Hazards) mapping for wetlands and littoral rainforests. As such, the following requirements are noted for the development:

"The proposed development will not significantly impact on:

- The biophysical, hydrological or ecological integrity of the adjacent coastal wetland or littoral rainforest, or
- The quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest."

Further details regarding the development and how it complies with these requirements are provided in Section 6.0.

Section 4
Stormwater Detention

4 Stormwater Detention

The proposed stormwater system has been designed to protect downstream private and conservation land from increased stormwater flows as a result of the proposed development.

As the development of the site will result in an increased impervious area, on-site detention (OSD) will be required to reduce the peak developed flows back to existing conditions. OSD will be provided by four (4) proposed end of line OSD/infiltration basins which will provide volume for both infiltration and detention.

The subject site is subdivided into a series of sub-catchments for the post-development scenario. Parameters such as sub-catchment areas, imperviousness, and time of concentration are used to simulate the catchment response to storm events to generate hydrographs and estimate the peak median discharge flows using the DRAINS software and computed method outlined in the MCC Site Specific Stormwater Drainage Guideline.

Stormwater detention facilities for the proposed development are proposed as private assets to be constructed, operated, and maintained by the developer.

4.1 Modelling

DRAINS modelling was used to analyse the effectiveness of the proposed OSD measures in attenuating the peak median developed flows discharging from the site to pre-development flows.

4.1.1 Rainfall Parameters

The rainfall data used in the proposed development's DRAINS model is based upon data from the Australian Rainfall and Runoff (ARR) Data Hub and the project site. The rainfall data is based on ARR 2019 and has been used in lieu of a specified rainfall IFD dataset from MCC. Details on the IFD rainfall data used are exhibited in Appendix A.

4.1.2 ILSAX/Horton Hydrological Model

An ILSAX/Horton loss model has been implemented in the DRAINS model for the proposed development in accordance with ARR 2019. The ILSAX/Horton loss model is a type of initial and continuing loss model determined by the Horton equation which calculates decaying continuing losses during a storm event.

Depression storages need to be specified in DRAINS to simulate surface storage of runoff for pervious and impervious catchments. The values nominated for depression storage in the DRAINS model are nominated in Table 2 and comply with the MCC Site Specific Drainage Guidelines. Supplementary areas have not been used in the DRAINS model except for the pre-developed scenario where they are warranted.

Table 2: DRAINS Depression Storage Parameters

Catchment Type	Storage (mm)
Paved (Impervious) Area	1
Grassed (Pervious) Area	5

The DRAINS model requires either a soil hydrological group to be nominated or specific parameters for Antecedent Moisture Condition (AMC) and Horton losses to be specified for the ILSAX/Horton loss model. A 'type 2' soil hydrological group (also known as 'type B' soil) has been nominated for both the pre-developed and post-developed scenarios which is equivalent to a 'clayey sand'. This assumption is consistent with the geotechnical findings from Section 2.2 as the test pits from geotechnical site investigation indicated the site was underlain by a clayey sand. The assumption stipulates that imported fill would need to be constructed from a soil with equal or better permeability characteristics than a 'type B' clayey sand. This is likely as it would be impractical to use clay as earthworks fill on top of the existing clayey sand within the site.

An AMC value of 3 has been used within the DRAINS model to represent saturated pre-burst soil conditions prior to modelled storm events.

4.1.3 Catchment Characteristics

The catchment impervious percentage assumptions are provided in Table 3 and are in accordance with the MCC Site Specific Stormwater Drainage Guidelines. Other assumptions for detention modelling are as follows:

- 100% of the roof area on sites has been assumed to be captured by rainwater tanks through charged drainage lines.
- Sites have conservatively been assumed as 70% impervious rather than 60% impervious as specified in Mid Coast Council Drainage Specification to better represent the proposed housing layout for the development.
- Residential sites have been assumed with an average area of 320m^2 to be consistent with the expected nature of the development.
- MHE roofs have an assumed average roof area of 180m^2 based on the proposed housing layout for the development.
- The community centre in catchment 3 has an assumed roof area of 1,200m^2.
- Drainage reserves have been modelled for MUSIC with a lower impervious % to avoid overestimating pollutant loads and with a higher impervious % to avoid double-counting infiltration area.

Table 3: Catchment Impervious Percentage Assumptions

Catchment Type	Impervious %
Predeveloped Area	Varies by catchment
Residential Sites	70
Road Reserve	75
Caravan Carpark	90
Community Centre	50
Drainage Reserve (MUSIC)	0
Drainage Reserve (DRAINS)	90
Landscaped Areas	0

Exhibit 3 provides a graphical summary of the proposed development subcatchments by their catchment type.

As previously mentioned in Section 2.1, the existing site generally grades to the south-western extent of the site. As such, there is a single pre-developed catchment as illustrated in Exhibit 1. However, to allow for a simple pre-post comparison of peak flows for the downstream point of both the eastern and western drainage reserves, the existing catchments have been proportioned to match the post-development catchment areas due to multiple discharge locations on a flat site. A general catchment area breakdown is provided in Table 4.

Table 4: Pre-Developed DRAINS Catchment Breakdown

Catchment Name	Total Area (ha)	Impervious %	Impervious Area (ha)	Pervious Area (ha)
Catchment 1	4.40	0%	0.02	4.38
Catchment 2	6.30	0%	0.00	6.30
Catchment 3	2.00	0%	0.00	2.00
Catchment 4	2.63	11%	0.30	2.33
Catchment 5	0.32	0%	0.00	0.32
Catchment 6	0.43	0%	0.00	0.43
Total Pre-Developed	16.08	2%	0.32	15.76

The post-development catchment areas for the site are described in Section 2.3 and Exhibit 2. There are six post-development catchments, four of which generally have a gradient of 0.5% towards the proposed drainage reserves. Some of the post developed catchments have been broken down into subcatchments to model WSUD facilities which are located within the larger catchment. A general catchment breakdown is presented in Table 5.

A more detailed catchment breakdown including sub-catchments is provided in Appendix B which includes area of roof to rainwater tanks.

Table 5: Post-Developed DRAINS Catchment Breakdown

Catchment Name	Total Area (ha)	Impervious %	Road (Ha)	Roof to Tank (Ha)	Impervious Area (ha)	Pervious Area (ha)
Catchment 1A	3.96	73%	1.07	1.46	0.61	0.82
Catchment 1B	0.44	73%	0.26	0.11	0.02	0.05
Catchment 2A	5.02	74%	1.23	1.64	1.16	0.99
Catchment 2B	0.83	50%	0.00	0.12	0.30	0.42
Catchment 2C	0.45	71%	0.20	0.14	0.02	0.08
Catchment 3	2.00	72%	0.57	0.67	0.35	0.41
Catchment 4	2.63	74%	0.49	0.99	0.58	0.57
Catchment 5	0.32	35%	0.15	0.00	0.00	0.17
Catchment 6	0.43	73%	0.25	0.11	0.02	0.05
Total Post-Developed	16.08	71%	4.22	5.23	3.06	3.57

The C2 conservation land located at the eastern and south-western extent of the site has been excluded from both pre-developed and post-developed modelling as it is diverted around the site from the earthworks fill pad in the post-developed scenario. The impervious characteristic of Chapmans Road has also not changed significantly as a result of the proposed development and hence has not been included in the DRAINS model.

4.1.4 Rainwater Tanks

Rainwater tanks have been proposed for the development to serve both water reuse and detention purposes for roof runoff from residential dwellings. Half of the rainwater tank capacity has been designated for detention storage to resemble the diagram in Section 4.5.8 of the MCC Site Specific Stormwater Design Guideline. The rainwater tanks are proposed as 3kL in size and are modelled as OSD basins in DRAINS with an initial water level at 50% capacity and an overflow outlet. Only roof sub-catchments have been modelled for detention in the rainwater tanks.

4.1.5 Flooding

The proposed development is located within the Wallamba River regional 1% AEP flood extents.

A flood impact assessment was conducted by Royal Haskoning DHV in December 2024 which examined potential flooding impacts on the proposed development (Royal Haskoning DHV, 2024). The impact assessment involved a 2D TUFLOW flood model of the site based on the WMA water Wallama River Flood Study model with an updated design surface for the site included in the model. The report detailed water levels, flood hazards, and peak flow velocity impacts based on the 5% AEP and 1% AEP storm events. Refer to the report prepared by Royal Haskoning DHV (Royal Haskoning DHV, 2024) for further details regarding flooding for the subject development.

From previous flood studies of the site (Royal Haskoning DHV, 2023), it is understood that the peak design storm event for the Wallamba River Floodplain is the 36 hour storm event. Peak flow and peak water levels around the subject site were found to be at the 29 hour timestep of the modelled storm event as indicated in Figure 6. As the proposed development has a small catchment relative to the catchment size of the Wallamba River, detained outflows from the proposed OSD basins will be discharged hours before the regional upstream flood waters arrive to the site. Therefore, there will be an insignificant interaction between the regional flood waters and the proposed basin discharge. As such, the proposed OSD basins have been modelled with a tailwater set by DRAINS rather than the regional flood level.

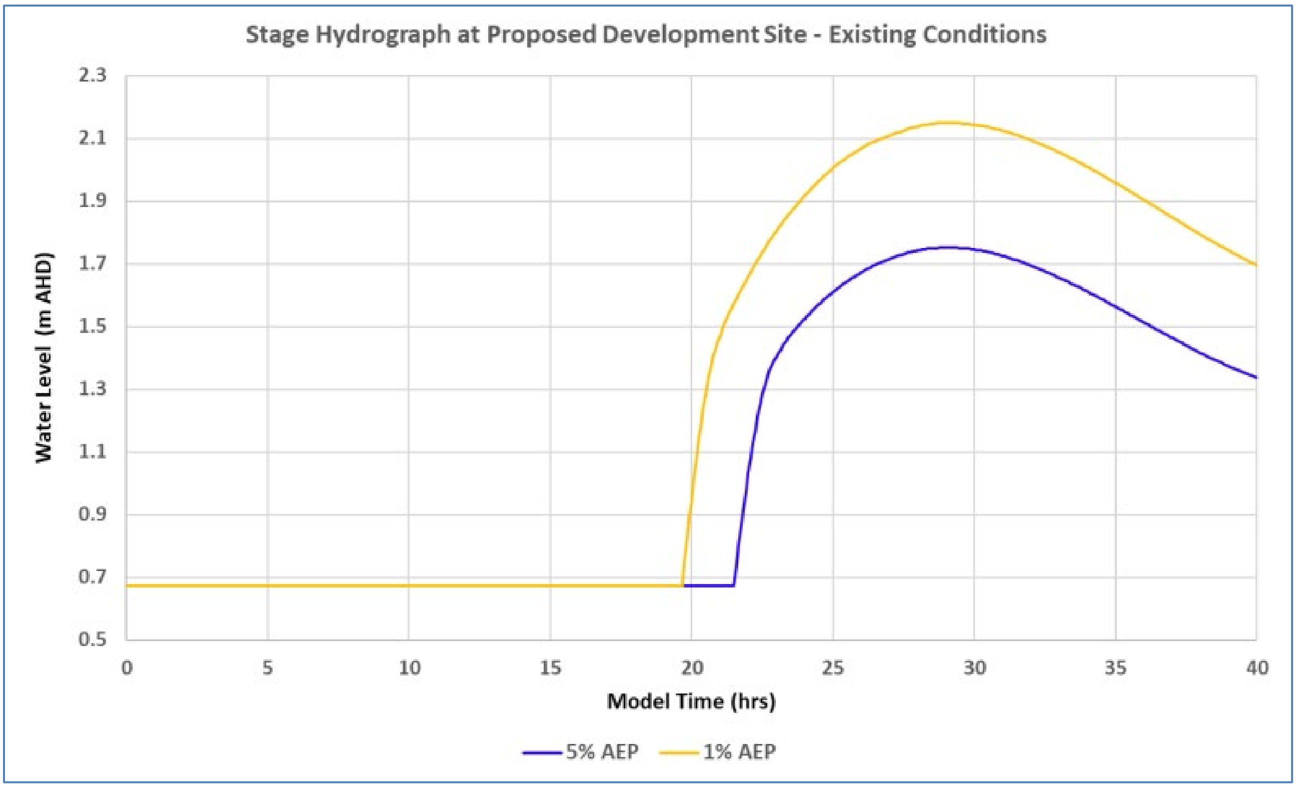


Figure 6: Modelled Flood Water Level (Source: Royal Haskoning DHV, 2023)

4.1.6 Water Quality Treatment Facilities

The storage associated with the proposed water quality treatment facilities has been included within the DRAINS model for the proposed development. This storage includes the storage available below the EDD and dynamic storage above the EDD which is calculated by DRAINS based on the modelled outlet control. For this reason, proposed bioretention raingardens and swales have been modelled in DRAINS as 'basin' nodes to model storage within water quality treatment facilities.

