REPORT

Halcyon Hotels Pty. Ltd.

The Maltings, Mittagong

Stormwater & Flood Management Strategy

July 2024

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Version control

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B	Oluchi Mbachu	Sabina Lohani	Sabina Lohani 	15/07/2024

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1. EXECUTIVE SUMMARY

J. Wyndham Prince Pty. Ltd. has been engaged by Halcyon Hotels Pty. Ltd. to prepare a Stormwater and Flood Management Strategy (SWFMS) to support the amending DA as well as its Modification to the original DA consent at the Maltings site in Mittagong. This report details the procedures used and presents the results of investigations undertaken by J. Wyndham Prince to confirm the performance and feasibility of the Stormwater and Flood Management Strategy proposed for the subject site.

This SWMFS report builds upon the Stormwater and Flood Management Strategy report prepared by J. Wyndham Prince on 31 May 2021 to support the Development Application (DA) which has been approved by New South Wales Land and Environment Court with conditions on 13 May 2022.

This investigation has determined that the proposed development will maintain the existing flood behaviour that occurs across the site. This will be accomplished through the retention of the existing buildings which are proposed to be refurbished with compatible uses on the ground floors, which will be “non habitable” spaces. The uses will be such that they will not be significantly impacted when a flood occurs. This approach will ensure that the Nattai River floodplain and neighbouring properties will not be impacted by the redevelopment of the Maltings site.

Details of the flooding on the site and how the development addresses the flooding requirements of the Mittagong Township Development Control Plans (DCP) (2019) are provided in Section 5, with further details of the prescriptive controls listed in the DCP in Appendix A.

The site is located within the Sydney Drinking Water catchment. It must, therefore, demonstrate ‘neutral or beneficial effect’ (NorBE), as defined by WaterNSW in regards to water quality management. A stormwater quality treatment train consisting of a combination of grassed swales and bioretention areas is proposed to ensure that statutory pollutant loads and concentration targets are met prior to discharge to the receiving waterways. The location and final configuration of the required treatment measures will be further refined as part of the ongoing integration of the landscape vision for the development and existing ecological constraints.

Details of the water quality modelling are provided in Section 6 of this report.

The proposed stormwater and flood management strategy for the proposed works at the Maltings site provides a basis for the future detailed design and development of the site to ensure that the environmental, urban amenity, engineering, economic and heritage objectives for stormwater and flood management are achieved.

The stormwater and flood management strategy is functional; delivers the required technical performance; lessens environmental degradation and pressure on downstream ecosystems and infrastructure, and provides for a ‘soft’ sustainable solution for stormwater management that can be integrated into the landscape of the Maltings site.

2. REVIEW OF REPORT

2.1. Project Description

This stormwater and flood management strategy has been prepared to support the amending DA and a modification of the original DA consent. The original DA:

- On 13 May 2022, consent was granted by the NSW Land and Environment Court for a staged development application (DA) relating to 2 Colo Street, Mittagong, commonly known as “The Maltings” (the site).
- The approved proposal consists of a development concept for adaptive re-use of the site, in conjunction with a detailed design proposal for alterations and additions to the former malthouses (M1, M2 and M3) and redevelopment of Maltster’s Cottage to accommodate a range of uses in multi-purpose spaces for art, exhibitions, functions, recreation activities and performances, as well as construction of a hotel with ancillary uses (M4). The detailed design proposal encompasses site works, including rehabilitation of the riparian corridor along Nattai River.

The current proposal seeks to amend the existing development consent via two separate but related applications that are prepared concurrently:

- A DA to alter the design of the alterations, additions and adaptive re-use of Maltings M3, and amendment to the façade and interiors of the M4 hotel.
- A section 4.55 modification to alter the design of the alterations, additions and adaptive re-use of Maltings M1, M2, the Southern Sheds, the new Northern Shed as well as the redevelopment of Maltster’s Cottage

2.2. Objectives

The objective of this study is to prepare a stormwater and flood management strategy in order to support the ammending DA as well as a section 4.55 modification to the approved DA in Wingecarribee Shire Council.

2.3. Development Conditions Of Consent

The New South Wales Land and Environment Court approved the DA with conditions on 13 May 2022 for the proposed development. As a part of DA approval, the Stormwater & Flood Management Strategy (SFMS) Report (dated 31 May 2021) prepared by J. Wyndham Prince is referenced in the conditions from Water NSW and Natural Resources Access Regulator (NRAR). These conditions are summarised in Table 2-1 along with responses.

Table 2-1– Agency Conditions and Response

Agency	Agency Conditions	Response
Water NSW	Water NSW has approved SMFS 2021 supporting the DA, however, states that any revised site layout, staging or external works that have an impact on water quality shall require an agreement of Water NSW (Part 1 of Condition 140). The reason for this condition was because Water NSW has based its assessment on the State Environmental Planning Policy (SEPP) (Sydney Drinking Water Catchment) 2011.	J. Wyndham Prince understands that SEPP 2011 is superseded by State Environmental Planning Policy (Biodiversity and Conservation), 2021. This strategy is prepared to support the amending DA as well as section 4.56 modification of the approved development, confirms that the updated site layout (ref: SD-A003 dated 20 December 2023, prepared by Snohetta) meets all of the water quality targets outlined in State Environmental Planning Policy (Biodiversity and Conservation), 2021 and is in accordance with the ‘Using MUSIC in Sydney’s Drinking Water Catchment (Water NSW)’ 2023 and ‘Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW)’ 2022.

Agency	Agency Conditions	Response
NRAR	Furthermore, NRAR has provided 'General Terms of Approval' (GTA) for the proposed development, however, if the proposed controlled activity is amended or modified, NRAR must be notified in writing to determine if any variations to the GTA will be required.	The amending DA as well as section 4.56 modification of the approved development do not consider any amendment/ modification around the riparian corridor, as such this condition does not apply to the site at this stage.

3. THE SITE

3.1. Locality

The Maltings site is located on the NSW Southern Highlands in the suburb of Mittagong within the Wingecarribee Shire Council local government area (LGA) and has an approximate area of 6.2 ha. The site is positioned on the south-eastern fringe of the Mittagong Township approximately 600 m northeast of Mittagong Railway Station and 100 m from the Old Hume Highway. The site is bounded by Ferguson Crescent to the north, the main southern railway line to the west, Southey Street to the east and Colo Street to the south. The site is dissected diagonally by the Nattai River and has established adjoining riparian zones. The site locality plan is shown in Plate 3-1.

Plate 3-1 – Site Locality (Nearmap)

3.2. Existing Site Features

The site comprises of three (3) large buildings on the western side of the Nattai River which historically were associated with the production of malt. There are also a number of ancillary/outbuildings which include large barley stores, sheds, a service building complex (engine rooms and pumps) and a company cottage and bridges over Nattai River. The site is a locally listed heritage site in the Mittagong Local Environment Plan (LEP). The site is also being considered for a state Heritage listing.

Refer to Plate 3-2 below for an overview of the existing site features.

Plate 3-2 – Existing Site Features (Nearmap)

3.3. Proposed Development

We understand that the vision of the proposed development is to celebrate the “ruin” nature of the site and create an arts hub with an exclusive club for the younger demographic of the Mittagong population.

The objective of the project is to create a unique hotel complemented by a series of functional spaces embedded within the heritage landscape in order to ensure that the historical buildings remain dominant and retain the character and uniqueness of the Maltings site.

The proposed development application comprises of two (2) applications:

- Concept approval will be sought for the below-listed potential uses, and building envelopes for the buildings referred to in the accompanying plans as Maltings 5 and 6:
    - Tourist and visitor accommodation
    - Residential development
    - Seniors living development
- Previous Detailed Development Proposal:

- Alterations/refurbishments to Maltings 1 and 2 (including the construction of a new 'shed' to north-east of Maltings 2) to allow this space to be used as a function centre including multi-purpose spaces, exhibition and performance spaces, restaurant and bar, and a pool.
- Alterations/refurbishments to Maltings 3 and development of Maltings 4 to enable its use for the purposes of a hotel, restaurant, exhibition space and private residence.
- Demolition of the Maltster's House and redevelopment to studio/exhibition.

- Detailed development consent

On 13 May 2022, development consent (DA20/1400) was granted by the NSW Land and Environment Court for a staged development application (DA) relating to 2 Colo Street, Mittagong, commonly known as "The Maltings" (the site).

The approved proposal consists of

- a development concept for adaptive re-use of the site,
- a detailed design for alterations and additions to the former malthouses (M1, M2, Southern Sheds and M3),
- the redevelopment of Maltster's Cottage and construction of a new Northern Shed to accommodate a range of uses in multi-purpose spaces for art, exhibitions, functions, recreation activities and performances, as well as construction of a new hotel with ancillary uses (M4).
- The detailed design scheme encompasses site works, including rehabilitation of the riparian corridor along Nattai River. The approved proposal also includes a development concept for potential residential and/or visitor accommodation (M5/M6).

- Current Detailed Development Proposal

The proponent is seeking to amend the existing development consent (DA20/1400) for adaptive re-use of the site via two separate but related applications that are prepared concurrently:

- A DA to alter the design of the alterations, additions and adaptive re-use of Maltings M3, and amendment to the façades and interiors of the M4 hotel.
- A section 4.56 modification to revise the design of the alterations, additions and adaptive re-use of Maltings M1, M2 and the Southern Sheds; and the design of the new Northern Shed and the redevelopment of Maltster's Cottage.

Refer to Plate 3-3 below for an indicative layout of the proposed site. This site plan that has been used to inform this strategy and is considered to be "fit for purpose" and demonstrates that a solution exists for the Maltings site.

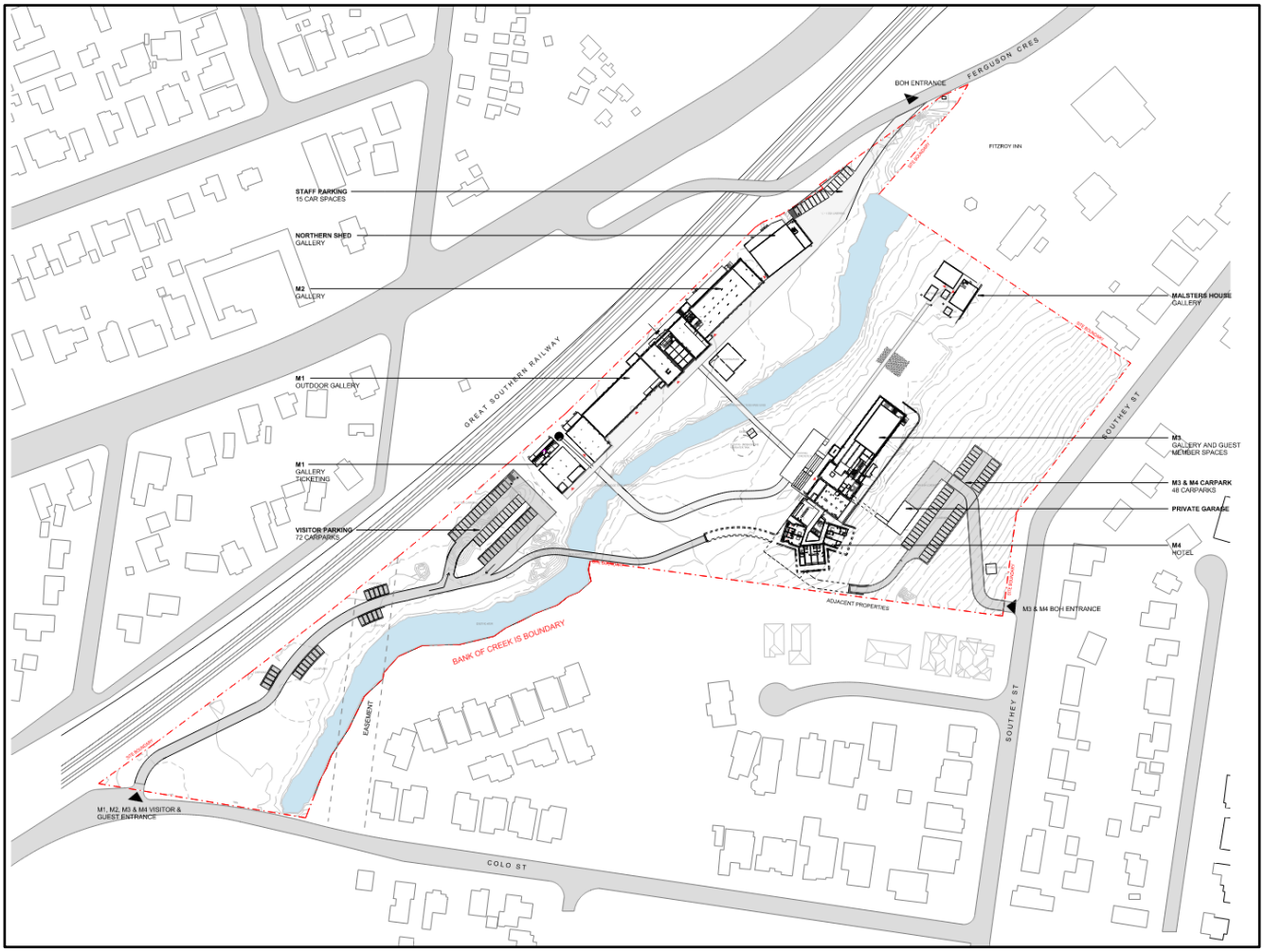

Plate 3-3 – Proposed Site Plan (Snohetta, December 2023)

4. RELEVANT CONTROL DOCUMENTS

The following control documents have been considered in the development of the Stormwater and Flood Management Strategy for the proposed development at The Maltings site in Mittagong:

- Wingecarribee Local Environmental Plan (WLEP) 2010
- State Environmental Planning Policy (Biodeversity and conservation) 2021
- Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW) 2022
- Using MUSIC in Sydney's Drinking Water Catchment (WaterNSW) 2023
- Mittagong Township Development Control Plan (DCP), 2021(Amendment 9 - adopted 9 December 2020).