4.1.7 On-Site Detention Basins

As previously discussed, the proposed development will require four (4) end-of-line OSD basins in the four corners of the site to detain post-developed peak flows to pre-developed flows. The OSD basins will manage post-developed peak flows by infiltration and controlled discharge.

Details regarding the basin sizes, volumes and outlet configurations are illustrated in Table 6. For all proposed OSD basins, the ultimate outlet pipe is to be designed at the detailed design phase to cater for the full discharge of the discharge control pit.

The arrangements of the proposed OSD/infiltration basins including diagrammatic sections are illustrated in Exhibits 4-8.

Table 6: Proposed Development OSD Basin Details

OSD Basin Parameter	Catchment 1 Basin	Catchment 2 Basin	Catchment 3 Basin	Catchment 4 Basin
Critical Groundwater Level[1]	RL 1.0m	RL 0.9m	RL 1.7m	RL 1.7m
Basin Base Level	RL 2.0m	RL 1.9m	RL 2.7m	RL 2.7m
Basin EDD level	RL 2.75m	RL 2.15m	RL 3.1m	RL 3.05m
Basin 1% AEP level	RL 3.15m	RL 2.95m	RL 3.78m	RL 3.78m
Basin Weir Level	RL 3.2m	RL 3.1m	RL 3.9m	RL 3.9m
Basin Crest Level	RL 3.5m	RL 3.4m	RL 4.2m	RL 4.2m
Outlet Control	1x0.6mx0.6m GSIP with grate at IL 2.95m; 3x0.7x0.25 culvert cutout at IL 2.75m; 5m weir at RL 3.2m.	1x0.6x0.6 GSIP with grate at IL 2.15m; DN450 pipe at IL 1.5m; 5m weir at RL 3.1m.	1x0.6x0.6 GSIP with grate at IL 3.1m; DN225 pipe at IL 1.8m; 5m weir at RL 3.9m.	1x0.6x0.6 GSIP with grate at IL 3.05m; DN300 pipe at IL 2.25m; 5m weir at RL 3.9m.
Base Surface Area	769m2	2286m2	640m2	740m2
EDD Depth	0.75m	0.25m	0.4m	0.35m
1% AEP Storage	1234m3	2875m3	937m3	1071m3
Governing OSD Criteria	Pre-post detention	Level spreader	Level spreader	Level spreader

[1]Critical groundwater levels based on recorded levels from monitoring wells on-site as determined by Douglas Partners and interpolated where necessary for basin locations (Douglas Partners, 2024b)

Infiltration for the proposed OSD basins has been modelled in DRAINS based on the geotechnical parameters discussed in Section 2.2. A conservative infiltration value of 100mm/hr has been assumed based on the geotechnical investigations of the site and the in-situ infiltration testing carried out by Douglas Partners (Douglas Partners, 2024a). A minimum of 1.0m clearance has been designed into the base level of the OSD basins to the critical groundwater level to ensure infiltration is uncompromised.

Where the proposed basins are to discharge to C2 conservation land within the subject site, the basins are to comply with the level spreader OSD criteria as described in the 2024 Mid Coast Council Site Specific Stormwater Drainage Guidelines. Where the proposed basins are to discharge to Chapmans Road, the basins are to comply with standard pre-post detention criteria.

4.2 Results

The pre-developed and post-developed peak flows have been modelled in DRAINS according to the assumptions and data presented in Section 4.1. Results have been provided for the point of discharge for each catchment as well as the overall site. These results are presented below in Table 7 to Table 13.

It is noted that there are two catchments, catchment 5 and catchment 6, which are to bypass the proposed OSD system and drain directly to Chapmans Road due to topographical and level constraints.

As the site is raised on a fill pad above the existing surroundings to comply with the regional flood planning level (RL 3.2m), there are catchments at the interface with existing levels which cannot be feasibly drained via gravity to the proposed stormwater facilities.

Table 7: Summary of DRAINS Results Downstream of Catchment 1 Basin

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction	Catchment 1 Basin Stage (m)
63.2	0.00	0.00	N/A	2.62
39.4	0.11	0.06	47%	2.81
20	0.37	0.22	41%	2.9
10	0.61	0.40	35%	2.97
5	0.85	0.62	26%	3.03
2	1.10	0.89	19%	3.09
1	1.36	1.12	18%	3.15

Table 8: Summary of DRAINS Results Downstream of Catchment 2 Basin

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction	Catchment 2 Basin Stage (m)
63.2	0.00	0.00	N/A	2.06
39.4	0.13	0.05	61%	2.20
20	0.47	0.31	34%*	2.34
10	0.82	0.35	26%*	2.46
5	1.13	0.39	18%*	2.61
2	1.50	0.44	8%*	2.85
1	1.83	0.46	3%*	2.95

*Reduction % to 20% AEP pre-developed peak flow based on level spreader criteria

Table 9: Summary of DRAINS Results Downstream of Catchment 3 Basin

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction	Catchment 3 Basin Stage (m)
63.2	0.00	0.00	N/A	2.93
39.4	0.05	0.01	82%	3.11
20	0.18	0.12	31%*	3.22
10	0.31	0.13	28%*	3.33
5	0.42	0.14	24%*	3.47
2	0.53	0.15	19%*	3,66
1	0.64	0.15	15%*	3.78

*Reduction % to 20% AEP pre-developed peak flow based on level spreader criteria

Table 10: Summary of DRAINS Results Downstream of Catchment 4 Basin

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction	Catchment 4 Basin Stage (m)
63.2	0.00	0.00	N/A	2.97
39.4	0.11	0.07	39%	3.11
20	0.28	0.17	40%*	3.23
10	0.42	0.18	35%*	3.37
5	0.55	0.20	30%*	3.51
2	0.70	0.21	25%*	3,65
1	0.84	0.22	20%*	3.78

*Reduction % to 20% AEP pre-developed peak flow based on level spreader criteria

Table 11: Summary of DRAINS Results Downstream of Catchment 5

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction
63.2	0.00	0.033	N/A
39.4	0.03	0.06	-120%
20	0.07	0.08	-24%
10	0.10	0.11	-11%
5	0.13	0.13	-2%
2	0.16	0.16	-5%
1	0.19	0.19	-1%

Table 12: Summary of DRAINS Results Downstream of Catchment 6

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction
63.2	0.00	0.00	N/A
39.4	0.02	0.00	100%
20	0.06	0.08	54%
10	0.10	0.11	11%
5	0.12	0.15	-4%
2	0.16	0.19	-3%
1	0.19	0.22	-4%

Table 13: Summary of DRAINS Results for Overall Development

Storm Event (AEP)	Pre-Developed Peak Flow (m3/s)	Post-Developed Peak Flow with Detention (m3/s)	% Reduction
63.2	0.00	0.003	N/A
39.4	0.41	0.19	55%
20	1.33	0.83	38%
10	2.22	1.09	51%
5	3.00	1.37	54%
2	3.93	1.92	51%
1	4.81	2.11	56%

From the results presented in Table 13 , it can be seen that the post-development flows for all storm events are less than the pre-development flows for all durations and storm events up to and including the 1% AEP for the overall site by a significant margin.

Furthermore, the level spreader criteria discussed in **Section 3.1** has been achieved for all catchments draining to C2 conservation land as post-developed peak flows for storm events larger than the 20% AEP are detained to the pre-developed 20% AEP peak flow.

Therefore, the proposed development successfully meets the required OSD criteria outlined in the MCC Stormwater Design Guideline.

Section 5

Water Quality/Water Sensitive Urban Design

5 Water Quality/Water Sensitive Urban Design

The proposed stormwater system, as detailed in Section 2.3, uses a combination of pit and pipe networks and WSUD elements to convey and treat stormwater runoff. It is intended that a combination of treatment devices within the drainage system will function to remove nutrients and sediments from the stormwater prior to discharging into the receiving environment.

WSUD facilities for the proposed development, excluding rainwater tanks, are proposed as private assets to be constructed, operated, and maintained by the developer.

5.1 Treatment Devices

The stormwater design for the proposed development will consist of a combination of at source, conveyance, and end of line controls to treat the stormwater runoff from the site. The treatment controls have been proposed in a pollutant treatment train for demonstration of compliance with Great Lakes DCP pollutant reduction targets outlined in Table 1 and can be summarised as follows:

Rainwater Tanks:	At-source treatment of roof catchments with first-flush system to remove gross pollutants and organic litter/debris.
Pit and Pipe Network:	Conveyance for developed stormwater runoff through the proposed internal road network for the minor storm event.
Sump Pit:	Capture of gross pollutants and suspended solids as a form of primary treatment prior to downstream treatment facilities.
Inlet Sediment Forebay:	Further capture of gross pollutants and suspended solids prior to downstream treatment facilities.
Bioretention Swales:	Proposed swales for boulevard roads with bioretention planting and filter media to treat and infiltrate road runoff.
Bioretention Raingardens:	End-of-line bioretention ponds with planting and filter media to biologically treat and infiltrate developed stormwater runoff.
Infiltration Basin:	Turf-lined infiltration basin with underlying sand media to infiltrate treated and bypass runoff as groundwater.

5.2 Modelling

The software used for the water quality modelling is MUSIC (Model for Urban Stormwater Improvement Conceptualisation). MUSIC is the industry standard model for prediction of stormwater quality outcomes from a proposed development. The modelling approach is based on continuous simulation, operating at time steps to match the scale of the catchment.

As MCC do not have an available MUSIC-Link, the standard meteorological template available on the MCC website has been used for rainfall and evapotranspiration data.

The meteorological template contains ten years of rainfall data ranging from 1969 to 1978 with a six (6) minute timestep. Evapotranspiration in the meteorological template is provided for the same time period with a daily timestep.

The MUSIC default parameters for rainfall and runoff, stormflow and baseflow pollutant concentrations have been amended to comply with MCC WSD Guidelines and the 2015 MUSIC Modelling Guidelines (BMT WBM Pty Ltd, 2015).

Details for the parameters used are presented in Appendix B.

5.2.1 Catchment Data

The catchments and associated parameters used for the MUSIC model are the same as those described in Section 4.1.3. The C2 environmental conservation land and Chapmans Road have been excluded from the MUSIC model.

The MUSIC catchment areas are identical to those modelled in DRAINS.

Details regarding the sub-catchment types described in Table 3 are illustrated in Exhibit 3 for the proposed development. A detailed catchment breakdown for the MUSIC node inputs is presented in Appendix B.

5.2.2 Rainwater Tank Details

The proposed development is to incorporate water retention or reuse measures to reduce the demand on potable water.

As part of the stormwater management for the proposed development, there will be a requirement to install a rainwater tank (RWT) to capture roof runoff. RWTs will be connected to toilet cisterns and be used for laundry and landscaping to minimise the demand on potable water supply. In addition, dwellings are to have AAA+ fixtures and appliances, dual flush toilets, and water efficient gardens.

Further details for MUSIC rainwater tank parameters and assumptions are provided in Appendix B including a breakdown of MUSIC node inputs for each catchment.

5.2.3 Sump Pit

The proposed treatment train is to incorporate a sump pit with a baffle wall prior to the downstream raingarden and OSD basin. The sump pit will serve three purposes: directing low flows to the downstream bioretention raingarden, directing high flows to the OSD basin, and collecting GP and TSS within a sump for pollutant removal during maintenance periods.

5.2.4 Inlet Sediment Forebay

An inlet sediment forebay (also known as a pre-treatment forebay) is proposed to collect GP and TSS prior to bioretention treatment in each end-of-line raingarden. Inlet sediment forebays allow for convenient maintenance of accumulated gross pollutants and prevent downstream secondary treatment devices from blockage. Inlet sediment forebays are nominated as a preferred treatment device over GPTs in the MCC WSD Guidelines.

5.2.5 Bioretention Details

The proposed development is to incorporate the use of bioretention raingardens and swales to treat frequent stormwater runoff (less than 3-month ARI). The bioretention raingardens and swales will allow treatment of stormwater through suitable vegetation and a filter media to remove nitrogen, phosphorous and gross pollutants before discharging the stormwater from site via infiltration to the groundwater table. The bioretention raingardens and swales are to be lined with a permeable geotextile liner to allow for convenient maintenance and replacement of the filter media over the design life of the asset.

To protect downstream GDEs and sensitive groundwater aquifers, the proposed raingardens require a minimum of 1.0m clearance from the underside of the proposed filter media to the predicted highest groundwater level. This clearance will prevent any potential impacts on stormwater treatment and infiltration performance due to groundwater mounding.

The proposed bioretention raingardens and swales have been modelled with MUSIC parameters which align with the requirements outlined in the MCC WSD Guidelines. Specific details for the proposed bioretention swales and raingardens are illustrated in Table 14 and Table 15 respectively.

Table 14: Proposed Development Bioretention Swale Details

Raingarden Parameter	Catchment 1B Swale	Catchment 2BC Swale	Catchment 6 Swale
Critical Groundwater Level	RL 1.3m	RL 1.7m	RL 1.7m
Base Level	Min RL 3.3m	Min RL 3.1m	Min RL 3.1m
EDD Level	Min RL 3.6m	Min RL 3.4m	Min RL 3.4m
EDD Depth	0.3m	0.3m	0.3m
Filter Area	396m2	164m2	171m2
Surface Area	523m2	248m2	380m2
Unlined Filter Perimeter	270m	168m	349m
Filter Depth	0.4m	0.4m	0.4m
Modelled Weir Length[1]	40m	16m	17m
TN Content of Filter Media	400mg/kg	400mg/kg	400mg/kg
Orthophosphate Content of Filter Media	40mg/kg	40mg/kg	40mg/kg

Table 15: Proposed Development Bioretention Raingarden Details

Raingarden Parameter	Catchment 1 Raingarden	Catchment 2 Raingarden	Catchment 3 Raingarden	Catchment 4 Raingarden
Critical Groundwater Level	RL 1.0m	RL 0.9m	RL 1.7m	RL 1.7m
Base Level	RL 2.4m	RL 2.3m	RL 3.1m	RL 3.1m
EDD Level	RL 2.7m	RL 2.6m	RL 3.4m	RL 3.4m
EDD Depth	0.3m	0.3m	0.3m	0.3m
Filter Area	697m2	1411m2	490m2	665m3
Surface Area	818m2	1545m2	566m2	764m2
Unlined Filter Perimeter	197m	218m	127m	161m
Filter Depth	0.4m	0.4m	0.4m	0.4m
Modelled Weir Length[1]	10m	10m	10m	10m
TN Content of Filter Media	400mg/kg	400mg/kg	400mg/kg	400mg/kg
Orthophosphate Content of Filter Media	40mg/kg	40mg/kg	40mg/kg	40mg/kg

5.2.6 Infiltration

Infiltration is proposed as a runoff control method for the stormwater management of the proposed development. Infiltration is proposed for water balance and volume management for the site within biofiltration raingardens, swales and OSD basins.

MCC provides two (2) methods of modelling infiltration in a MUSIC model: setting treatment node exfiltration rates to 0mm/hr or providing a secondary drainage link to source and treatment nodes to return baseflow and infiltrated pollutants to the model.

The MUSIC modelling for the proposed development will use secondary drainage links and a modelled conservative exfiltration rate of 100mm/hr to accurately represent the hydrological processes and water balance of the site.

A minimum of 1.0m clearance from the base of the proposed bioretention basins has been provided to the predicted highest groundwater level at the existing natural surface. In providing clearance to the groundwater level, the performance and efficiency of the raingardens will not be compromised.

The proposed development is only permitted to discharge stormwater runoff in five (5) or less storm events per year on average according to the objectives outlined in Section 16.5.5 of the Great Lakes DCP. Infiltration of treated stormwater runoff in the OSD basins is proposed as a management method to meet this requirement, the results of which is discussed in Section 5.3.

The OSD basins have been modelled in MUSIC as infiltration basins with an infiltration media depth of 0.01m so that they do not provide any treatment advantages. The OSD basins have been modelled with EDD in MUSIC corresponding with the proposed design with an overflow weir to model the lowest basin outlet. Although the OSD basins would provide some treatment of GP and TSS in reality, the OSD basins have been conservatively modelled to only serve storage and infiltration purposes.

5.3 Results

In accordance with the MUSIC target reduction requirements outlined in Table 1, modelling has been undertaken to demonstrate Great Lakes DCP compliance for the proposed development prior to discharge of stormwater into the downstream property.

The MUSIC treatment reduction results of the proposed development are provided as a pre-post pollutant load comparison in Table 16.

Table 16: Summary of Proposed Development MUSIC Pollutant Load Results

	Source		Residual		Reduction %	
Pollutant	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Flow (ML/yr)	70.9	138.0	70.9	121.0	0.0	12.3
Total Suspended Solids (kg/yr)	11200.0	20200.0	11200.0	1660.0	0.0	91.8
Total Phosphorus (kg/yr)	16.7	41.4	16.7	11.9	0.0	71.3
Total Nitrogen (kg/yr)	127.0	298.0	127.0	127.0	0.0	57.4
Gross Pollutants (kg/yr)	88.4	2900.0	88.4	0.0	0.0	100.0

Based on the results presented in Table 16, the proposed development achieves the water quality targets outlined in the Great Lakes DCP. In particular, total suspended solids well exceed the required NorBe reductions from the Great Lakes DCP.

The proposed development has been modelled in MUSIC such that the stormwater runoff and stormwater baseflow can be analysed separately. The modelled runoff and baseflow in MUSIC are depicted in Figure 7 and Figure 8 respectively. The results from MUSIC indicate that over the modelled rainfall period from 1969 to 1978, 46 days with surface runoff exceeding 5L/s occur. A threshold of 5L/s has been specified for daily surface runoff.

Therefore, an average of 4.6 days per year experience a surface runoff event with the proposed treatment train which is less than the required average five (5) days per year DCP requirement.

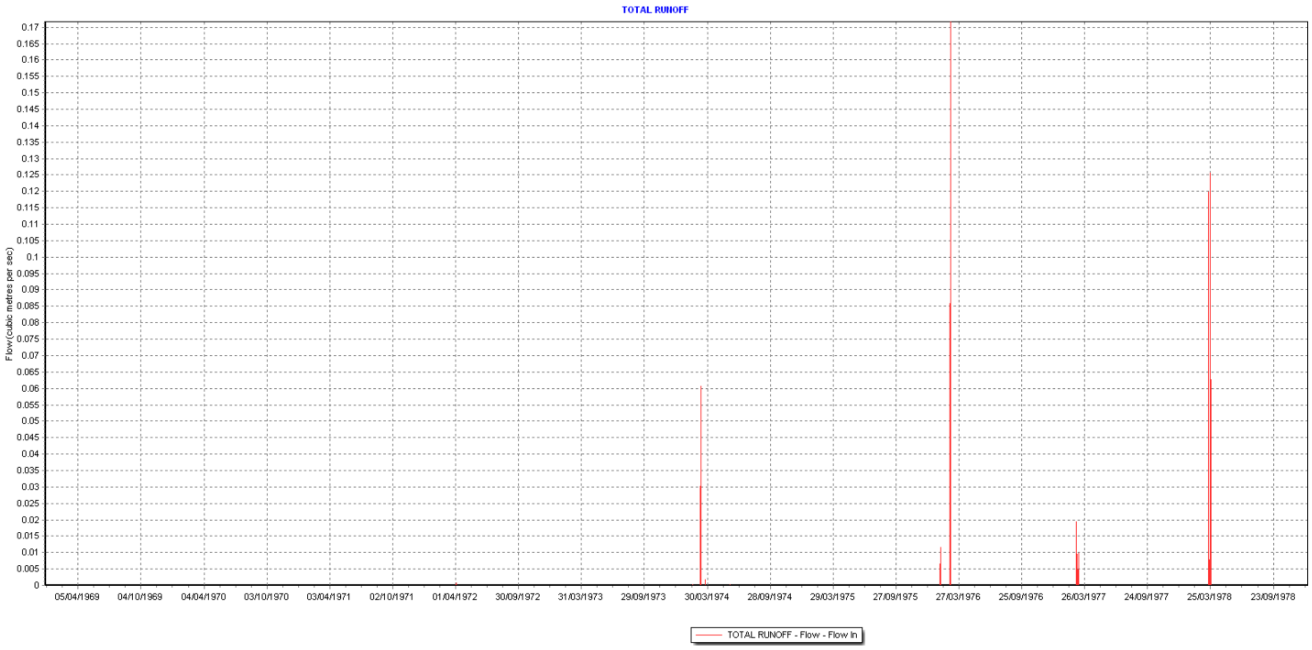


Figure 7: Total Modelled Runoff from Proposed Development (Source: MUSIC)

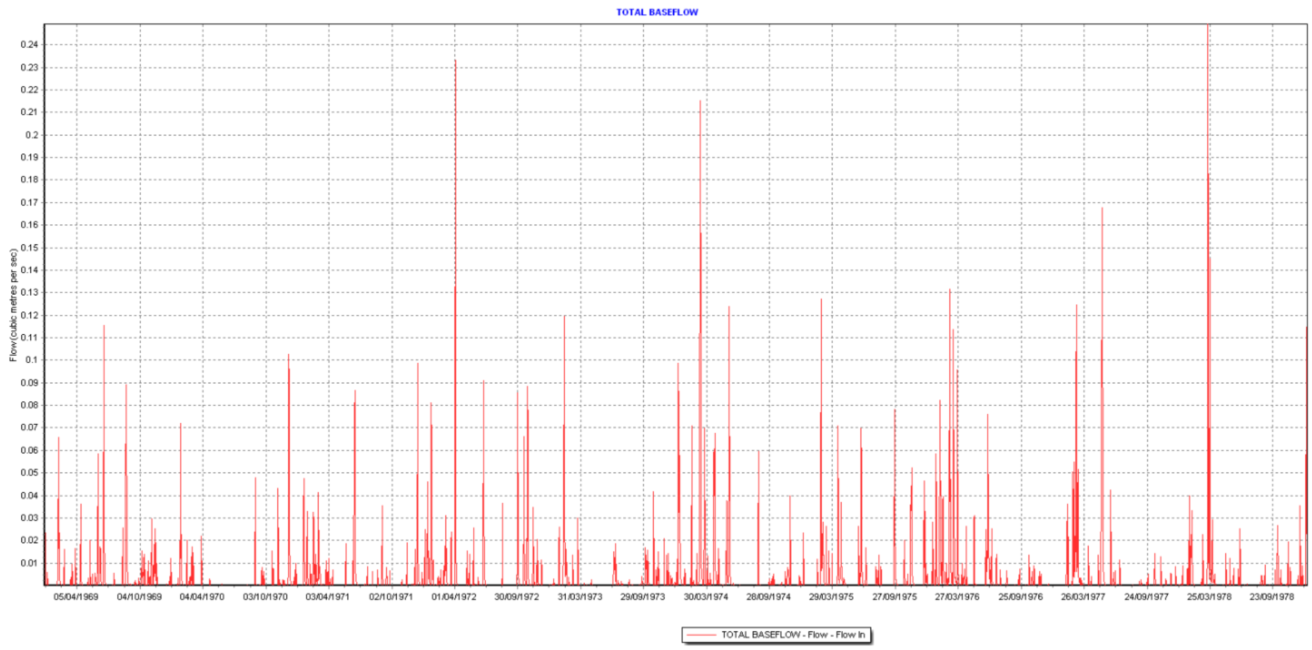


Figure 8: Total Modelled Baseflow from Proposed Development (Source: MUSIC)

Furthermore, daily runoff events were also modelled for the pre-developed scenario to calibrate the MUSIC model against the information presented in the Great Lakes DCP. Pre-developed runoff over the modelled rainfall period is presented in Figure 9 and results in an average of 6.3 daily runoff events per year which exceed a discharge rate of 5L/s. This result closely resembles the criteria of five (5) average daily runoff events per year specified in the Great Lakes DCP and supports the validity of the assumptions and parameters used within the MUSIC model.