Details of the relevant controls and guidelines pertaining to the subject site are provided below.

4.1. Wingecarribee Local Environmental Plan, 2010

4.1.1 Natural Resources Sensitivity – Water

The Wingecarribee Local Environmental Plan (2010) identifies the following objectives for consideration with regard to sensitive waterway management (Clause 7.5):

- To maintain the hydrological functions of riparian land waterways and aquifers, including:
  - protecting water quality and
  - protecting natural water flows and
  - protecting the stability of the bed and banks of waterways, and
  - protecting groundwater systems.

A 'Category 1 – Environmental Corridor' bisects the subject site (refer to Plate 4-1 below). This means that the proposed development must consider:

- the natural flow regime,
- the water quality of receiving waters,
- the waterway's natural flow paths,
- the stability of the waterway's bed, shore and banks,
- the flow, capacity and quality of groundwater systems

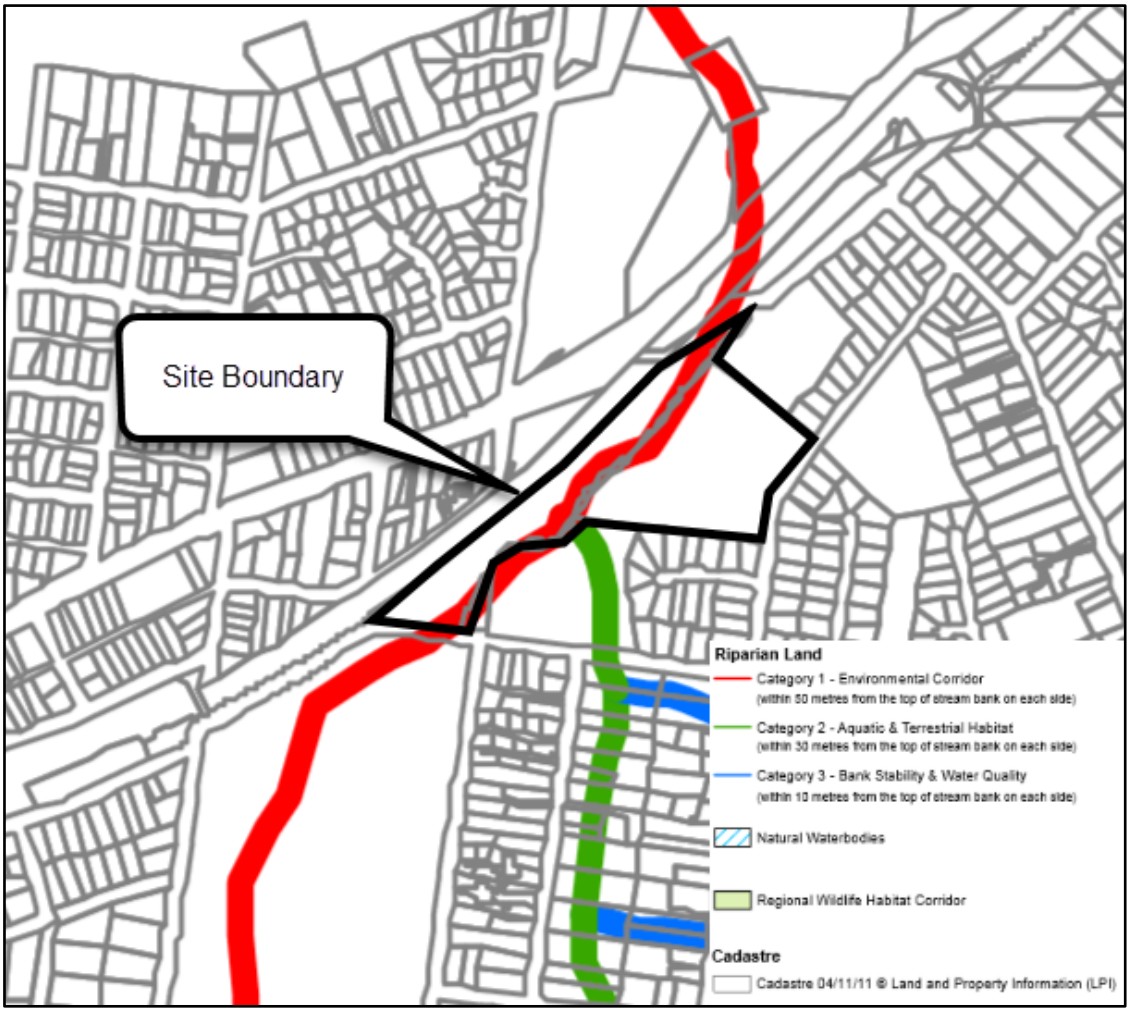

Plate 4-1 – Natural Resources Sensitivity Map (extract from WLEP, 2010, Sheet NRS_007)

4.1.2 Flood Planning

The Wingecarribee Local Environmental Plan (2010) identifies the following objectives for consideration with regard to flood planning management (Clause 7.9):

- to minimise the flood risk to life and property associated with the use of land
- to allow development on land that is compatible with the land's flood hazard, taking into account projected climate change
- to avoid significant adverse impacts on flood behaviour and the environment.

The WLEP also outlines that development consent for lands identified as "Flood Planning Area" will not be granted unless it is demonstrated that the development:

- is compatible with the flood hazard of the land, and
- will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and
- incorporates appropriate measures to manage risk to life from flood, and
- will not significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of river banks or watercourses, and
- will not be likely to result in unsustainable social and economic costs to the community as a consequence of flooding

It is noted that the Maltings development site is not categorised by the WLEP as “flood planning area”, however, it is understood that the subsequent Nattai River Flood Study (CSS, 2014) identifies flood affectation on the site. Therefore, the requirements of the WLEP relating to flooding will apply to the site. Refer to Section 5 for details of the previous studies.

4.2. State Environmental Planning Policy (Biodiversity and Conservation), 2021

A Review of the NSW Government’s, State Environmental Planning Policy (SEPP) Biodeversity and Conservation (2021) indicates that the site is located within the Sydney Drinking Water Catchment. Therefore, the site is subject to the development controls imposed by this SEPP, including conditional approval to be provided by WaterNSW.

Refer to Plate 4-2 for the site location within Sydney’s Drinking Water Catchment.

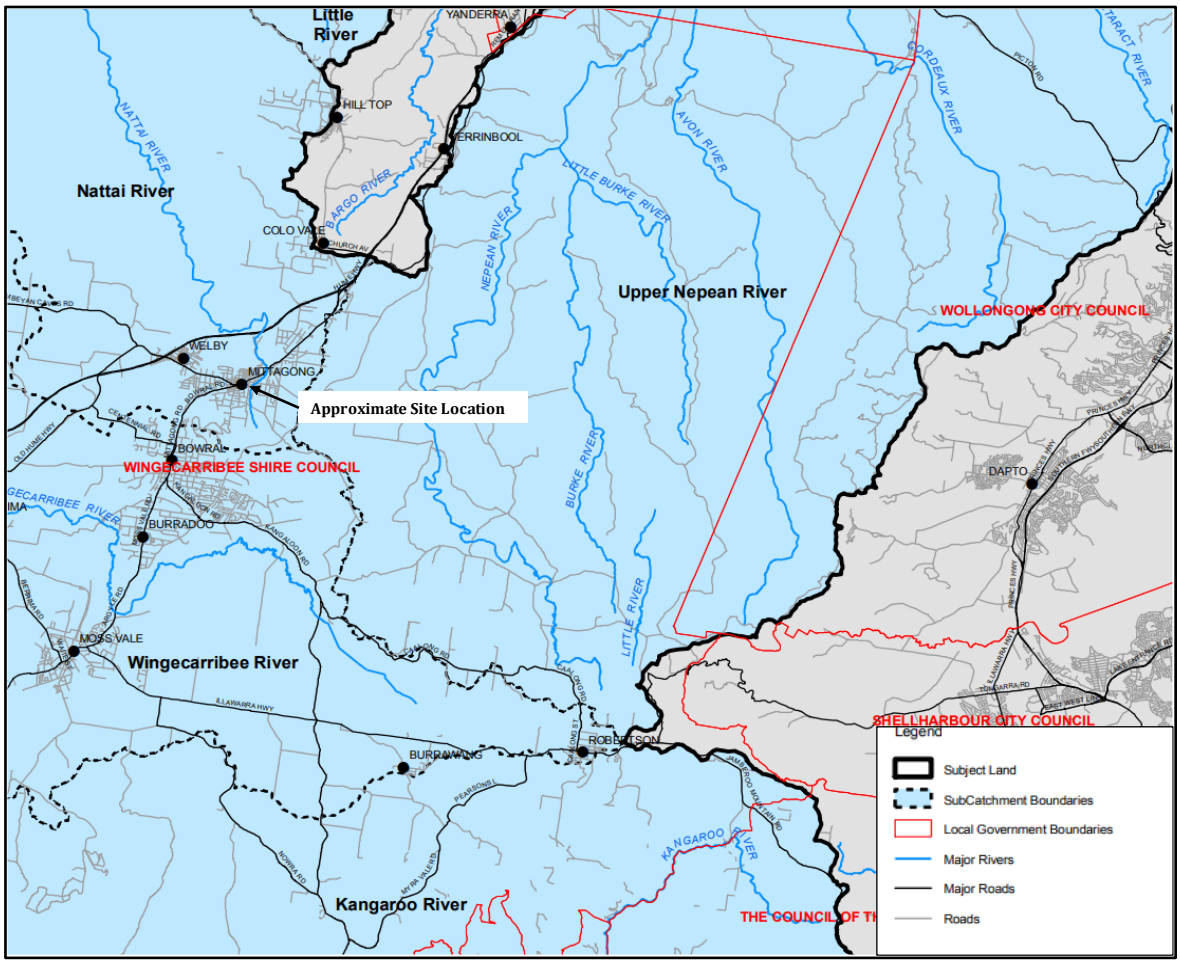

Plate 4-2 – Sydney Drinkinking Water Catchment Map 2011 (SEPP_SDWC_015_20101215)

4.2.1 Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW) 2022

The Neutral or Beneficial Effect on Water QualityAssessment Guideline 2022 supports the implementation of the Biodiversity and Conservation ((B&C) SEPP and provides guidance on the requirement under State Environmental Planning Policy B&C SEPP 2021 for all development in the Sydney drinking water catchment to have a neutral or beneficial effect on water quality

As outlined in this guideline, a “Neutral or Beneficial Effect” (NorBE) on water quality is satisfied if a proposed development:

- has no identifiable potential impact on water quality, or
- will contain any water quality impact on the development site and prevent it from reaching any watercourse, waterbody or drainage depression on the site, or
- will transfer any water quality impact outside the site where it is treated and disposed of, to standards approved by the consent authority.

Therefore, to ensure development approval is granted for the proposed development, a NorBE of water quality will be required.

4.2.2 Using MUSIC in Sydney’s Drinking Water Catchment (WaterNSW) 2023

WaterNSW has developed Using MUSIC in the Sydney Drinking Water Catchment in February 2023 to help consultants prepare MUSIC stormwater quality models to demonstrate a neutral or beneficial effect on water quality can be achieved for proposed urban and rural land use developments.This guideline has been integral in the development of this water quality strategy.

- NorBE Criteria and MUSIC Modelling

To ensure that a development and its associated treatment systems (measures) achieve NorBE, it must meet the following criteria.

  + The mean annual pollutant loads for the post-development case (including mitigation measures) should aim for 10% less than the pre-development case for total suspended solids (TSS), total phosphorus (TP) and total nitrogen (TN). For gross pollutants, the post development load only needs to be equal to or less than pre-development load.
  + Pollutant concentrations for TP and TN for the post-development case (including mitigation measures) must be equal to or better compared to the pre-development case for between the 50th and 98th percentiles over the five-year modelling period when runoff occurs.