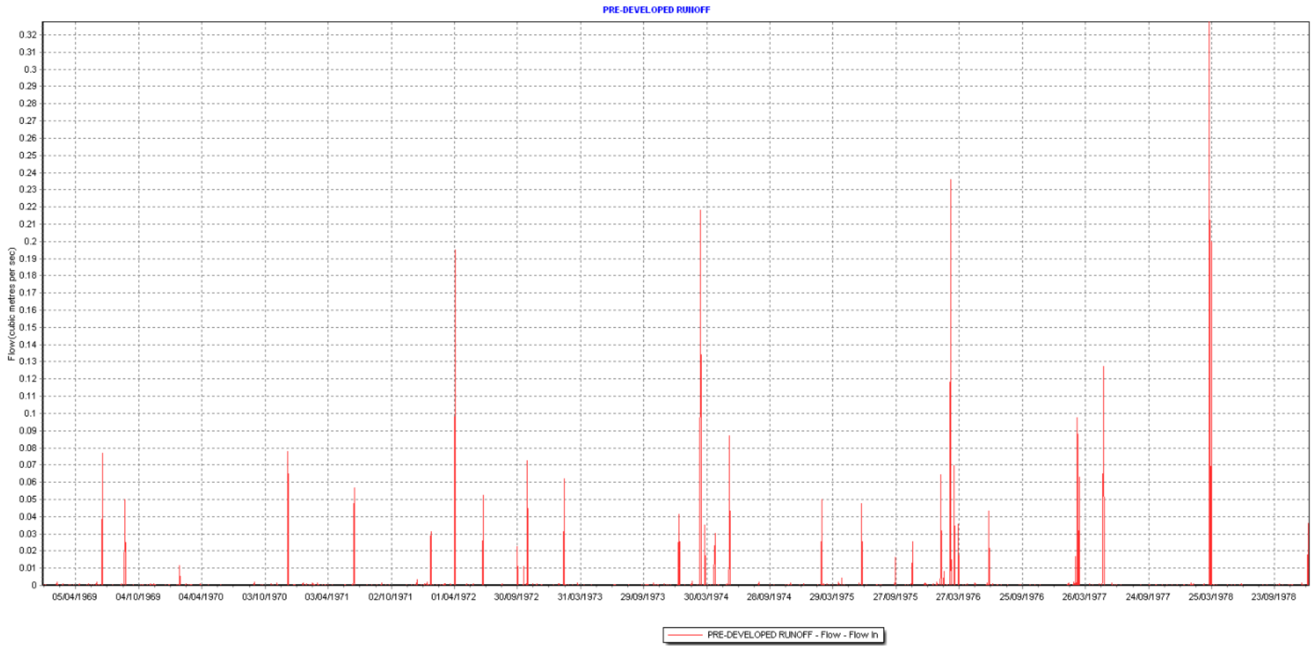


Figure 9: Total Modelled Runoff from Pre-Developed Site (Source: MUSIC)

In light of the results presented, modelling for the proposed development confirms that the required Great Lakes DCP controls in terms of pollutant reduction targets and runoff event exceedances are achieved.

Section 6

Wetland Management Consideration

6 Wetland Management Consideration

The proposed development has been identified as being located within the proximity zone to an existing wetland in accordance with the Resilience and Hazard SEPP 2021 mapping and legislation. The arrangement of the site and the adjacent wetland and buffer zone is illustrated in Figure 10. The figure shows that a very small portion of R2 zoned land encroaches on the land mapped as 'coastal wetland' and a larger portion of the indicative masterplan is located within the 'proximity area for coastal wetlands'.

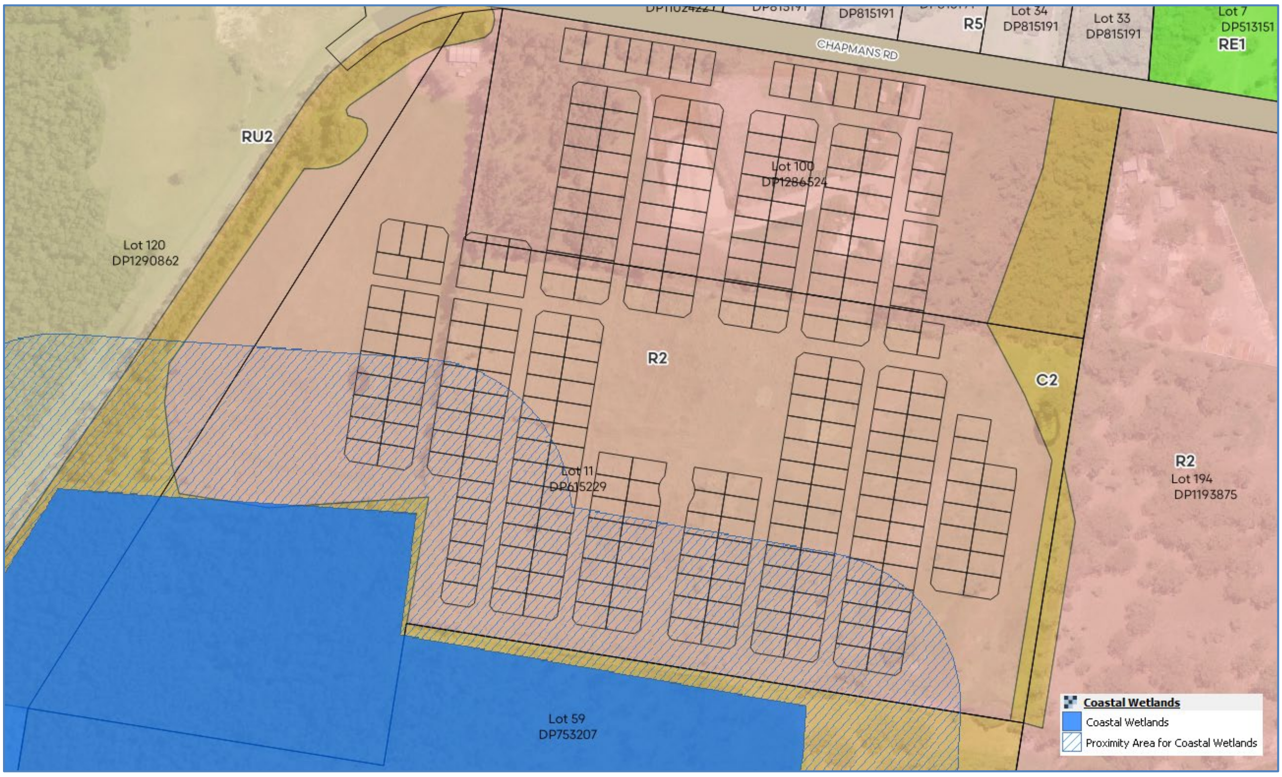


Figure 10: Coastal Wetland SEPP 2021 Mapping (Source: NSW Planning Portal)

Based on the mapping presented, the development must satisfy the conditions outlined in Section 3.6 to not adversely impact the integrity of the downstream wetland. A discussion is provided below with responses to the controls outlined in the 2021 SEPP Resilience and Hazards legislation to outline how the development intends to preserve the integrity of the existing wetland.

Chapter 2, Part 2.2, Division 1, Section 2.8(1)(a)
The proposed development will not significantly impact on the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or littoral rainforest.

Response:
The proposed development will not propose any works within the area mapped as 'coastal wetlands' within Figure 10, thereby not directly or physically impacting the mapped wetland area. The proposed development will not clear any land mapped as 'wetland', thereby protecting the ecology and existing vegetation of the adjacent coastal wetland.

The proposed development will mimic the overland hydrological regime of the existing site as demonstrated with the results and methodology presented in Section 4.0. For any developed catchment discharging to the southern boundary (where the existing wetland and buffer zone is mapped), the development greatly exceeds pre-post stormwater detention requirements. Additionally, all surface developed stormwater flows discharging to land mapped as 'wetland' or 'C2 conservation land' is proposed to discharge through a level spreader. The proposed development meets MCC's level spreader criteria where discharging through a level spreader and by discharging through a level spreader, the proposed development will not scour or damage existing vegetation within the wetland.

As demonstrated in **Section 5.0**, the proposed development will maintain the overland flow conditions and infiltration-centric regime of the existing site. Based on 10 years of rainfall data, the proposed stormwater system has been modelled to discharge overland flow from the site less than 5 days in a given year on average. By infiltrating a majority of the stormwater runoff developed from the site after biological treatment to NorBe criteria, the proposed development will maintain the groundwater regime which currently nourishes the adjacent wetland and its associated ecosystem.

An erosion and sediment control plan has been developed to protect the downstream wetland from erosion and sediment caused by construction phase activities by proposing sediment capture devices and diverting dirty water from direct release to the wetland.

In light of the previously discussed provisions, the proposed development will not significantly impact the biophysical, hydrological or ecological integrity of the adjacent coastal wetland.

Chapter 2, Part 2.2, Division 1, Section 2.8(1)(b)
The proposed development will not significantly impact on the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest.

The stormwater quantity regime of the existing site is preserved through the provision of rainwater tanks, infiltration/OSD basins, and level spreaders where discharging to C2 conservation land. Rainwater tanks have been proposed to promote stormwater harvesting and reuse, thereby reducing the quantity of stormwater and associated pollutants entering the stormwater network. Proposed infiltration facilities have been demonstrated to greatly exceed MCC's pre-post detention requirements and also achieve the site-specific overland flow criteria (average of 5 days per year). The character of overland flow leaving the site has been preserved through the provision of level spreaders and rip rap scour protection to disperse and reduce the velocity of developed flows leaving the site.

Through a proposed treatment train involving stormwater harvesting, gross and suspended pollutant capture devices, and biological treatment with bioretention facilities, the proposed development has been modelled to achieve NorBe water quality targets. As modelling indicates the development will achieve NorBe targets over the modelled 10 year rainfall period, the development will maintain or improve the water quality currently experienced by the existing site.

Therefore, the proposed development will not significantly impact the quantity or quality of surface and ground water flows to and from the adjacent coastal wetland.

Section 7

Chapmans Road Capacity Assessment

7 Chapmans Road Capacity Assessment

The proposed development will discharge stormwater runoff to the Chapmans Road reserve as part of the stormwater strategy from multiple catchments. Due to the site not discharging stormwater runoff to Chapmans Road in the existing scenario, it is necessary to determine the capacity of the Chapmans Road reserve to cater for the additional flows. The following section details the existing stormwater infrastructure available, the capacity of various existing and proposed stormwater conveyance facilities, and any necessary additional infrastructure to cater for the development.

7.1 Existing Chapmans Road Capacity

The existing site generally discharges via infiltration to the groundwater table as primary source of discharge. As indicated in Exhibit 1, the existing site discharges via surface sheet flow and shallow channelised drains throughout the site to the south-western corner of the site in infrequent and rare storm events. From the south-western C2 conservation land, it is understood that the site runoff reaches the Wallamba River by an existing DN600 culvert located on the private road to the Tuncurry Lakes Resort.

On the northern extent of Chapmans Road, runoff from Chapmans Road and the adjacent northern properties is conveyed through a shallow grass lined swale which is formalised in shape and has existing culverts for driveway crossings. The northern swale discharges under the Chapmans Road intersection via 3 x DN375 pipe culverts as overland flow towards the Wallamba River. The condition of the northern swale and the existing culverts is shown in Figure 11.

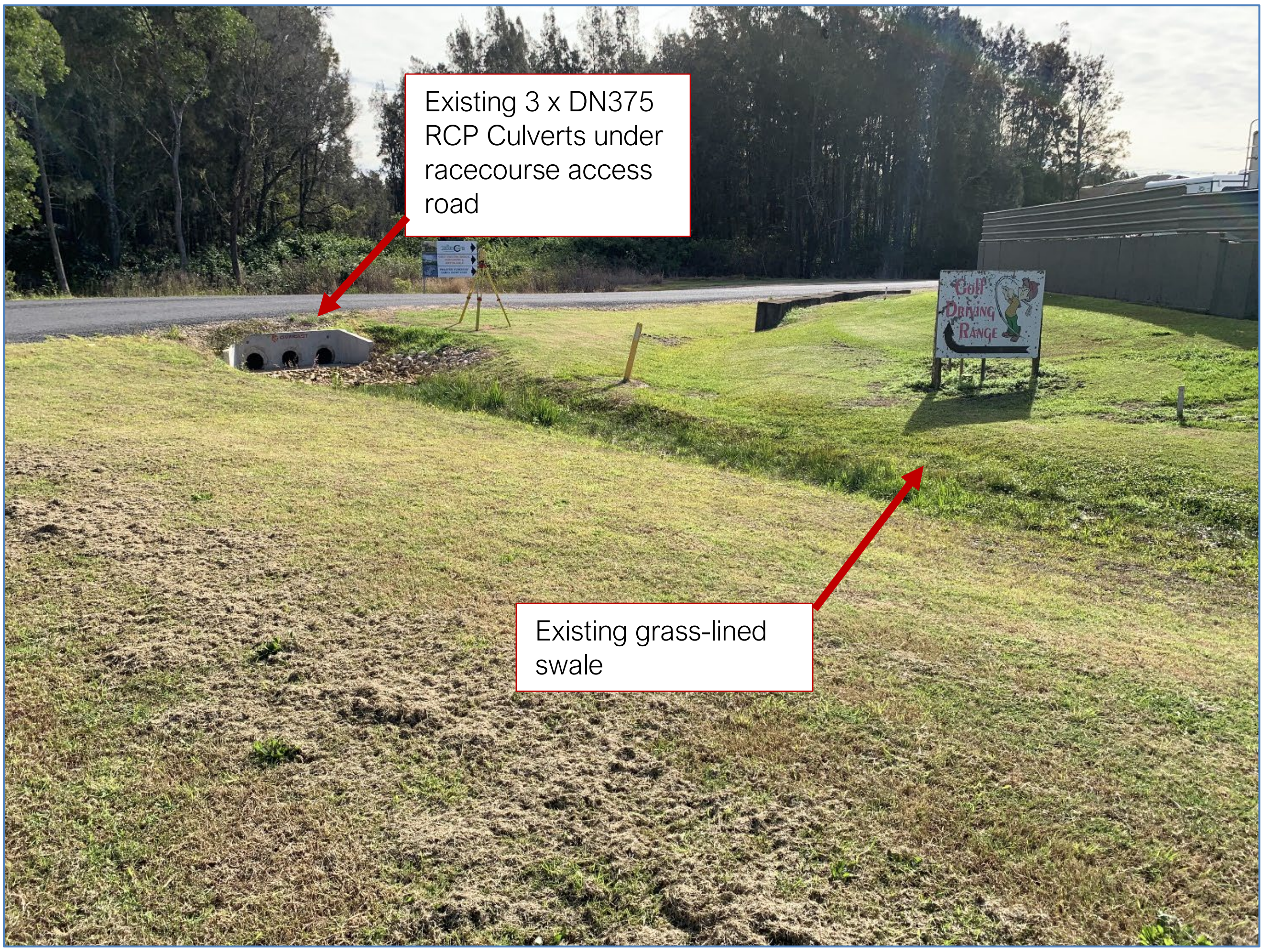


Figure 11: Existing Swale and Culverts on Northern Side of Chapmans Road (Looking Downstream)

The Chapmans Road reserve also conveys surface runoff through an unformed grass-lined swale along the full frontage of the site. Due to the adjacent properties upstream and an inconsistent top of bank formation, the extent of the contributing catchment for the swale is difficult to determine as the swale likely overflows into adjacent land during larger storm events. The condition of the existing swale is illustrated in Figure 12.

Figure 12: Existing Swale on Southern Side of Chapmans Road along Development Frontage (Looking Downstream)

7.2 Proposed Development

The proposed development will re-direct a portion of the developed site catchment to the Chapmans Road reserve as a legal point of discharge. Given that the proposed catchment to discharge to Chapmans Road is greater than that of the existing scenario, it is anticipated that more formalised conveyance of overland flow through the road reserve will be required.

While there is a DN600 culvert located to the south-west, it is identified as existing within private land and is isolated from the proposed development by a strip of C2 zoned conservation land. Therefore, any stormwater runoff discharged from the site to the Chapmans Road reserve should be conveyed to the northern side of Chapmans Road to remain within public MCC stormwater infrastructure. This has been identified as the preference of discharge from the site by in previous discussions with Mid Coast Council as identified in previous Section 34 responses (Matlawski, 2024):

"Once the water is transferred to the Chapmans Rd Road Reserve, investigations would be required to explore the possibility of transferring the water to the northern side of Chapmans Rd where it could then be directed to the existing driveway crossing to the racecourse. From here, the water will follow its natural course to the river."

The proposed forms of conveyance of stormwater through the Chapmans Road reserve will be:

1. A roadside grass-lined swale along the development frontage as detailed in **Section 7.4**.
2. A shallow box culvert crossing to discharge site runoff to the northern side of Chapmans Road as detailed in **Section 7.5**.

The subsequent sections will discuss how the proposed development can safely convey and discharge stormwater runoff through the Chapmans Road reserve.

Exhibit 9 provides a graphical summary of the Chapmans Road reserve and the proposed conveyance controls for stormwater.

7.3 Design Parameters and Criteria

In accordance with the MCC's infrastructure specification 0074 – Stormwater Drainage (Design), the design criteria for drainage in urban road reserves is 20% AEP for minor storms and 1% AEP for major storms respectively.

For conveyance of stormwater through the Chapmans Road reserve, gutter flow width and maximum velocity criteria will govern the design of the proposed roadside swale and road overland flow. For the minor and major design events, the following criteria must be met in accordance with 0074 – Stormwater Drainage (Design) and Austroads AGRD05A Table 5.1 and Table 5.2 for residential streets:

Minor storm event (20% year AEP)

- Gutter flow width: At least one lane width should be trafficable.
- Maximum swale velocity: 0.5m/s
- Maximum Velocity depth product: 0.4 m^2/s

Major storm event (1% year AEP)

- Gutter flow width: Total flow contained within road reserve.
- Maximum swale velocity: 1.0m/s
- Maximum velocity depth product: 0.4 m^2/s

Based on the criteria previously discussed, the proposed roadside grass-lined swale and box culvert will be sized to cater for the 20% AEP storm event with the road reserve catering for flows in rare and extreme events such as the 1% AEP storm event.

DRAINS modelling has been undertaken for the capacity assessment to determine peak design flows from Chapmans Road and the proposed development. The DRAINS model setup for the capacity assessment is identical to that of **Section 4.0** except with the inclusion of the Chapmans Road half road catchment for the full frontage of the development site. The Chapmans Road catchment has been calculated as a 65% impervious 0.41Ha catchment with a calculated time of concentration of 12 minutes.

Based on the DRAINS modelling carried out, the minor storm design peak flows have been determined for the sizing of the required infrastructure in the Chapmans Road reserve to cater for the development. These results are presented in the hydrograph pictured in **Figure 13** and **Figure 14** and are summarised below:

Chapmans Road reserve overland flow: 162L/s
Chapmans Road culvert: 292L/s

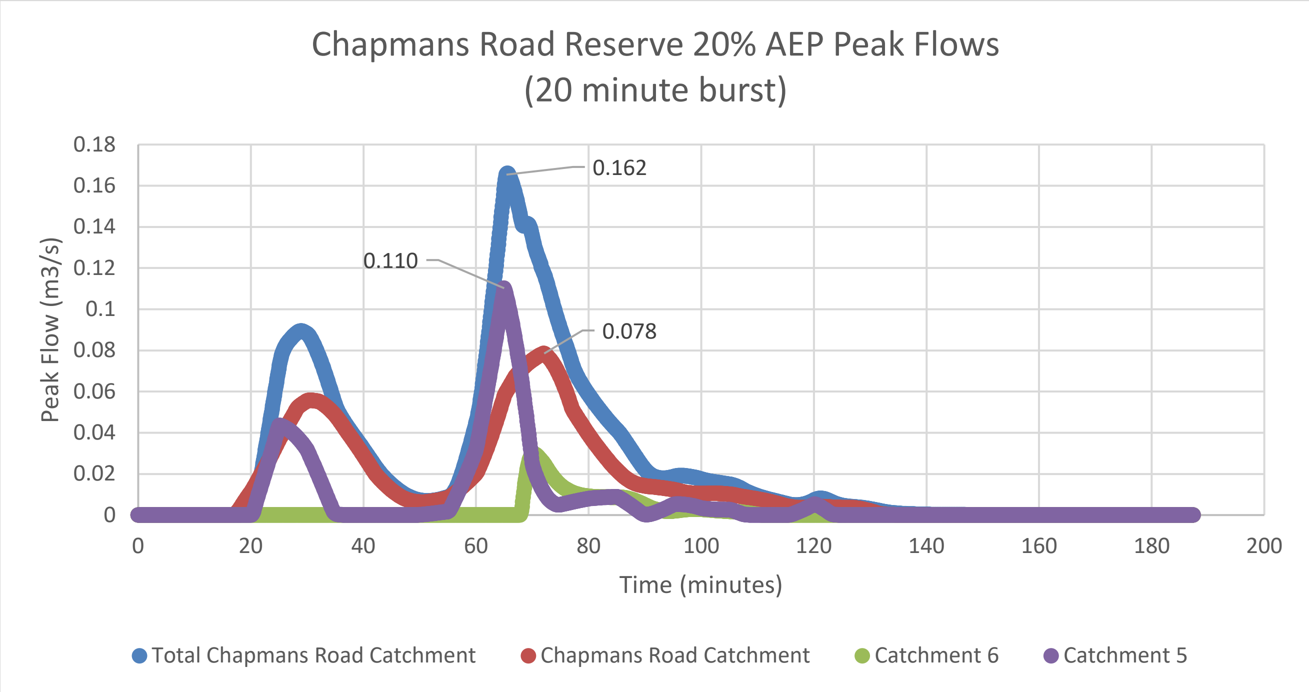


Figure 13: Chapmans Road Reserve 20% AEP Peak Flows (Source: DRAINS)

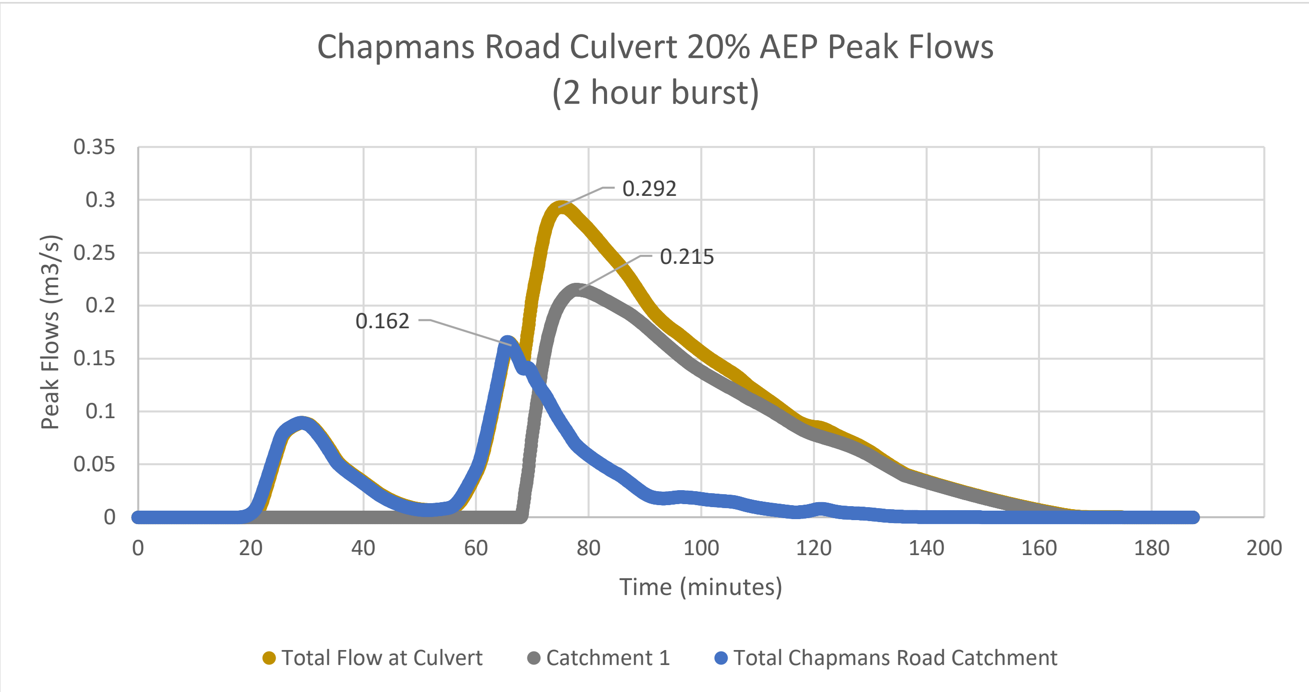


Figure 14: Chapmans Road Culvert 20% AEP Peak Flows (Source: DRAINS)

7.4 Chapmans Road Overland Flow Capacity

Based on the DRAINS modelling carried out in **Section 7.3**, the Chapmans Road reserve must be capable of conveying 162L/s safely and in accordance with the gutter flow width criteria. The channel to convey runoff through the Chapmans Road reserve for the proposed development is a composite roadside swale and gutter channel which is illustrated in Figure 15.