4.3. Mittagong Township Development Control Plan, Ammendement 9, 2021

The Mittagong Town Development Control Plan (DCP)-Amendment 9 - adopted 9 December 2020 and implemented on 1 January 2021, outlines a series of objectives and controls related to ‘Water Management’ (Section A4) and ‘Flood Liable Land’ (Section A5).

4.3.1 Water Management

The ‘Water Management’ section of the DCP provides guidance on:

- The Protection of Watercourses and Riparian Lands,
- Development in the Sydney Drinking Water Catchments,
- Water Cyclemanagement
- Stormwater Management
- Water Sensitive Urban Design
- Water Treatment Train

4.3.2 Flood Liable Land

The objectives of the ‘Flood Liable Land’ section of the DCP are to:

- Increase public awareness of the hazard and extent of land affected by all potential floods, including floods greater than the 100 year average recurrence interval (ARI) flood and to ensure essential services and land uses are planned in recognition of all potential floods.
- Inform the community of Council's policy for the use and development of flood prone land.
- Manage the risk to human life and damage to property caused by flooding through controlling development on land affected by potential floods.
- Provide detailed controls for the assessment of applications lodged in accordance with the Environmental Planning and Assessment Act 1979 on land affected by potential floods.

The DCP contains a matrix of floodplain controls which varies dependant on the type of development and the flood risk precinct. The proposed Maltings development is commercial/residential and is located in the medium flood risk precinct. A copy of this matrix is provided in Table 4-1.

Table 4-1 – Prescriptive Controls Matrix (DCP, 2019)

Prescriptive Controls — Flood Risk Precincts (FRP's) — Template: V6.0

Planning Consideration	Low Flood Risk							Fringe-Low Flood Risk							Medium Flood Risk							High Flood Risk						
	Critical Uses & Facilities	Sensitive Uses & Facilities	Residential	Commercial & Industrial	Recreation & Non-Urban	Concessional Development		Critical Uses & Facilities	Sensitive Uses & Facilities	Residential	Commercial & Industrial	Recreation & Non-Urban	Concessional Development		Critical Uses & Facilities	Sensitive Uses & Facilities	Residential	Commercial & Industrial	Recreation & Non-Urban	Concessional Development		Critical Uses & Facilities	Sensitive Uses & Facilities	Residential	Commercial & Industrial	Recreation & Non-Urban	Concessional Development	
Floor Level		3							3	2,6,7	5,6,7	1,6	4,7				2,6,7	5,6,7	1	4,7				1	4,7		
Building Components		2							2	1	1	1	1				1	1	1	1				1	1		
Structural Soundness		3							3	2	2	2	2				2	2	2	2				1	1		
Flood Effects		2							2	2	2	2	2				2	2	2	2				1	1		
Car Parking & Driveway Access		1,3,5, 6,7							1,3,5, 6,7	1,3,5, 6,7	1,3,5, 6,7	2,3,4, 6,7	6,7,8				1,3,5, 6,7	1,3,5, 6,7	2,3,4, 6,7	6,7,8				2,3,4, 6,7	6,7,8		
Evacuation		2							2	2	1 or 2	3	2				2	1 or 2	3	2				3	2		
Management & Design		1,4,5							1,4,5	1	1,2,3,5	1,2,3,5	1,2,3,5				1	1,2,3,5	1,2,3,5	1,2,3,5				1,2,3,5	1,2,3,5		

5. PREVIOUS STUDIES

The following previous studies have been considered in the development of the Stormwater and Flood Management Strategy for the proposed development at The Maltings, Mittagong:

- Nattai River Flood Study – Final Report (Catchment Simulation Solutions, 2014)
- Nattai River Floodplain Risk Management Study and Plan – Final Report (WMA Water, 2016)

5.1. Nattai River Flood Study – Final Report (Catchment Simulation Solutions, 2014)

In 2014, Catchment Simulations Solutions (CSS) was commissioned by Wingecarribee Shire Council to prepare a flood study for the Nattai River catchment in the Southern Highlands of NSW. The study was aimed at defining the flood behaviour within the catchment across a range of flood events. This included the development of a hydraulic flood model using TUFLOW software to define the existing flood extents, levels, depths, velocities and hazards throughout the catchment. The study forms the first and second steps (data collection and flood study) in the development of a Flood Risk Management Plan for the area.

Importantly, the Nattai River Flood Study assessed the flood behaviour on the existing Maltings site. This includes flood extents/depths, flood hazards and hydraulic categories. The 1% AEP flood maps in the vicinity of the Maltings site have been extracted from the flood study and are illustrated in Plates 5-1, 5-2 and 5-3 below.

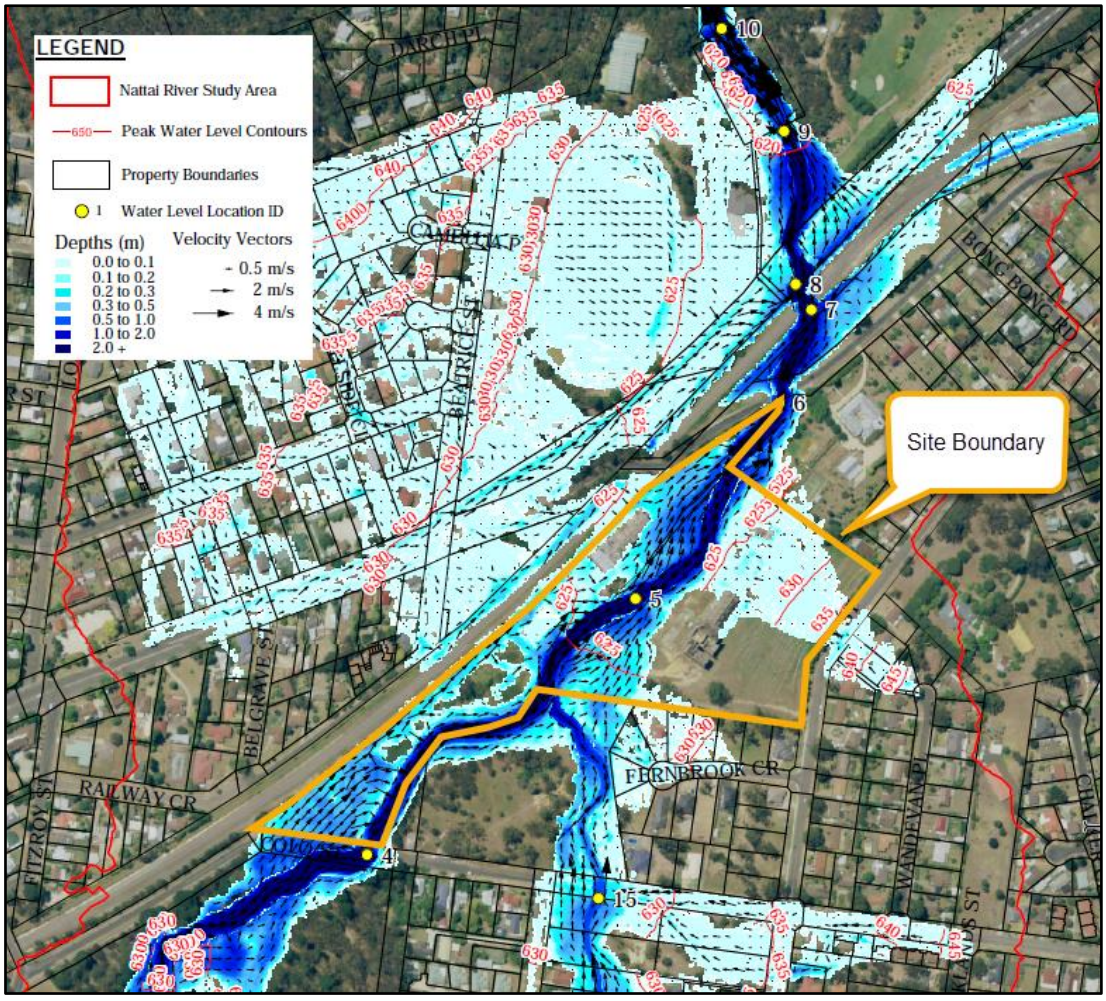

Plate 5-1 – 1% AEP Flood Depth and Velocity Map (CSS, 2014)

The flood results indicate that the existing Maltings site is inundated in the 1% AEP event with a flood level of 624.42 mAHD measured centrally within the site. Notably, the flood extent mapping shows that the existing buildings on the site are inundated by flood waters, however to a depth of only 0.1-0.3 m. This includes both “mainstream” flood waters generated in Nattai River, which affects the existing buildings on the western side of the river, and overland flooding emanating from Southey street which affects the existing (and proposed future buildings) on the eastern side of the river.

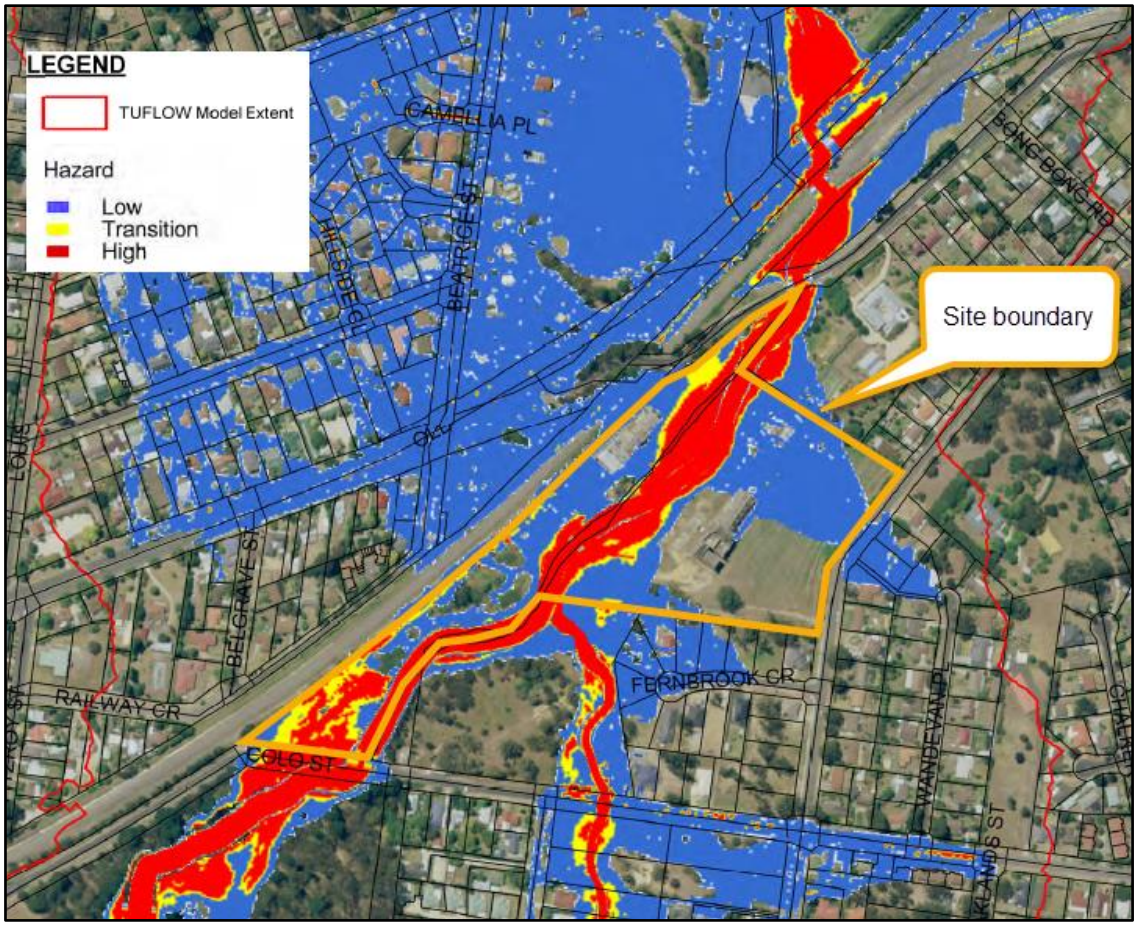

Plate 5-2 – 1% AEP Provisional Flood Hazard (CSS, 2014)

The provisional flood hazard mapping shows that, in the 1% AEP flood event, the existing buildings and the works proposed in this DA are generally located within the low hazard area. Importantly, the proposed future buildings on the eastern side of Nattai River (M5 and M6) are located in the low hazard category, and any changes in the flood behaviour will be manageable.