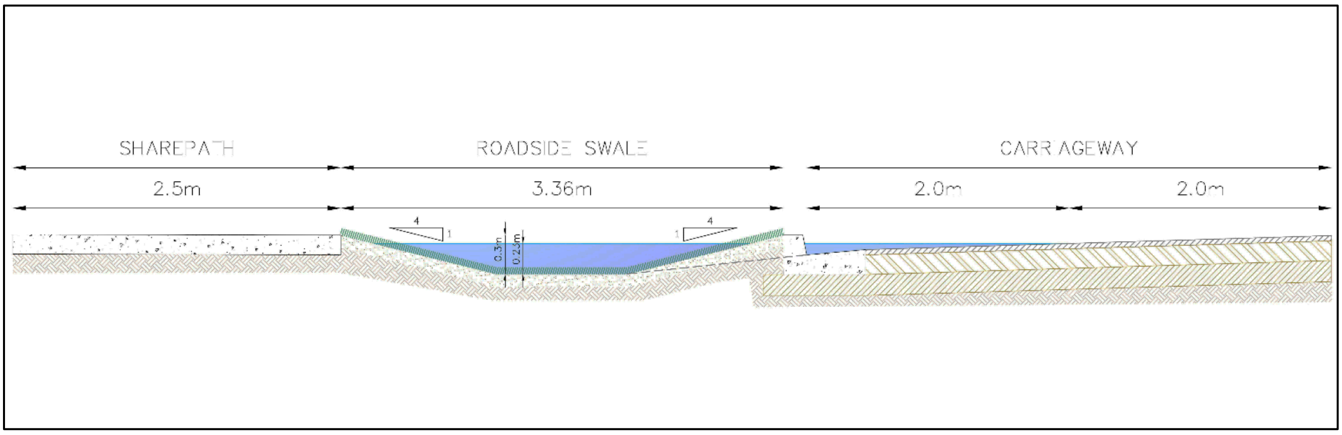


Figure 15: Chapmans Road Typical Section with Max Allowable Flow Width (20% AEP)

Calculations have been carried out to determine the capacity of the section displayed in **Figure 15** and to demonstrate that the road reserve is capable of conveying the 20% AEP storm event flows. These calculations are summarised in **Table 17**.

Table 17: Mannings Calculation for Chapmans Road Reserve Channel

Parameter	Roadside Swale	Kerb and Gutter	Unit
Slope	0.003	0.003	m/m
Mannings n	0.040	0.014	
Area	0.45	0.07	m2
Perimeter	2.92	2.09	m
Hydraulic Radius	0.15	0.03	m
Velocity	0.39	0.39	m/s
Normal Depth relative to invert	0.23	0.09	m
VxD Factor	0.09	0.04	m2/s
Discharge	0.177	0.026	m3/s
Available Combined Capacity	203		L/s
Required Capacity	162		L/s

In light of the results presented in **Table 17**, the proposed roadside swale and kerb and gutter channel are capable of conveying the 20% AEP minor storm event while maintaining adequate clear widths through the Chapmans Road carriageway.

7.5 Chapmans Road Culvert Crossing

As discussed in **Section 7.2** and **Section 7.3**, a culvert is required under Chapmans Road to convey flows from the southern side of Chapmans Road to the northern side. The culvert will allow for flows from the proposed development to remain in the Council road corridor and reach Wallamba river via public land.

In discussions with Council, it has been identified that a 450mm high box culvert would be ideal to minimise blockage and impacts on the shallow road profile of Chapmans Road. A preliminary sizing of the culvert to cater for the minor design storm has been carried out and it is recommended that a 450mm high x 1200mm wide box culvert is constructed. The culvert will be laid at a near flat grade and will therefore be outlet controlled.

Section 8

Erosion & Sedimentation Control

8 Erosion & Sedimentation Control

Erosion and sedimentation control measures need to be implemented during any construction on the proposed development to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the construction site to the receiving environment.

The erosion and sediment control methodology discussed in this section is indicative only as another erosion and sediment control plan will be provided as part of the Construction Certificate drawings and a further plan will be provided by the contractor before construction takes place.

For the proposed development, it is recommended that permanent detention or water quality treatment facilities are constructed early and used as temporary sediment basins during construction. Stormwater runoff during construction should be diverted to the sediment basins using berms and diversion drains to capture and store sediments. Runoff stored within the proposed sediment basins is not to be discharged until the water has been adequately flocculated and treated. Once sites and roads are constructed and stabilised, the sediment basins should be decommissioned and the permanent OSD basins should be constructed. The location and size of the sediment basins have been determined using the RUSLE calculation method from the Landcom Blue Book and are documented for the proposed development in Exhibit 10. Typical details and notes regarding the proposed erosion and sediment controls are presented in Exhibit 11.

Despite the proposed development and Western Precinct being underlain predominately by 'type B' hydrological soil groups, a 'type D' with a high erosion hazard risk has been assumed for sediment basin sizing to conservatively estimate the required volume for sedimentation and storage.

Sediment fencing should be constructed on downslope areas where there is a risk of sediments being transported to surrounding property or the downstream environment.

As part of the proposed erosion and sediment control plan, rip rap scour protection and level spreaders will be proposed at all stormwater outlets. Scour protection and level spreaders will be important for the outlet adjacent to the eastern C2 conservation land to minimise scour of native vegetation.

Section 9
Great Lakes DCP Compliance

9 Great Lakes DCP Compliance

This section presents a discussion on how the information presented within this WCMP addresses and complies with relevant site-specific controls within the Great Lakes DCP Section 16.5.5 and Section 16.5.7 relating to water quality/stormwater management and protection of aquifer respectively. Details of the discussion are illustrated in Table 18.

Table 18: Outline of WCMP Compliance with Great Lakes DCP

Section	Great Lakes DCP Control	Compliance Statement
Section 16.5.5	*Control 1(a)* *Proposed stormwater management measures and facilities will be designed and constructed in accordance with the document titled Chapman's Road, Tuncurry – Stormwater Management Strategy (as adopted 27/4/10).*	Proposed measures such as rainwater tanks, bioretention raingardens and bioretention swales have been incorporated in the WCMP to be in accordance with the SWMS. Infiltration cells have not been proposed as they pose a significant maintenance burden and are hence unlikely to perform at their intended efficiency.
	Control 1(b) *Construction phase impacts on water quality will be adequately managed through erosion and sediment control and appropriate site management.*	*The WCMP discusses erosion and sediment controls for the proposed development which covers the whole Western Precinct.*
	Control 1(c)(i) *Development shall not adversely impact on the natural values of waterways, wetlands, groundwater or any areas of ecological importance.*	*The proposed WCMP incorporates infiltration measures and NorBe treatment prior to infiltration. These two strategies ensure that the proposed development does not adversely impact downstream ecological areas and GDEs.*
	Control 1(c)(ii) *Development shall be capable of controlling the loads and concentrations of pollutants in stormwater discharges from the site in accordance with established targets.*	*MUSIC modelling indicates that the proposed development achieves NorBe targets in accordance with the Great Lakes DCP prior to infiltrating runoff.*
	Control 1(c)(iii) *Adverse impacts on site water balance1 and/or flow regimes are to be minimised.*	*Rainwater tanks have been incorporated into the WCMP to encourage stormwater reuse and minimise the quantity of runoff from the development. Natural flow regimes are preserved by infiltrating a vast majority of runoff to the groundwater table, a majority of which is treated to NorBe.*
	Control 1(c)(iv) *Development shall be integrated with the landscape to achieve multiple benefits including water quality protection, stormwater retention and detention, public open space and recreational and visual amenity.*	*Tiered raingarden and OSD basin arrangements have been proposed to minimise the visual impact of stormwater management measures to the site and surrounding properties. These stormwater management measures will be landscaped to provide improved visual amenity.*
	Control 1(c)(v) *Where possible, stormwater shall be used to reduce potable water demand.*	*Rainwater tanks and reuse have been incorporated into the WCMP and MUSIC model to reduce potable water demand.*
	Control 1(d) *Stormwater from the development will not result in unacceptable changes to waterway stability or alignment.*	*There are no defined watercourses in close proximity to the development. However, level spreaders and riprap scour protection have been proposed to minimise impacts on nearby C2 conservation land.*
	Control 1(e) *Stormwater from the development will not result in an unacceptable change in vegetation or habitat, including limiting the number of days with surface runoff to the target of 5 per year.*	*Points of discharge for the proposed development are proposed to have level spreaders and riprap scour protection where discharging to C2 conservation land. Stormwater runoff will be treated to NorBe requirements in bioretention facilities prior to infiltrating to protect GDEs. Surface runoff targets were achieved for the proposed development.*

Section	Great Lakes DCP Control	Compliance Statement
	Control 1(f) *Stormwater management will be undertaken in a manner that does not encourage the introduction of nonindigenous flora or fauna.*	*Operation and maintenance conducted by the developer is to ensure that non-indigenous flora and fauna are not introduced to the development.*
	Control 1(g) *Stormwater management will be undertaken in a manner that does not degrade visual or recreational amenity of local waterbodies.*	*There are no natural permanent waterbodies in close proximity to the site.*
	Control 1(h) *Stormwater drainage infrastructure will be sized to convey the design storm event and manage the design flood event.*	*Hydraulic modelling has been conducted for proposed basin outlet structures to cater for all storm events up to and including the 1% AEP storm event. Internal stormwater drainage infrastructure has been sized to convey the design storm event.*
	Control 2 *As part of the first development application the developer shall provide, for Council's endorsement, a stormwater strategy detailing stormwater management measures for all of the land identified within the "Western Precinct" and staging, as well as lifecycle costing of the proposed stormwater management system with regard to capital, maintenance, modification and decommissioning costs.*	*The WCMP has included a stormwater management plan which covers the proposed development which covers the developable area within the Western Precinct. Measures of managing runoff from the proposed development in the context of the Western Precinct have been discussed regarding overland flow and drainage. The proposed infrastructure is to remain in private ownership and hence capital, maintenance, and decommissioning costs are not relevant as Council is not burdened by them.*
	Control 3 *The developer is to contribute to the public engineering works, future water quality monitoring and maintenance costs arising in relation to each subdivision consent granted from the commencement of construction until a specified future date as agreed between the developer and Council. The monetary amount shall be based on a lifecycle costing of the proposed stormwater management system that includes capital, maintenance, modification and decommissioning costs.*	*WSUD and stormwater detention facilities for the proposed development, excluding on-lot rainwater tanks, are to be constructed, operated, and maintained as a private asset by the developer.*
	Control 4 *Disturbance of soils will be regulated in accordance with a sediment and erosion control plan which is to be submitted with any Development Application for the site. The plan should detail measures to prevent erosion during any earth works or the construction works. The plan is to be in accordance with Council's Sediment and Erosion Control Policy and Department of Housing's Managing Stormwater Urban Soils and Construction 2004.*	*Erosion and sediment control measures presented in the WCMP have been designed in accordance with the Managing Stormwater Urban Soils and Construction guideline, also known as 'the blue book'. A copy of the erosion and sediment control plan is also provided in the concept engineering plans to be submitted to Council as part of the Development Application.*
Section 16.5.7	*Control 1* *Stormwater modelling for all future development must demonstrate adequate protection of the underlying aquifer by complying with Stormwater Management Performance Criteria set out in the Water Sensitive Design Section relating to Large Scale Development.*	*The WCMP proposes treatment of frequent stormwater runoff (at least less than 3 month ARI) to NorBe targets prior to infiltrating flows to the groundwater table. MUSIC modelling has demonstrated that NorBe pollutant reductions are achieved by the proposed development. WSUD facilities have been designed in accordance with the 2019 Mid Coast Council WSD Guidelines. It is therefore demonstrated that the WSUD strategy of this WCMP will not adversely impact the local aquifer.*
	Control 1 Note *This Plan still allows local infiltration measures (trenches, leaky pipes, etc) to be utilised, but the invert of such measures will have to be located at least one (1) metre above the highest predicted groundwater level. However sealed structures (pipes, etc) can be located within the one (1) metre buffer.*	*All proposed infiltration measures, whether biofiltration raingardens/swales or OSD basins, have been designed and modelled with a minimum 1.0m clearance to the predicted critical groundwater level at the existing natural surface.*

Section 10
Conclusion

10 Conclusion

This WCMP has been prepared to accompany the Development Application for a 283 site MHE development and accompanying community facility under Allam MHE Development No.2 Pty Ltd land holdings.

The preparation of this WCMP has been undertaken to document stormwater management facilities for the proposed development. The WCMP has detailed how the proposed stormwater detention, water quality treatment, and erosion and sediment control infrastructure achieves the requirements outlined in the Great Lakes DCP, WSUD and stormwater drainage criteria specified by MCC. The context of the proposed development within the Western Precinct has been considered by proposing and modelling stormwater management measures regarding detention, water quality and water balance.