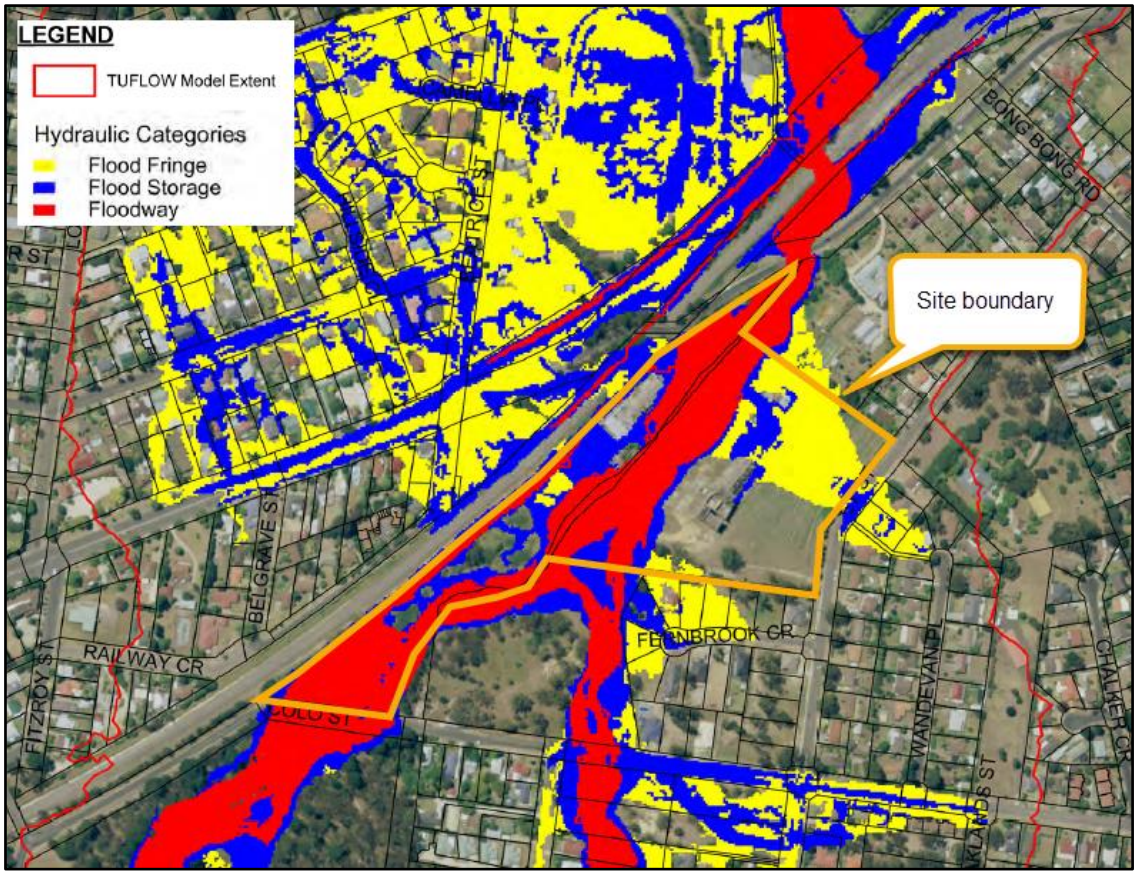

Plate 5-3 – 1% AEP Hydraulic Categories Map (CSS, 2014)

The hydraulic category mapping shows that, in the 1% AEP flood event, the western half of the site is generally situated in flood storage areas while the eastern half of the site is generally situated in flood fringe areas. It is noted that the proposed buildings under this DA are located in the eastern half of the site within the flood fringe area. According to the NSW Floodplain Development Manual (2005), filling within flood fringe areas are typically acceptable and result in minimal flood impacts downstream. Furthermore, given the proposed use of the western side of the site (Malting 1 and 2), the flood storage that exists in the area will be unchanged.

5.2. Nattai River Floodplain Risk Management Study and Plan – Final Report (WMA Water, 2016)

In 2016, WMA Water was commissioned by Wingecarribee Shire Council to prepare the Nattai River Floodplain Risk Management Study and Plan (FRMS&P), which forms the third and fourth steps in the floodplain risk management process. This study aims to identify potential flood mitigation options to alleviate the impacts of flooding within Nattai River and on surrounding properties and infrastructure. A number of flood mitigation strategies were investigated in this process, including property modification, flood modification and response modification measures.

The FRMS&P identifies the removal of the existing weir in Nattai River within the Maltings site as a potential flood mitigation measure for the catchment. Flood modelling of this option shows that improvements of up to 1m in the 1% AEP would be experienced in the vicinity of the existing weir with reductions becoming lesser further upstream. It was ultimately determined that no significant benefit would be experienced by any surrounding properties from the removal of the weir, and that the environmental and heritage implications of the option would likely outweigh the benefits.

6. FLOOD MANAGEMENT

6.1. Existing Flood Behaviour

The Maltings site at Mittagong is traversed by the Nattai River which conveys flows from a contributing catchment of 675 ha through the Mittagong township to the downstream forestland and gorges. The site experiences significant flooding under existing conditions with mainstream flooding breaching the river banks in the 10% AEP event.

According to the Nattai River Flood Study, the Maltings site receives approximately 116 m³/s of flow during a 1% AEP storm event which results in a peak flood level of 624.42 mAHD. This inundates a large portion of the site, including the existing buildings to the west of the river, i.e. Maltings M1 and M2. Much of the sites flood affectation is due to “mainstream” flooding generated by flows within Nattai River. However, some overland flow enters the site from Southey Street to the east, which creates visible flooding in the area of the existing building M3 and proposed future buildings M5 and M6. It is noted that this is sheet flow in the order of 0.0-0.2 m in depth and 0.5 m/s in velocity.

Refer to Figures 6.1 and 6.2 in Appendix B for an illustration of the existing flood conditions in the 20% AEP and the 1% AEP flood events. Figure 6.3 depicts the hazard mapping in the 1% AEP flood event. All maps have been generated based on the flood modelling undertaken in the Nattai River Flood Study (CSS, 2014).

6.1.1 Existing Roughness Assumptions

The roughness assumptions that have been assumed in the Nattai River Flood Study are important to consider in the development of The Maltings site. An important component of the development is the vegetation planting and landscaping designs, particularly in the vicinity of the riparian corridor.

Table 6-1 lists the various values that were used in the Nattai River TUFLOW model. Key values that apply to the Maltings site are highlighted in red. Not listed in the table is the assumption for the creek itself, which is defined separately within the body of the report as having a manning’s of 0.05.

Table 6-1 – TUFLOW Manning’s ‘n’ Roughness Values

Material Description	Manning's 'n'
Open space (i.e., grass)	0.035
Rural grasslands / light brush	0.045
Grass with sparse trees	0.050
Grass with medium density trees	0.075
Dense tree coverage	0.100
Rock outcrops	0.040
Roadway pavement	0.016
Concrete surfaces	0.015
Water bodies	0.030
Railway corridor	0.06
Buildings	10.00

Plate 6-1 below is also from the Nattai River Flood Study and illustrates which areas of the Maltings site are defined as which materials.

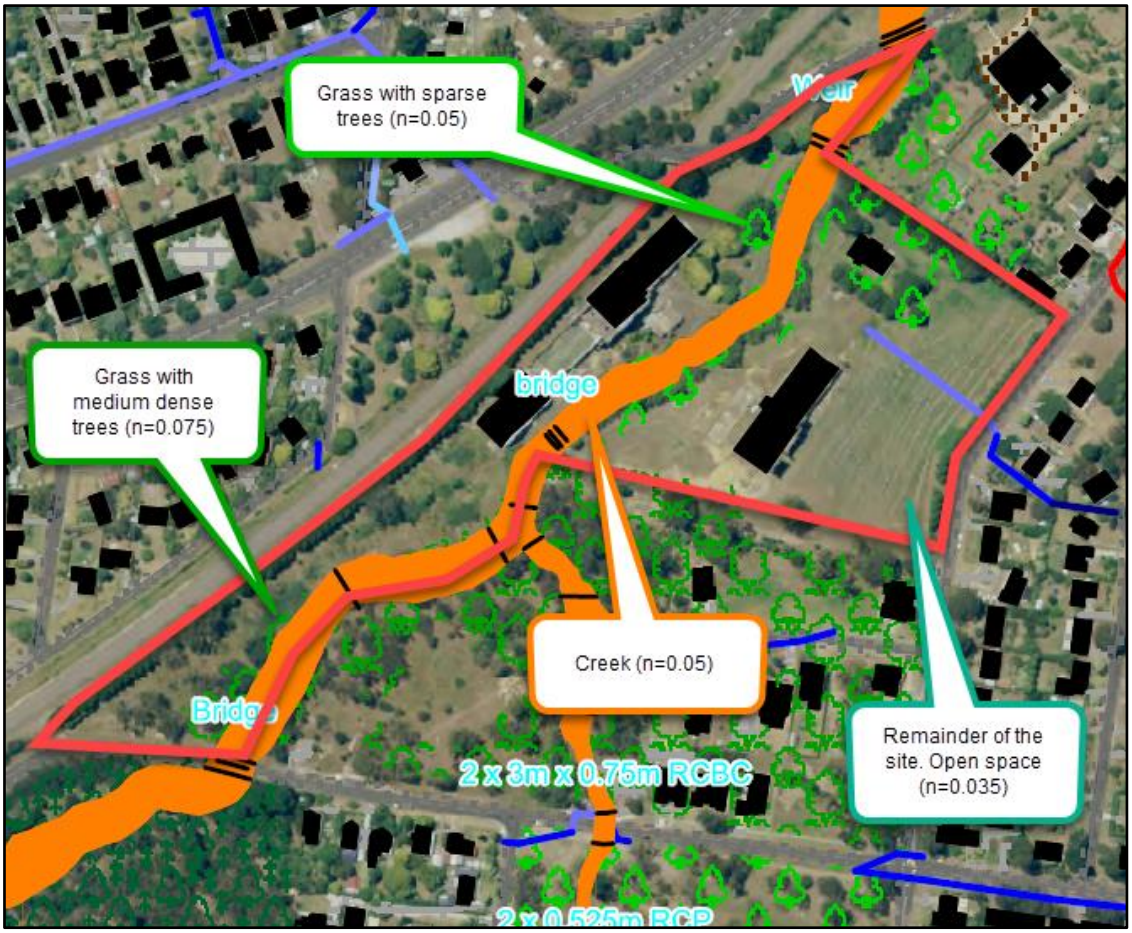

Plate 6-1 – Manning's Assumptions Mapping

An extract from the "Natural Channel Design Guidelines" (Brisbane City Council, 2003) has been included in Appendix C which contains illustrations of varying natural landscapes in floodplains. These illustrations correspond with the existing conditions roughness assumptions of the Nattai River Flood Study and provide a context for the vegetation in different channel profiles.

6.2. Proposed Conditions

The proposed development involves the

- retention of five (5) existing buildings within the site, M1, M2, M3, Southern Shed 1 and Southern Shed 2
- redevelopment of Maltster's Cottage
- construction of four (4) new buildings, M4, M5, M6 and Northern Shed.

All five (5) existing buildings are affected by flooding in the 1% AEP event. Building M4 is proposed to be located clear of flooding, while buildings M5 and M6 are proposed within the minor overland flow path from Southey Street flooding in the east.

No external works are proposed for the existing buildings. Rather, it is proposed that internal reinforcement and refurbishment works would be undertaken to ensure that the existing nature of the site is maintained while ensuring no significant adverse flood impacts occur on the surrounding flood sensitive environment. Majority of the existing finished floor levels (FFL) in the buildings will be maintained meaning that no changes to the surrounding flood levels.

However, there are minor levelling of the floor levels within M1 and M2 and M3 to ensure Work Health and Safety requirements for the use of these spaces can be achieved. In addition to this, the internal refurbishments of the existing buildings in the mainstream floodplain will ensure that the proposed uses are compatible with the expected 1% AEP flood inundation over the FFL (i.e. non-habitable uses at the ground floor level).

The floor levels for M1, M2 and M3 are summarized in Table 6-2 below with their location presented in Plate 6-2. The floor levels of the buildings are below 1% AEP flood level except for M1 Hanging Gardens and M3 Northern Gallery.

Table 6-2 – Building Flood Levels

Site	Proposed Finished Floor Level (m AHD)	1% AEP Flood Level (m AHD)	Floor Level compared to 1% AEP Flood Level (m)
Southern Shed 1	625.5	625.8	-0.30
Southern Shed 2	625.36	625.5	-0.14
M1 Outdoor Gallery	624.80	625.1	-0.30
M1 Gallery	624.57	624.6	-0.03
M1 Hanging Gardens	624.55	624.2	0.35
M2 Gallery	624.01	624.1	-0.09
Northern Shed	623.51	623.8	-0.29
Malsters House	625.01	625.1	-0.09
M3 Gallery	625.53	625.6	-0.07
M3 Northern Gallery	626.37	625.6	0.77

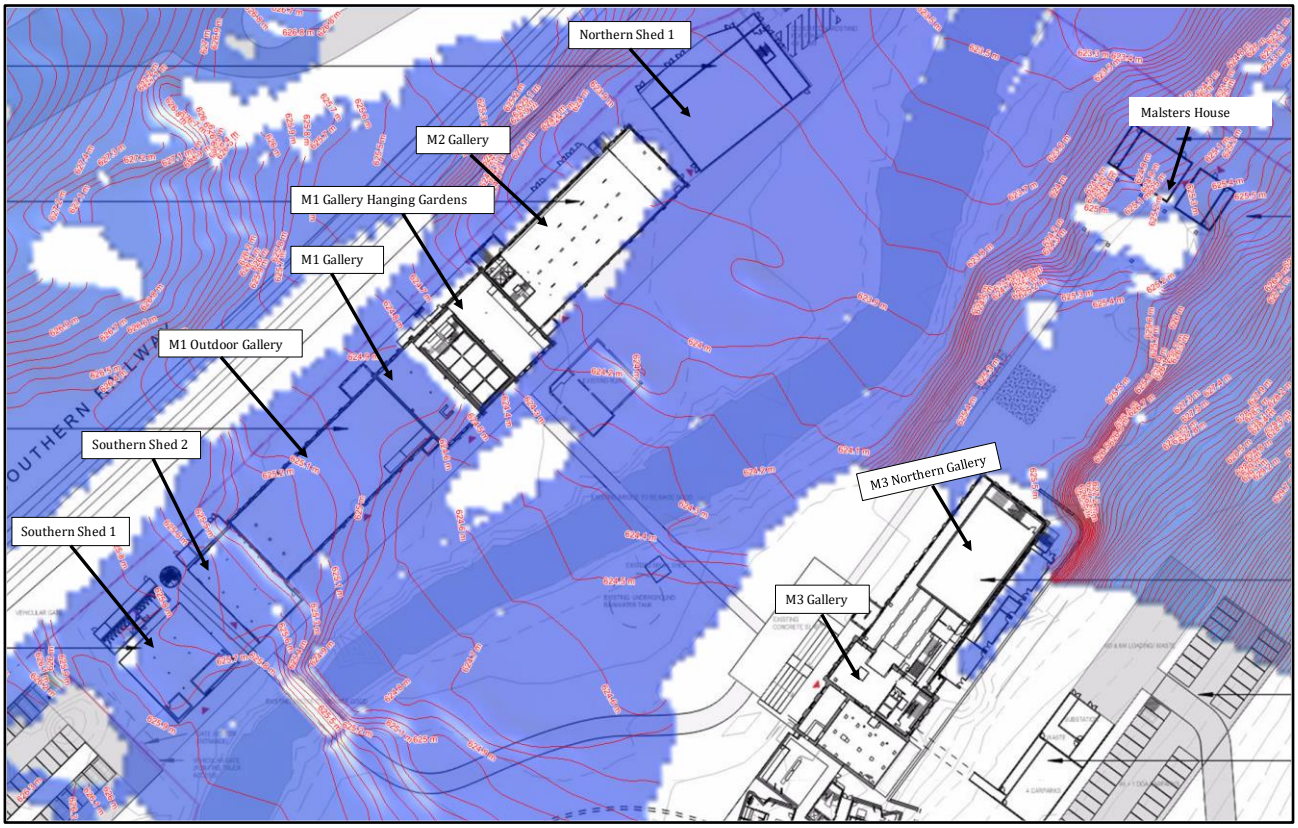

Plate 6-2 – 1% AEP Flood Level(Source:Nattai River Flood Study 2014)

The finished floor level of the proposed development summarised in Table 6-2 suggests that most of the floor levels are lower than 1% AEP flood level from the Nattai River Flood Study 2014. Raising the floor level of M1 would have no impact in the flood plain given that the Nattai River Flood Study 2014 has modelled building polygons to define the impediment to flow by buildings across the catchment, as seen in Plate 6-2. Hence, there would be insignificant flood impact within the Nattai River floodplain as a result of this development

The proposed buildings (M4, M5 and M6) will be situated above the standard flood planning level in the "mainstream" floodplain. The shallow overland flows (0.0-0.2 m in depth) will be managed by strategically designed drainage solutions to divert flows around the proposed buildings M5 and M6 without resulting in any significant adverse flood impacts external to the Maltings site. We have estimated that based on the size of the Southey Street catchment in the east (2.95 ha), overland flows in the order of 1 m³/s in the 1% AEP event will need to be managed. This can be achieved in a 900 mm pipe or an equivalently sized catch drain. This will be confirmed at the detailed design stages. A conceptual location for the drainage network is shown in Figure 6.4.

It is noted that overland flooding in the east is mainly within the "flood fringe" hydraulic category, meaning filling is generally acceptable in these areas (according to the NSW Floodplain Development Manual, 2005).

With regard to flood evacuation, we believe that this should not be necessary given that there is no regional evacuation strategy for the Nattai River floodplain. The relatively small nature and size of the broader Nattai River catchment (compared to other riverine catchments with evacuation strategies) indicates that flood affectation will be of short duration and not require evacuation.

Further information on the flooding at the Maltings site and how the development addresses the 'Flood Liable Land' requirements of the Mittagong Township DCP are provided in Appendix A.

6.2.1 Proposed Vegetation and Landscape

The vegetation management plan (VMP) prepared by Eco Logical Australia considers the existing conditions of the Nattai River riparian corridor. The planting proposed in the VMP considers the Manning's roughness assumptions of the Nattai River Flood Study (CSS, 2014) and will ensure similar roughness outcomes are achieved as part of the design outcomes.

The proposed VMP is described in Tables 6-3 and 6-4, which have been provided by ELA. The wider riparian zone will not alter the density of plantings but will affect the area, i.e. in Table 6-3 MZ3 Riparian corridor will be a larger area and MZ4 Great Meadow will be a smaller area.

As can be seen in Table 6-4, planting densities will have a different total number of plants. Currently, the riparian zone has one tree per 100 m² and one shrub per 20 m² and the Great Meadow has no trees or shrubs. The density will not be altered, however, when the areas are recalculated, the total number of trees and shrubs will increase i.e. if there is 1,000 m² additional riparian corridor the number of trees will increase by 10 to give a total number of 110, and shrubs will increase by 20 to a total of 220 along the total length of the riparian corridor. This will mean less grasses at the density of one per 1 m² in the riparian corridor, and less plants overall. ELA considers the riparian zone will equate to grasses with sparse trees, i.e. Manning 0.05.

Table 6-3 – Planting Assumptions and Mulch Requirements

Zone	Description	Total area (m²)	Revegetation Area (%)	Revegetation. area (m²)	Jute Matting (%)	Mulch (%)	Jute matting (m²)	Mulch area (m²)
MZ1	Revegetation of Southern Highlands Shale Woodlands (Outer Protection Area)	6,600	80	5,280	-	100-	-	5,280
MZ2	Assisted Regeneration - Southern Highlands Shale Woodlands	2,000	-	-	-	-	-	-
MZ3	Revegetation of riparian corridor	10,000	100	10,000	100	-	10,000	-
MZ4	Great meadow	19,300	100	19,300	-	100	-	19,300
MZ5	Landscaping	11,700	100	11,700	-	100	-	11,700
Total		**49,600**	**93**	**46,280**	**13**	**38**	**10,000**	**36,280**

Table 6-4 – Revegetation Densities and Plant Number Requirements

Zone	Description	Revegetation Area (m²)	Total plant number requirements				
			Trees	Shrubs	Herbs / scramblers	Sedges / Grasses	Total
MZ1	Revegetation of Southern Highlands Shale Woodlands (Outer Protection Area)	5,280	1/50	1/20	1.00	3.00	**21,490**
MZ2	Assisted Regeneration - Southern Highlands Shale Woodlands	-	-	-	-	-	-
MZ3	Revegetation of riparian corridor	10,000	1/100	1/50	1.00	3.00	**10,300**
MZ4	Great meadow	19,300	-	-	1.00	3.00	**77,200**
MZ5	Landscaping	11,700	1/100	1/50	1.00	3.00	**47,151**
Total		**46,280**					**186,141**

7. STORMWATER QUALITY MODELLING

The stormwater quality analysis for the development was undertaken using the modelling software MUSIC (Model for Urban Stormwater Improvement Conceptualisation) version 6.3. MUSIC modelling provides several features relevant to this development. It can model the potential nutrient reduction benefits of treatment devices, and it incorporates mechanisms to model stormwater re-use as a treatment technique. It also provides mechanisms to evaluate the effectiveness of treatment devices in attaining water quality objectives.

Stormwater has the potential to be laden with several pollutants such as Suspended Solids, Phosphorous, Nitrogen and Gross Pollutants. Development works generally include proposed changes to the surface's types on the site (such as concrete and gravel areas), which impacts on the quantity of pollutants generated when compared to existing conditions. To preserve the environment, Wingecarribee Shire Council and WaterNSW requires these pollutants to be reduced when delivering new developments in the Sydney Drinking Water Catchment.

7.1. Model Setup

A MUSIC model of SWFMS 2021 has been used as a base for this assessment and has been updated to include the development for the Maltings, Mittagong project which reflects both the existing and developed conditions on the site. The catchment area was broken into the different "source nodes" to reflect the various land uses (i.e. roof, road, urban pervious, urban impervious areas, revegetated land and unsealed road). The MUSIC model setup has been undertaken to be consistent with the NSW MUSIC Modelling Guidelines (BMT WBM, 2015) and MUSIC in the Sydney Drinking Water Catchment (WaterNSW, 2023).

7.1.1 Existing Conditions Model

The existing conditions MUSIC model for the Maltings site builds upon the SWFMS 2021 and has been updated considering the stormwater pollutant parameters for the existing land use in accordance with the MUSIC in the Sydney Drinking Water Catchment (WaterNSW, 2023).

Consistent with SWFMS 2021, the existing site consists of five (5) buildings (M1, M2, M3, Southern Sheds and Maltster's House) which have been modelled as roofed areas, impervious areas (adjacent to M2 and M3), exposed gravel/bare earth which has been modelled as unsealed road. The remaining pervious areas have been assumed to consist of 5% impervious to reflect the exposed/bare earth across the existing site.

The land use breakup for the existing conditions model included the following assumptions:

- Roofed areas = 100% impervious
- Impervious / hardstand areas = 100% impervious
- Unsealed road = 100% impervious
- Remaining pervious areas = 5% impervious

Refer to Plate 7-1 below for an illustration of the existing conditions MUSIC model breakup. For further detail, refer to Figure 7.2.