Hydrological modelling indicated that the respective detention criteria for each proposed basin discharge location was met for all storm events up to and including the 1% AEP storm event. A mixture of standard pre-post detention and level spreader detention requirements governed each modelled facility based on the receiving downstream environment. Where site catchments drained to Chapmans Road and didn't achieve detention requirements, the bypass plus the detained flow from the rest of the site still greatly exceeded pre-post requirements in accordance with Section 4.4 of the Mid Coast Council Site Specific Stormwater Guidelines.

Water quality treatment has been modelled using the MUSIC software to demonstrate compliance of the proposed WSUD facilities with MCC's WSD Guidelines and Great Lakes DCP controls for the proposed development. A treatment train including devices such as rainwater tanks, sump pits, inlet sediment forebays, bioretention raingardens, and infiltration was shown to achieve the target reductions in pollutant loads specified in the Great Lakes DCP. In addition, the surface runoff criteria of no more than 5 days on average per year, as outlined in the MCC WCP, was achieved for the proposed development.

A discussion was provided which outlined that the proposed development did not adversely impact the mapped downstream wetland based on the modelling carried out and the proposed stormwater management principles and facilities.

A capacity assessment found that adequate capacity was available in the Chapmans Road reserve to convey the minor storm developed flows from the site. Additionally, a 450mm high x 1200mm wide box culvert was proposed to maintain flows within the public road corridor.

An erosion and sedimentation control plan was proposed to minimise the risk of erosion to disturbed areas and limit the transport of sediments from the proposed development to the downstream environment during construction.

The information presented in this WCMP demonstrates that the proposed development at 40-80, 82 Chapmans Road, Tuncurry sustainably manages stormwater detention, water quality, and erosion and sediment control to minimise development impacts on the receiving environment. The WCMP demonstrates that the proposed stormwater management facilities for the proposed development complies with the Great Lakes DCP.

Section 11
References

11 References

- BMT WBM Pty Ltd (2010), “Chapmans Road, Tuncurry – Amended Stormwater Management Strategy”, R.1644.001.03.
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- Douglas Partners (2023a), “Report on Preliminary Groundwater Study”, R.001.Rev1.
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- Douglas Partners (2024b), “Results of Data Logger Download – Proposed Manufactured Housing Estate 40-80 & 82 Chapmans Road, Tuncurry NSW”, R.008.Rev0.
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- Land Dynamics Australia (2023), “Stormwater Management Plan”, revision C.
- Mid Coast Council (2019), “Guidelines for Water Sensitive Design Strategies”, revision 05.
- Matlawski, A, (2024). “Section 34 conference – Review of Proposed Stormwater Strategy for 40-80 Chapmans Road, Tuncurry”, 29th January 2024.
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- Royal Haskoning DHV (2023), “40-80 Chapmans Road, Tuncurry – Flood Impact Assessment and Hydrological Investigation”, PA3653-RHD-WR-RP-CI-0001.
- Royal Haskoning DHV (2024), “40-80 & 82 Chapmans Road, Tuncurry – Flood Impact Assessment and Hydrological Investigation”.

Exhibits

Appendix A

DRAINS Details – ARR Data Hub Details

Table A1: DRAINS Catchment Breakdown

DRAINS DETAILS							
Scenario	**Catchment**	**Total Area (ha)**	**Impervious %**	**Road (ha)**	**Roof to tank (ha)**	**Impervious Area (ha)**	**Pervious Area (ha)**
Pre-Developed	Catchment 1	4.40	0%			0.02	4.38
	Catchment 2	6.30	0%			0.00	6.30
	Catchment 3	2.00	0%			0.00	2.00
	Catchment 4	2.63	11%			0.30	2.33
	Catchment 5	0.32	0%			0.00	0.32
	Catchment 6	0.43	0%			0.00	0.43
	Total Pre-developed	**16.08**	**2%**			**0.32**	**15.76**
Post-Developed	Catchment 1A	3.96	73%	1.07	1.46	0.61	0.82
	Catchment 1B	0.44	73%	0.26	0.11	0.02	0.05
	Catchment 2A	5.02	74%	1.23	1.64	1.16	0.99
	Catchment 2B	0.83	50%	0.00	0.12	0.30	0.42
	Catchment 2C	0.45	71%	0.20	0.14	0.02	0.08
	Catchment 3	2.00	72%	0.57	0.67	0.35	0.41
	Catchment 4	2.63	74%	0.49	0.99	0.58	0.57
	Catchment 5	0.32	35%	0.15	0.00	0.00	0.17
	Catchment 6	0.43	73%	0.25	0.11	0.02	0.05
	Total Post-developed	**16.08**	**71%**	**4.22**	**5.23**	**3.06**	**3.57**

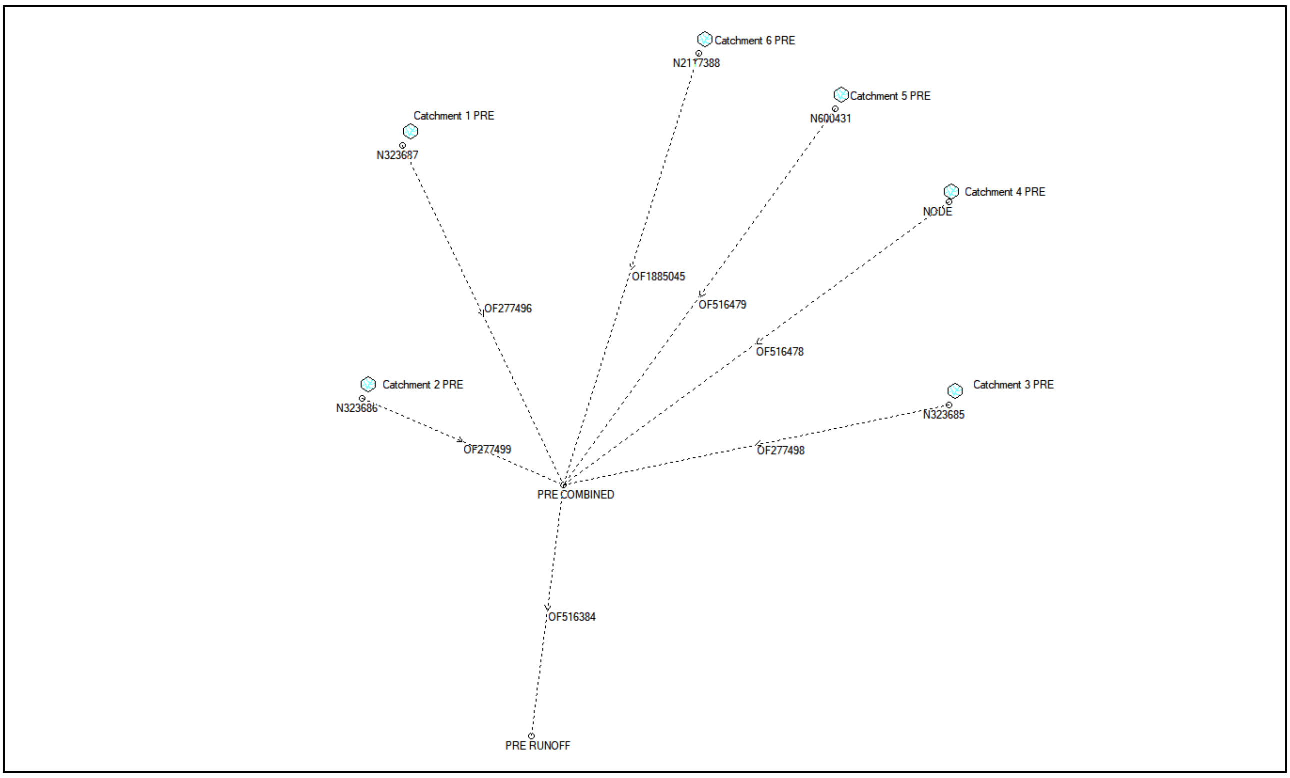


Figure A1: Pre-Development DRAINS Model

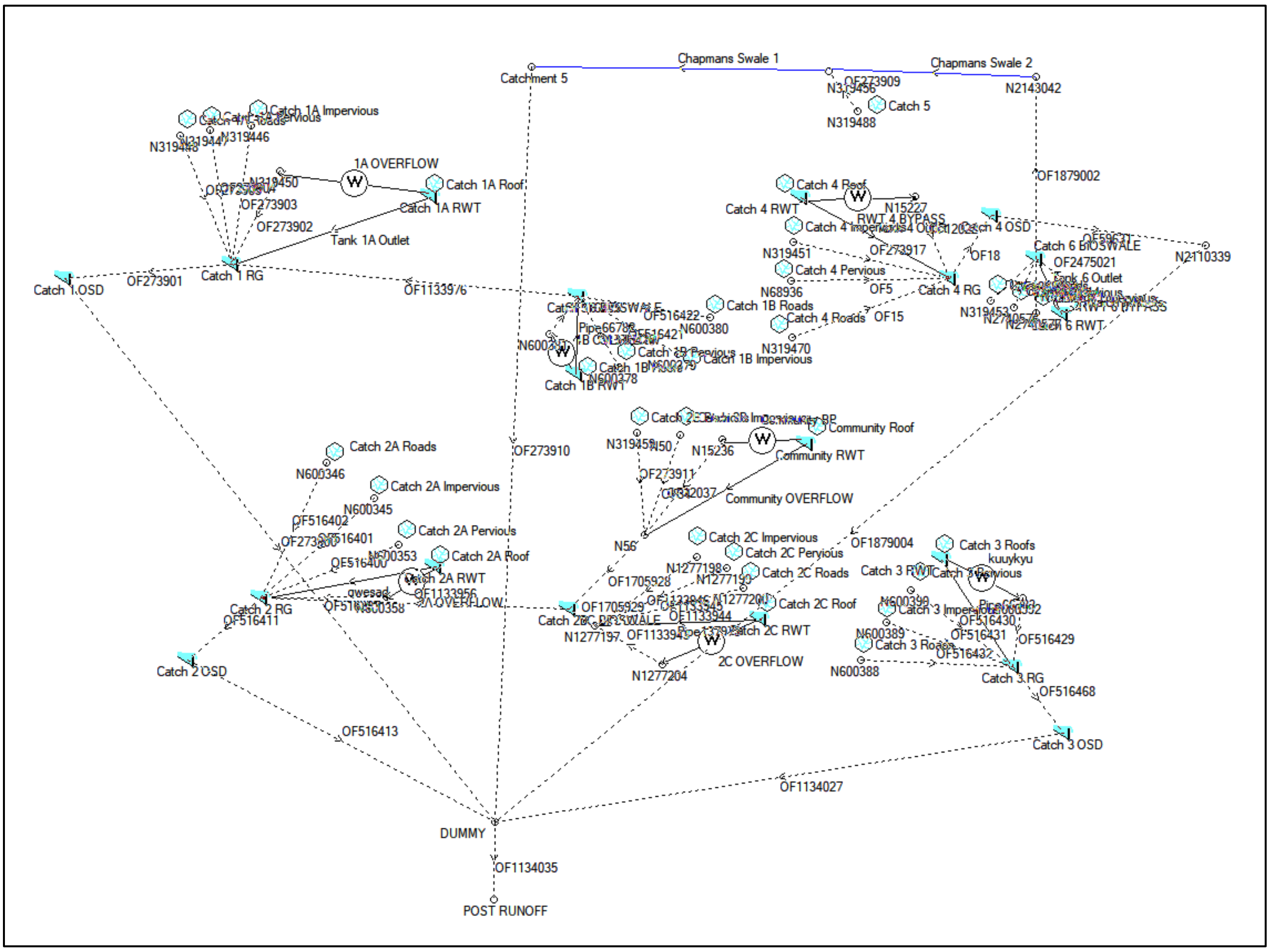


Figure A2: Post-Development DRAINS Model

Appendix B

MUSIC Details

Table B1: MUSIC Catchment Details

	Catchment Details										MUSIC Node Inputs				
Scenario	Catchment	Total Catchment Area	# Lots	Lot Area (ha)	Road Area (ha)	Carpark Area (ha)	Community Centre (ha)	Basin Area (ha)	Undeveloped Area/Landscaped Area (ha)	Total Area Check	Road (ha)	Roof to tank (ha)	Urban Impervious (ha)	Urban Pervious (ha)	Total Area modelled check
Pre-Developed	Catchment 1	4.40							4.40	4.40			0.02	4.38	4.40
	Catchment 2	6.30							6.30	6.30				6.30	6.30
	Catchment 3	2.00							2.00	2.00				2.00	2.00
	Catchment 4	2.63							2.63	2.63			0.30	2.33	2.63
	Catchment 5	0.32							0.32	0.32				0.32	0.32
	Catchment 6	0.43							0.43	0.43				0.43	0.43
	Total Pre-developed	**16.08**							**16.08**	**16.08**			**0.32**	**15.76**	16.08
Post-Developed	Catchment 1A	3.96	81	2.48	1.07			0.37	0.04	3.96	1.07	1.46	0.28	1.15	3.96
	Catchment 1B	0.44	6	0.18	0.26					0.44	0.26	0.11	0.02	0.05	0.44
	Catchment 2A	5.02	91	2.82	1.23	0.26		0.66	0.05	5.02	1.23	1.64	0.57	1.58	5.02
	Catchment 2B	0.83					0.83			0.83	0.00	0.12	0.30	0.42	0.83
	Catchment 2C	0.45	8	0.24	0.20				0.01	0.45	0.20	0.14	0.02	0.08	0.45
	Catchment 3	2.00	37	1.11	0.57			0.27	0.05	2.00	0.57	0.67	0.11	0.65	2.00
	Catchment 4	2.63	55	1.74	0.49			0.39	0.01	2.63	0.49	0.99	0.23	0.92	2.63
	Catchment 5	0.32			0.15				0.17	0.32	0.15	0.00	0.00	0.17	0.32
	Catchment 6	0.43	6	0.18	0.25					0.43	0.25	0.11	0.02	0.05	0.43
	Total Post-developed	**16.08**	**284**	**8.75**	**4.22**	**0.26**	**0.83**	**1.69**	**0.33**	**16.08**	**4.22**	**5.23**	**1.54**	**5.09**	16.08

Table B2: MUSIC Rainwater Tank Details

RAINWATER TANK DESIGN												
						High Flow By-pass				Overflow Pipe Dia	PET - RAIN	
Scenario	Catchment	# Lots	Equivalent Pipe Area (m2)	Equivalent Pipe radius (m)	Total Area of Roof to Tank (ha)	1yr flow on roof (m3/s)	Total Tank Volume (m3)	Volume below overflow pipe (kL)	Tank Surface Area (m2)	Equivalent Pipe dia (mm)	Annual Demand (kL/yr)	Daily Demand (kL/day)
Proposed Development	Catchment 1A	81	0.159	0.225	1.46	0.399	243	121.5	151.88	0.450	532	7.0
	Catchment 1B	6	0.012	0.061	0.11	0.030	18	9	11.25	0.122	39	0.5
	Catchment 2A	91	0.179	0.238	1.64	0.449	273	136.5	170.63	0.477	598	7.9
	Catchment 2B	1	0.002	0.025	0.12	0.033	15	7.5	9.38	0.050	124	1.6
	Catchment 2C	8	0.016	0.071	0.14	0.039	24	12	15.00	0.141	53	0.7
	Catchment 3	37	0.073	0.152	0.67	0.182	111	55.5	69.38	0.304	243	3.2
	Catchment 4	55	0.108	0.185	0.99	0.271	165	82.5	103.13	0.371	361	4.8
	Catchment 5											
	Catchment 6	6	0.012	0.061	0.11	0.030	18	9	11.25	0.122	39	0.5

	PROPOSED AND FUTURE LOTS	COMMUNITY CENTRE	UNIT	
PET - Rain for landscape area	18	340	L/day/dwelling	
Assumed Daily Demand	87	1646	L/day/dwelling	
Adopted Tank Size	3	15	kL	
Assumed 50% reuse and 50% detention	50%	50%		
Useable tank	1.5	7.5	kL	
Assumed tank height	1.6	1.6	m	
Depth above overflow	0.8	0.8	m	
Rainfall intensity on roof	98.6	98.6	mm/hr	*For 5 minute duration for 1 year ARI

Table B3: MUSIC Rainfall-Runoff Parameters

Rainfall Runoff Parameter	Value
Impervious	
Rainfall Threshold	1mm
Pervious	
Soil Storage Capacity	107mm
Initial Storage	25%
Field Capacity	75mm
Infiltration Capacity Coefficient (a)	250
Infiltration Capacity Coefficient (b)	1.3
Groundwater	
Initial Depth	10mm
Daily Recharge Rate (%)	60
Daily Baseflow Rate (%)	45
Daily Deep Seepage Rate (%)	0

Table B4: MUSIC Baseflow Pollutant Concentrations (Source: BMT WBM Pty Ltd, 2015)

	TSS		TP		TN	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Large Areas of Interest						
Residential	1.20	0.17	-0.85	0.19	0.11	0.12
Business	1.20	0.17	-0.85	0.19	0.11	0.12
Industrial	1.20	0.17	-0.85	0.19	0.11	0.12
Rural	1.15	0.17	-1.22	0.19	-0.05	0.12
Agricultural	1.30	0.13	-1.05	0.13	0.04	0.13
Eroding gullies	1.20	0.17	-0.85	0.19	0.11	0.12
Quarries	1.20	0.17	-0.85	0.19	0.11	0.12
Re-vegetated land	1.15	0.17	-1.22	0.19	-0.05	0.12
Forest	0.78	0.13	-1.22	0.13	-0.52	0.13
Small Areas of Interest						
Roofs	n/a	n/a	n/a	n/a	n/a	n/a
Sealed road pavement	1.20	0.17	-0.85	0.19	0.11	0.12
Unsealed road pavement	1.20	0.17	-0.85	0.19	0.11	0.12
Landscaped areas	1.20	0.17	-0.85	0.19	0.11	0.12

Table B5: MUSIC Stormflow Pollutant Concentrations (Source: BMT WBM Pty Ltd, 2015)

	TSS		TP		TN	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Large Areas of Interest						
Residential	2.15	0.32	-0.60	0.25	0.30	0.19
Business	2.15	0.32	-0.60	0.25	0.30	0.19
Industrial	2.15	0.32	-0.60	0.25	0.30	0.19
Rural	1.95	0.32	-0.66	0.25	0.30	0.19
Agricultural	2.15	0.31	-0.22	0.30	0.48	0.26
Eroding gullies	3.00	0.32	-0.30	0.25	0.34	0.19
Quarries	3.00	0.32	-0.30	0.25	0.34	0.19
Re-vegetated land	1.95	0.32	-0.66	0.25	0.30	0.19
Forest	1.60	0.20	-1.10	0.22	-0.05	0.24
Small Areas of Interest						
Roofs	1.30	0.32	-0.89	0.25	0.30	0.19
Sealed road pavement	2.43	0.32	-0.30	0.25	0.34	0.19
Unsealed road pavement	3.00	0.32	-0.30	0.25	0.34	0.19
Landscaped areas	2.15	0.32	-0.60	0.25	0.30	0.19

Figure B1: Pre-Developed MUSIC Model

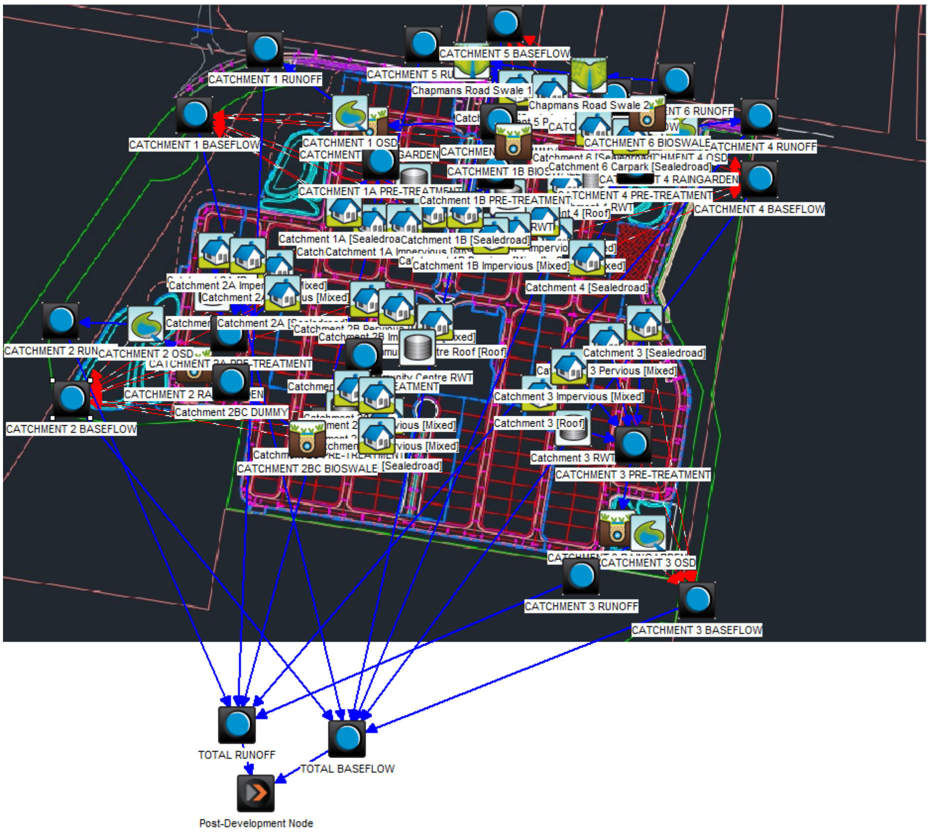
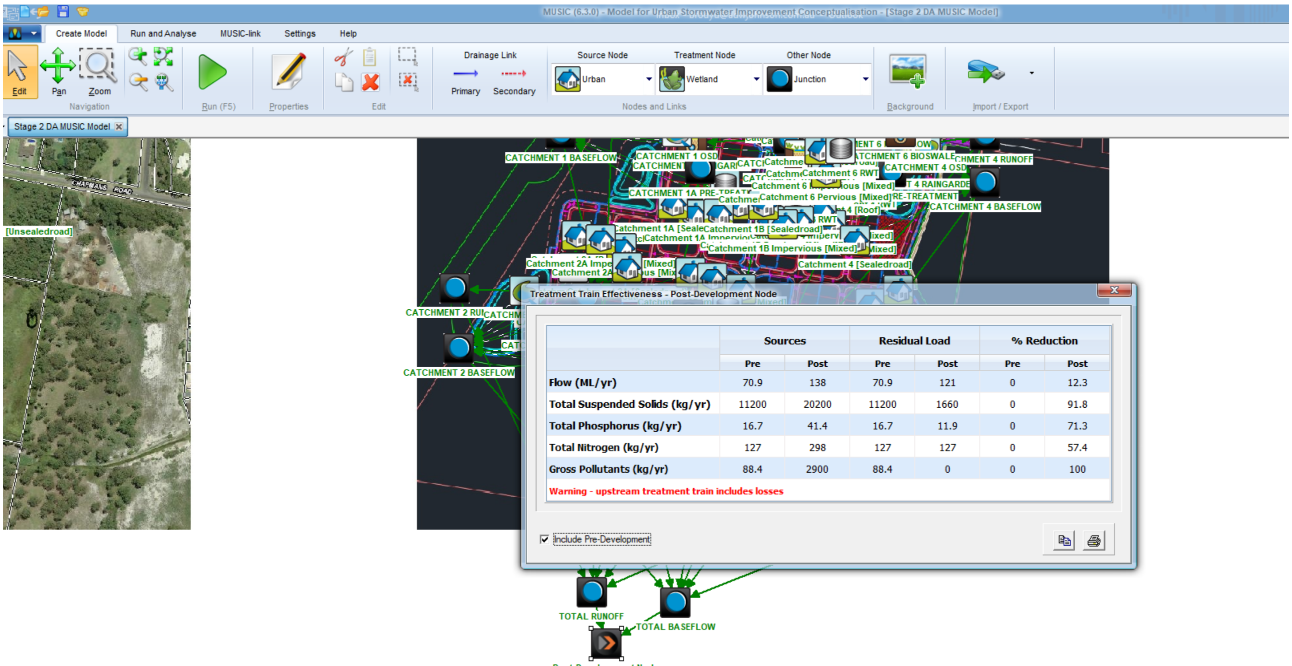


Figure B2: Post-Developed MUSIC Model



	Sources		Residual Load		% Reduction	
	Pre	Post	Pre	Post	Pre	Post
Flow (ML/yr)	70.9	138	70.9	121	0	12.3
Total Suspended Solids (kg/yr)	11200	20200	11200	1660	0	91.8
Total Phosphorus (kg/yr)	16.7	41.4	16.7	11.9	0	71.3
Total Nitrogen (kg/yr)	127	298	127	127	0	57.4
Gross Pollutants (kg/yr)	88.4	2900	88.4	0	0	100

Warning - upstream treatment train includes losses

Figure B3: MUSIC Results Screenshot

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