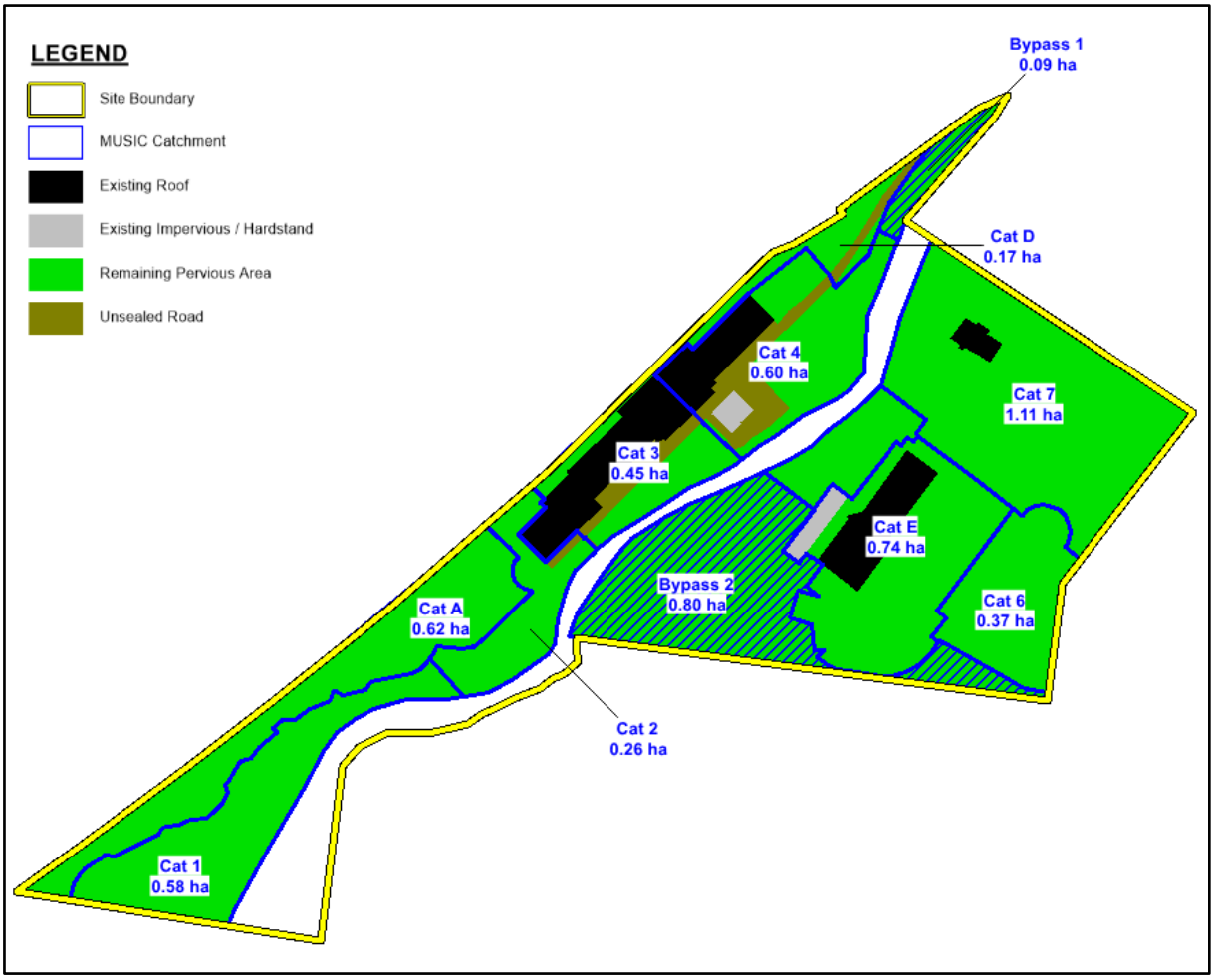

Plate 7-1 – MUSIC Breakup – Existing Conditions

Model ref: MU02_The Maltings.sqz

7.1.2 Developed Conditions Model

The developed conditions model builds upon the existing model, adding builings proposed in the post-development catchment plan. This includes introducing the newly proposed buildings (Northern Shed, M4, M5 and M6) which have been modelled as roofed areas, revegetated land, driveway/carpark areas which have been modelled as sealed roads together with the compacted granite sand and other impervious areas throughout the site.

The land use breakup for the developed conditions model included the following assumptions:

- Roofed areas = 100% impervious
- Revegetated land = 0% impervious
- Impervious / hardstand areas = 100% impervious
- Sealed roads / driveways / carparks = 100% impervious
- Remaining pervious areas = varying levels of impervious based on proposed footpaths and other hardstand areas within the relevant catchment.

The developed MUSIC model which is based on the architectural site plan (ref: SD-A003 dated 20 December 2023) prepared by Snohetta, has been divided into a series of sub-catchments to allow for the implementation of catchment level water quality controls at specific locations adjacent to the Nattai River. See an overview of the developed conditions catchment breakup in Plate 7-2 below. For further detail, refer to Figure 7.3.

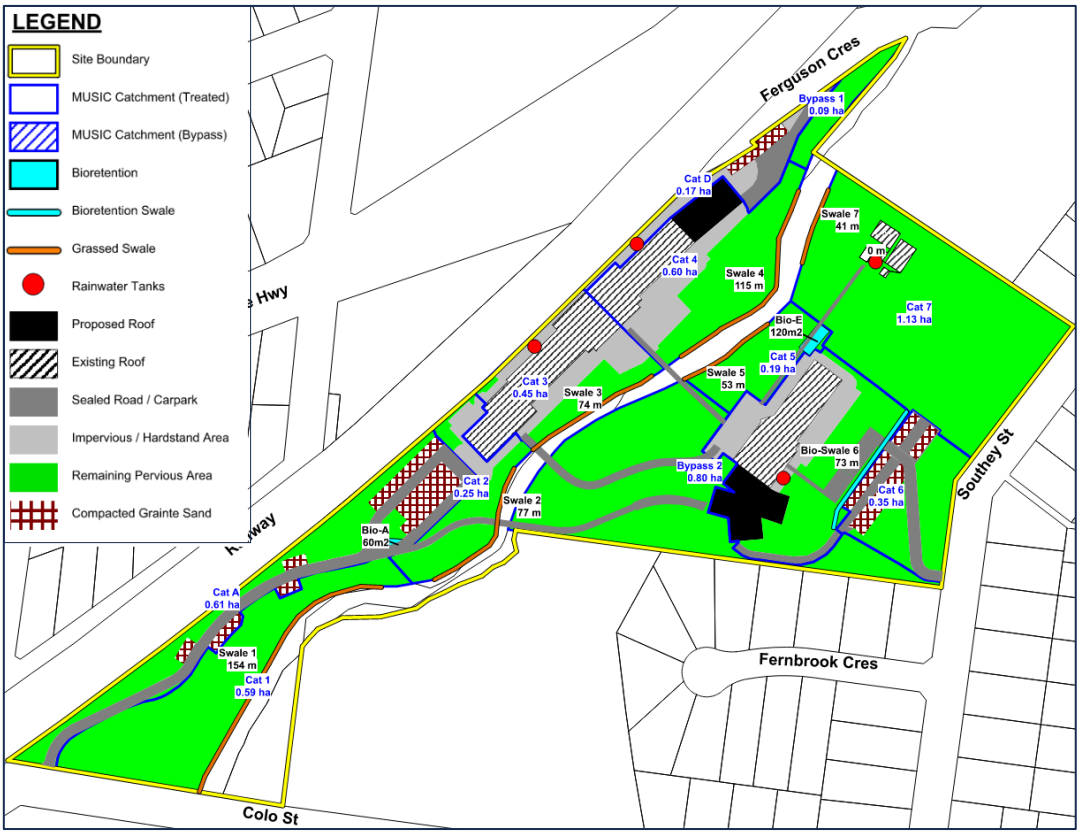

Plate 7-2 – MUSIC Breakup – Developed Conditions

Model ref: MU03_The Maltings without infiltration media.sqz

7.1.3 Rainfall- Runoff parameters

The stormwater pollutant parameters for the adopted landuse and the soil surface parameter were adopted Using MUSIC in Sydney's Drinking Water Catchment (WaterNSW) 2023. The parameters used within the MUSIC model are presented in Tables C-1 and Table C-2 of Appendix D.

Additionally, the default MUSIC parameter values for initial storage (percentage of capacity) and initial depth (mm) for all soil types have been used as recommended by Using MUSIC in Sydney's Drinking Water Catchment (WaterNSW) 2023

7.1.4 Water Quality Measures

The water quality treatment train proposed for the development consists of the following:

- Grassed swales located adjacent to the Nattai River to capture, direct and provide primary treatment of runoff from the developed site;
- Bioretention areas to provide treatment of the runoff from the newly proposed areas of the site.
- Rainwater tanks to capture roof water run-off and allow internal and external re-use.

Refer to Figure 7.1 in Appendix B for an illustration of the proposed water quality strategy.

Further details of the proposed water quality measures are provided in Appendix D. It should be noted that the modelled swale lengths differ from the actual swale length shown indicatively on Figure 7.1. The swale location and lengths on Figure 7.1 are to ensure runoff from the development is captured and drained to the secondary treatment devices. This means that the full length of the swales is required as a drainage element, however, only a portion of the swales has been used to deliver the required water quality objectives.

It is also important to note that the location of these swales are indicative only and will need to be adjusted to consider the landscape vision for the development and the existing ecological constraints on the site. Further refinement design for the drainage elements will be undertaken at the Construction Certificate phase.

7.2. Water Quality Results

As described in Section 4.2.1, the Maltings development site is required to achieve a Neutral or Beneficial Effect (NorBE) on water quality, consisting of both pollutant load and pollutant concentration reductions.

7.2.1 Pollutant Loads

A comparison of the pollutant loads being generated on the site has been made between existing and developed conditions. A summary of the mean annual pollutant load for existing and developed conditions (including treatment devices) is shown in Table 7-1.

Table 7-1 – Summary of Pollutant Load Reductions

Pollutant	Mean Existing Source Loads	Mean Developed Source Loads	Target Reduction Required	Total Reduction Achieved
	(kg/yr)	(kg/yr)	(%)	(%)
TSS	1920	565	10.0	70.5
TP	3.86	1.98	10.0	48.6
TN	30.0	20.3	10.0	32.3
Gross Pollutants	330	56.0	0.0	83.0

The result shown in Table 7-1, suggests that the treatment train (combination of grassed swales, bioretention areas, and RWTs) successfully achieved the target pollutant load reduction required from the development in accordance with Using MUSIC in Sydney's Drinking Water Catchment requirements (WaterNSW) 2023.

7.2.2 Pollutant Concentrations

A NorBE assessment is also required to achieve pollutant concentrations for TP and TN in the post-development case that are equal to or less than the pollutant concentrations for the pre-development case within the 50th to 98th percentile range.

The cumulative frequency graphs provided in Plate 7-3 and Plate 7-4, indicate that the post-developed pollutant concentrations for TP and TN are less than the pollutant concentrations in the pre-development scenario. Note blue, represents "pre-developed"case and red represents "post-developed" case.

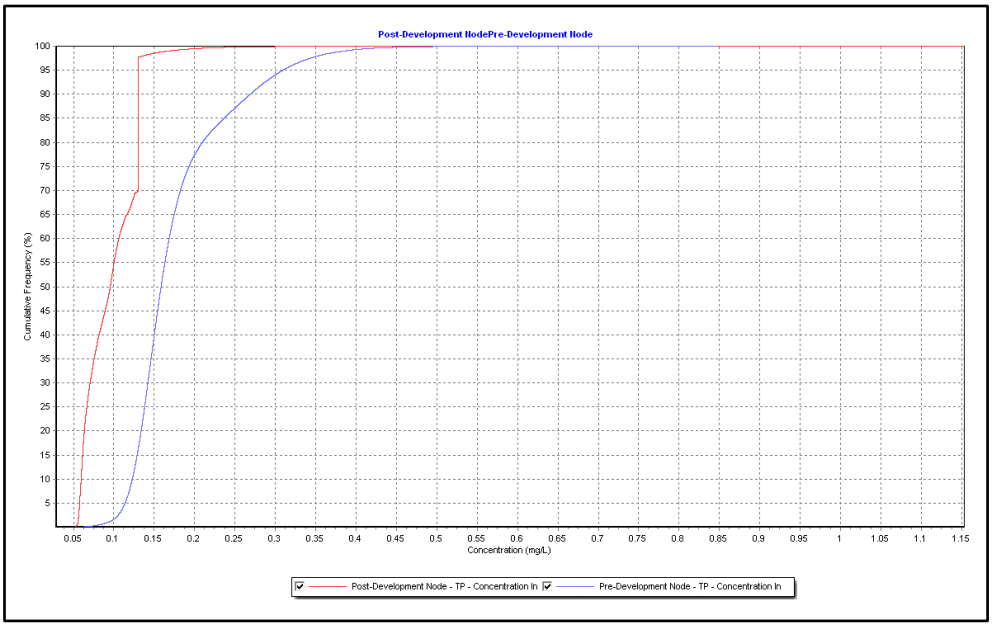

Plate 7-3 – Pollutant Concentrations – Total Phosphorus

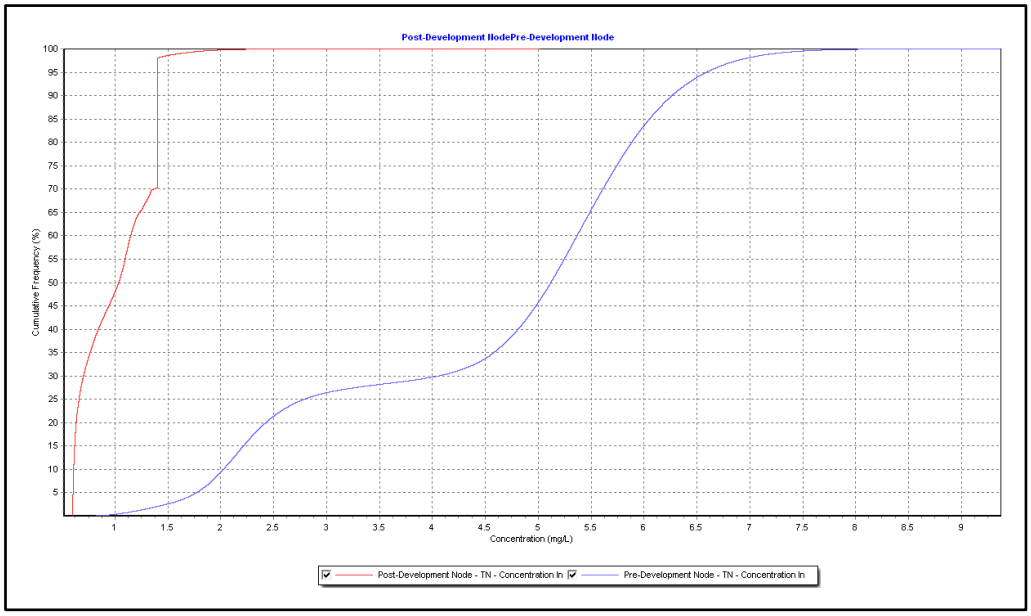

Plate 7-4 – Pollutant Concentrations – Total Nitrogen

7.3. Conclusion

This report outlined a stormwater and flood management strategy for the proposed commercial development located at 2 Colo Street, Mittagong, commonly known as “The Maltings”. From a water quality and flood management preceptive for the proposed redevelopment, the Malting site complies with the statutory requirements, ensuring compatible uses will occur for the flood-impacted locations and deliver a new destination for the resident of the Mittagong area.

The strategy for the management of stormwater on the subject site shows compliance with:

- Using MUSIC in Sydney’s Drinking Water Catchment requirements (WaterNSW) 2023,
- Neutral or Beneficial Effect on Water Quality Assessment Guideline (WaterNSW) 2022,

Therefore the above strategy can be implemented, and all Mittagong Town Development requirements can be achieved, with no net negative effect on the downstream waterways.

8. REFERENCES

BMT WBM (2015), *NSW MUSIC Modelling Guidelines*

Brisbane City Council (2010), *Natural Channel Design Guidelines*

Catchment Simulation Solutions (2014), *Nattai River Flood Study – Final Report*

NSW Government (2021), *State Environmental Planning Policy (Biodiversity and Conservation)*

J. Wyndham Prince (2021), *Stormwater and Flood Management Strategy – Issue D Report*

Water NSW (2023), *"Using MUSIC in Sydney's Drinking Water Catchment – A Sydney Catchment Authority Standard", prepared for the NSW Government*

Water NSW (2022), *"Neutral or Beneficial Effect on Water Quality Assessment Guideline"*

WMA Water (2016), *Nattai River Floodplain Risk Management Study and Plan – Final Report*

Wingecarribee Shire Council (2010), *Wingecarribee Local Environmental Plan*

Wingecarribee Shire Council (2021), *Mittagong Township - Development Control Plan (DCP), adopted 9 December 2020, effective 1 January 2021*

APPENDIX A

PRESCRIPTIVE CONTROLS AND RESPONSES

Prescriptive Controls		Responses
FLOOR LEVEL		
5	The level of habitable floor areas to be equal to or greater than the 100 year flood level plus freeboard. If this level is not practical for a development in a Business zone, the floor level should be as high as possible.	All newly proposed, habitable buildings will be located clear of the 1% AEP (100 year ARI) flood extent. Existing buildings located in the flood plain are non-habitable and will consist of compatible uses for the extent flooding that the buildings are subject to.
6	Non-habitable floor levels to be equal to or greater than the 100 year flood level plus freeboard where possible, or otherwise no lower than the 5 year flood level plus freeboard unless justified by site specific assessment.	As mentioned above, all newly proposed buildings will be located clear of the 1% AEP flood extent, as well as the 20% AEP (5 year ARI) flood extent. Existing buildings within these flood extents will consist of compatible uses for the levels of inundation experienced.
7	A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated above finished ground level, confirming that the undercroft area is not to be enclosed, where Council considers this may potentially occur	No undercrofts are proposed as part of this development.
BUILDING COMPONENTS		
1	All structures to have flood compatible building components below the 100 year flood level plus freeboard	All structures, existing and proposed, will consist of flood compatible building components below the 1% AEP plus freeboard.
STRUCTURAL SOUNDNESS		
2	Applicant lo demonstrate that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year flood plus freeboard, or a PMF if required to satisfy evacuation criteria (see below). An engineer's report may be required	The proposed and existing buildings will be adequately designed, reinforced and constructed to reduce the risks associated with flood damage. Given there age, they have already stood the test of time and demonstrated structural soundness.
FLOOD EFFECTS		
2	The flood impact of the development to be considered to ensure that the development will not increase flood effects elsewhere, having regard to (i) loss of flood storage; (ii) changes in flood levels and velocities caused by alterations to the flood conveyance; and (iii) the cumulative impact of multiple potential developments in the floodplain. An engineer's report may be required.	The proposed development will ensure that no significant adverse flood impacts occur. (i) floodplain balance will be provided in the site (ii) the only proposed change to the flood conveyance on the site will occur through the introduction of the future buildings M5 and M6. Drainage infrastructure will be provided to ensure that the existing overland flow from Southey Street is managed. (iii) No further development is proposed in the Maltings site beyond this current proposal. Any future development will need to reinvistigate the flooding implications across the site.
CAR PARKING & DRIVEWAY ACCESS		
1	The minimum surface level of open car parking spaces or carports shall be as high as practical, and not below: (i) the 5 year flood level plus freeboard: or (ii) the level of the crest of the road at the location where the site has access, (which ever is the lower). In the case of garages, the minimum surface level shall be as high as practical but no lower than the 5 year flood level plus freeboard.	The proposed open carparks will be located above the 20% AEP flood level and the crest of the adjacent roads to the driveways.
3	Garages capable of accommodating more than 3 motor vehicles on land zoned for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year	The proposed underground parking and contributing driveway are both clear of the 1% AEP flood extents.
5	Where the level of the driveway providing access between the road and parking space is lower than 0.3m below the 100 year flood, the following condition must be satisfied - the depth of inundation on the driveway during a 100 year flood shall not exceed: (i) the depth at the road, or (ii) the depth at the car parking space. (Refer to Schedule 3). A lesser standard may be accepted for single detached dwelling houses where it can be demonstrated that risk to human life would not be compromised.	The depth of 1% AEP flooding in the proposed driveway will not exceed the depth of flooding in Colo Street to the south.
6	Enclosed car parking and car parking areas accommodating more than 3 vehicles (other than on Rural zoned land) with a floor level below the 5 year flood level plus freeboard or more than 0.8m below the 100 year flood level shall have adequate warning systems signage and exits.	Adequate warning systems signage and exits will be provided.
7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year flood.	Suitable restraints/barriers will be provided.

EVACUATION		
1, OR	Reliable access for pedestrians or vehicles required during a 100 year flood.	Reliable access/egress will be provided for the new buildings on the east side of the site. The existing buildings to the west of the site are inundated in the 1% AEP (and larger events) and will continue to be inundated in the developed case. Suitable uses will be proposed in the ground floors of the flood affected buildings. For evacuation purposes, it is recommended that a local evacuation plan be prepared for the western buildings (M1 and M2) which involves evacuating via Ferguson Street (to the north of the site) before heading east and crossing the railway.
2	Reliable access for pedestrians or vehicles is required from the building, commencing at a minimum level equal to the lowest habitable floor level to an area of refuge above the PMF /eve/, or a minimum of 20% of the gross floor area of the dwelling to be above the PMF level. In the case of alterations or additions to an existing development, this may require retro-fitting the existing structure if required to support a refuge above the PMF.	
MANAGEMENT & DESIGN		
1	If this application involves subdivision, Applicant to demonstrate that potential development as a consequence of the subdivision, can be undertaken in accordance with this DCP.	This application doesn't involve subdivision.
2	Site Emergency Response - Flood Plan required where floor levels are below the design floor level, (except for single dwelling-houses).	A Site Emergency Response Plan will be prepared for the flood affected buildings on the site.
3	Applicant to demonstrate that area is available to store goods above the 100 year flood level plus freeboard.	Area will be available above the 1% AEP flood for storage of goods in the upper levels of the buildings.
5	No storage of materials below the design floor level which may cause pollution or be potentially hazardous during any flood	No potentially hazardous materials is to be stored below the design floor levels.

APPENDIX B
FIGURES

MAPPED FLOODING HAS BEEN ADOPTED FROM THE NATTAI RIVER FLOOD STUDY (CSS, 2014)

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

LEGEND

- Nattai River Study Area
- 650 Peak Water Level Contours
- Property Boundaries
- 1 Water Level Location ID

Depths (m)
- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

Velocity Vectors
- 0.5 m/s
- 2 m/s
- 4 m/s

N

0 80
metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6.1

The Maltings, Mittagong

20% AEP Flood Depths, Levels and Velocities
Existing Conditions

Date 17/12/19 Issue A

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MAPPED FLOODING HAS BEEN ADOPTED FROM THE NATTAI RIVER FLOOD STUDY (CSS, 2014)

BELGRAVE ST
FERNBROOK CR
WANDEYAN P

6
5
4
15

J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

LEGEND

- Nattai River Study Area
- 650 Peak Water Level Contours
- Property Boundaries
- 1 Water Level Location ID

Depths (m)
- 0.0 to 0.1
- 0.1 to 0.2
- 0.2 to 0.3
- 0.3 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0
- 2.0 +

Velocity Vectors
- 0.5 m/s
- 2 m/s
- 4 m/s

N

0 80
metres
Scale 1:2,000 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6.2

The Maltings, Mittagong

1% AEP Flood Depths, Levels and Velocities
Existing Conditions

Date 17/12/19 Issue A

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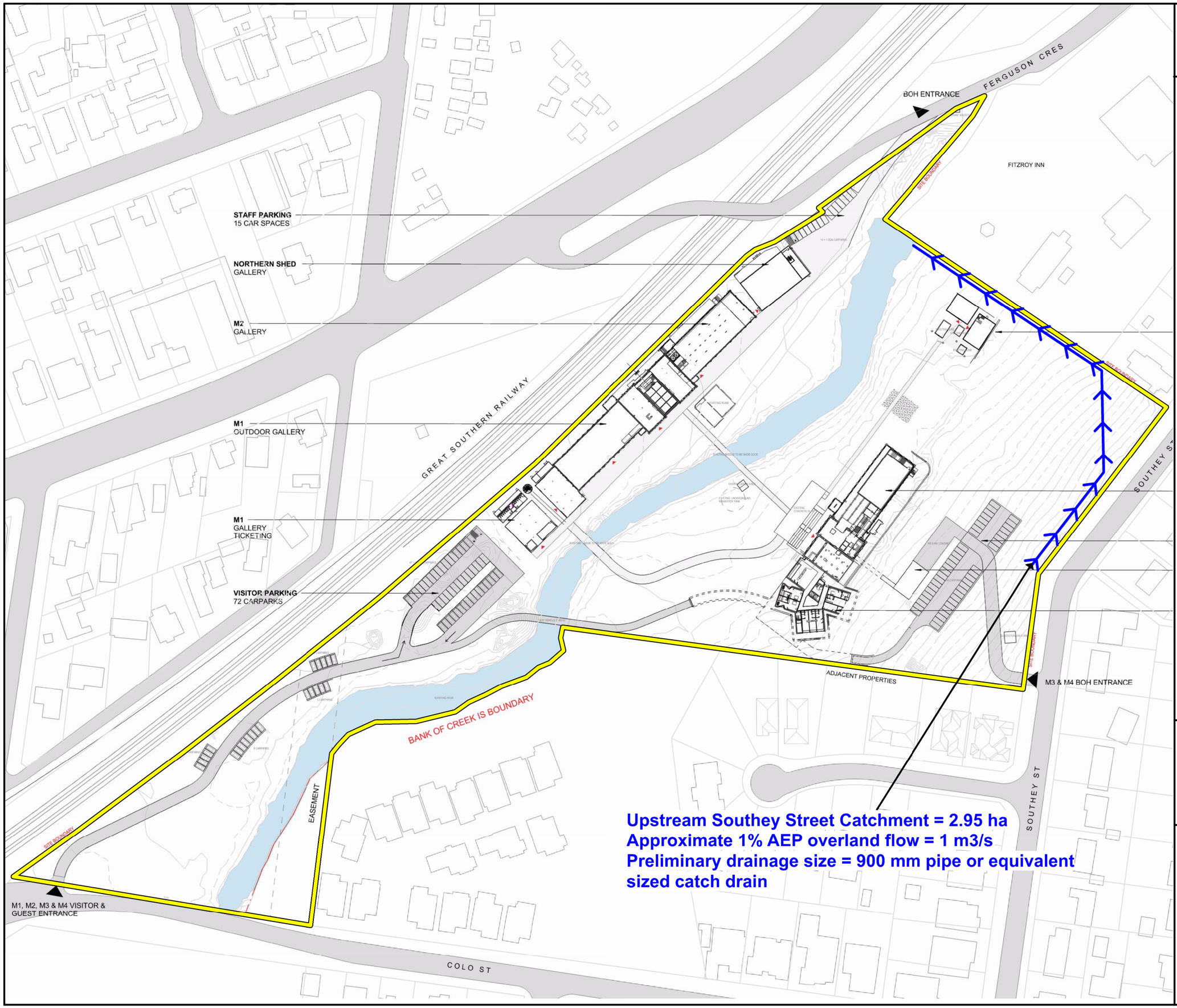
Filename: "J:\110608 - The Maltings, Mittagong\02 - DA Package\SW&E\MapInfo\Figures\110608_Fig6.4_Concept Drainage Plan_E.wor"



J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS
& PROJECT MANAGERS

LEGEND

- Site Boundary
- Concept Drainage Location

N

0 60
metres
Scale 1:1,700 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 6.4

The Maltings, Mittagong

Conceptual Drainage Solution
Southey Street Overland Flows

Date 9/02/2024

Issue B

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J. WYNDHAM PRINCE
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LEGEND

- Site Boundary
- MUSIC Catchment Boundary
- Grassed Swale
- Bioretention
- Bioretention Swale
- Rainwater Tanks

N

0 60
metres
Scale 1:1,700 @ A3

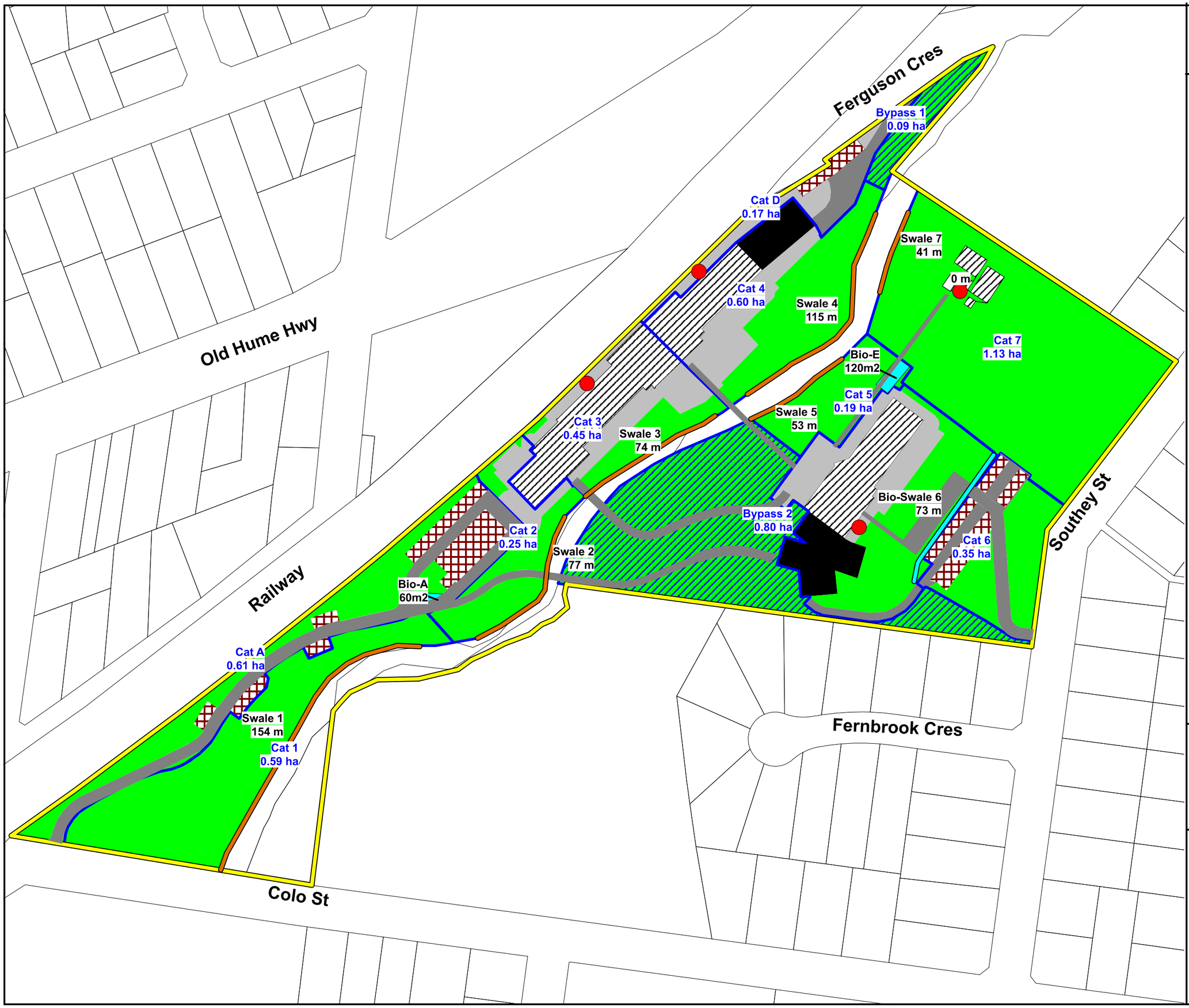
Projection: GDA 1994 MGA Zone 56

Figure 7.1

The Maltings, Mittagong

Water Quality Strategy

Date 12/07/2024 Issue B



J. WYNDHAM PRINCE
CONSULTING CIVIL INFRASTRUCTURE ENGINEERS & PROJECT MANAGERS

LEGEND

- Site Boundary
- MUSIC Catchment (Treated)
- MUSIC Catchment (Bypass)
- Bioretention
- Bioretention Swale
- Grassed Swale
- Rainwater Tanks
- Proposed Roof
- Existing Roof
- Sealed Road / Carpark
- Impervious / Hardstand Area
- Remaining Pervious Area
- Compacted Grainte Sand

N

0 60
metres
Scale 1:1,700 @ A3

Projection: GDA 1994 MGA Zone 56

Figure 7.3

The Maltings, Mittagong

MUSIC Catchment Plan
Developed Conditions

Date 12/07/24 Issue B

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APPENDIX C

NATURAL CHANNEL DESIGN GUIDELINES – MANNINGS EXAMPLES

Photo C4

Regular cross section, slight meandering, mown overbanks.

Bankfull: n = 0.04

Overbank grass: n = 0.03 (shallow flow depth assumed)

Photo C5

Mown grass banks, unmaintained wetland plants on bed, regular cross section, very slight meander.

Bed: Manning's n is variable depending on flow depth.

Bankfull components:
bed n = 0.035
bank n = 0.030
resulting in a bankfull n =0.035

Photo C6

Canopy trees in early stages of growth, straight, regular channel.

Bankfull: n = 0.04
Overbank: n = 0.15

Photo C7

Rock size approx. 300 mm, this results in a Manning's n = 0.034 assuming deep water flow.

Bed: n =0.04

Photo C8

Deep channel, irregular cross section, meandering channel.

Bankfull: n = 0.045

Photo C9

Near straight channel, full canopy cover with few weeds, pool-riffle system, shallow pools with boulders.

Bed: n = 0.045
Bank: n = 0.09

Photo C16

Irregular mountain creek with flexible understorey plants, few vines or woody shrubs.

Bankfull: n = 0.10 to 0.12

Photo C17

Overbank vegetation at approximately 8 metre spacing with no shrubs.

Overbank: n = 0.05

Photo C18

Overbank vegetation consists of tall truck trees, no low branches or shrubs. Tree spacing of approx. 8 metres.

Overbank: n = 0.05

Photo C19

Irregular channel with meanders.

Channel: n = 0.04 to 0.05 depending on channel irregularity and debris content.

Overbank area consists of single truck trees with no low branches or shrubs.

LHS (5 m spacing): n = 0.055

RHS (6-7 m spacing): n = 0.05

Photo C20

Trees at approx. 5 metre spacing, no low branches.

Overbank: n = 0.055

Photo C21

Irregular natural channel and wetland system with many weeds.

Overbank: n = 0.06

APPENDIX D

MUSIC MODELLING ASSUMPTIONS & PARAMETERS

MUSIC Catchment Breakup

	Existing Conditions Catchment Division Areas (ha)				
Catchment	Total Catchment Area (ha)	Roof	Impervious Areas (Urban)	Unsealed Road (Urban)	Remaining Pervious Areas (Urban)
% Impervious		100%	100%	100%	0%
Cat 1	0.578				0.578
Cat A	0.615				0.615
Cat 2	0.264			0.010	0.254
Cat 3	0.447	0.207		0.064	0.176
Cat 4	0.602	0.122	0.021	0.115	0.284
Cat D	0.170			0.029	0.202
Cat 5	0.190				0.190
Cat E	0.735	0.143	0.038		0.555
Cat 6	0.373				0.373
Cat 7	1.107	0.027			1.080
BP 1	0.091				0.091
BP 2	0.803				0.803
Sum	5.975				

	Developed Conditions Catchment Division Areas (ha)						
Catchment	Total Catchment Area (ha)	Existing Roof	Proposed Roof	Driveways (Sealed Road)	Car Spaces (Pervious Pavement)	Impervious Areas (Urban)	Remaining Areas (Urban)
% Impervious		100%	100%	100%		100%	Varies
Cat 1	0.587						0.587
Cat A	0.611			0.206	0.120		0.285
Cat 2	0.260					0.056	0.204
Cat 3	0.447	0.207				0.126	0.114
Cat 4	0.602	0.122	0.061			0.132	0.288
Cat D	0.169			0.066	0.024	0.079	
Cat 5	0.190						0.190
Cat E	0.735	0.143	0.098	0.102		0.163	0.230
Cat 6	0.352			0.101	0.062		0.189
Cat 7	1.129		0.034				1.095
BP 1	0.091						0.091
BP 2	0.802			0.098			0.704
Sum	5.975						

Rainfall & Evapotranspiration Data

A summary of the rainfall and evapotranspiration data used in the MUSIC model is provided in Plate C1 below. The rainfall data set has been adopted from the rainfall gauge at Bowral (68102) which is modelled at a 6 minute time step.

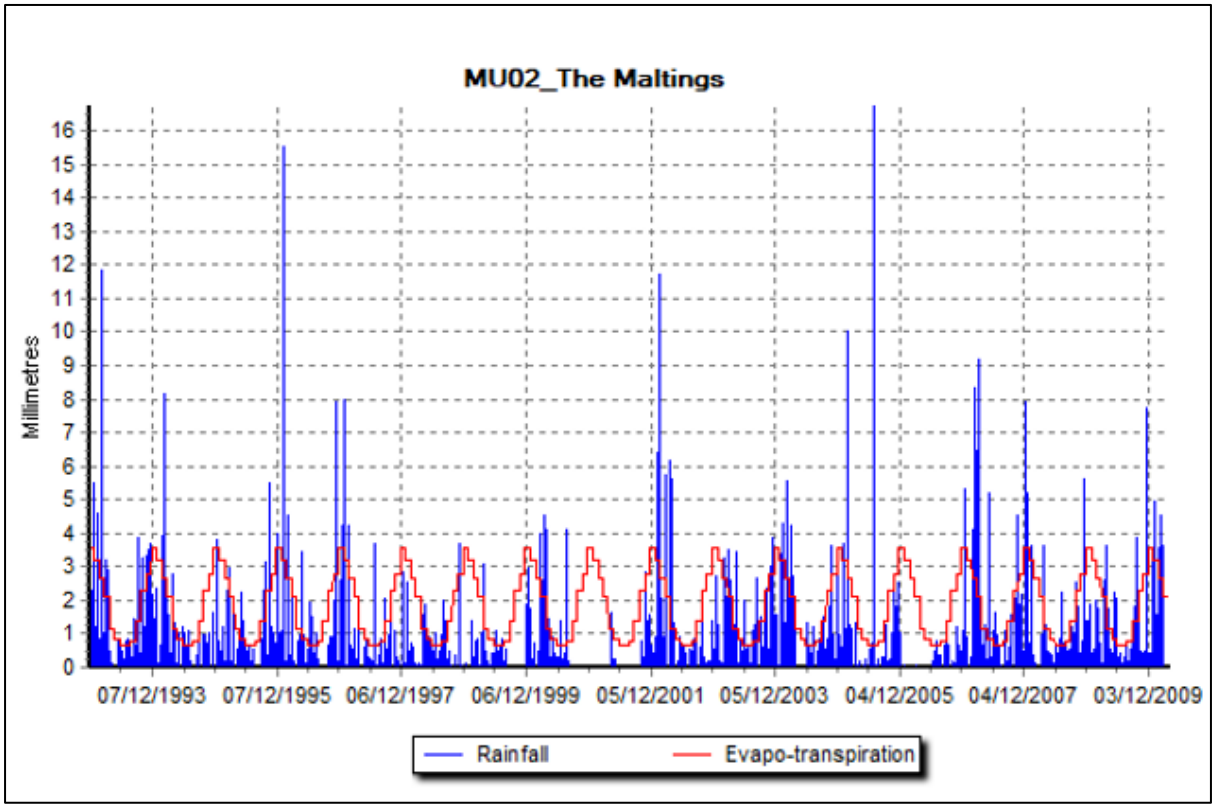


Plate C1 – Rainfall-Runoff Parameters for Penrith

MUSIC Modelling Land Use Parameters

Details of the soil / groundwater parameters adopted for the MUSIC modelling undertaken for this development are presented in Table C1 below. The adopted Annual Pollutant event mean concentrations are also presented in Table C2 below.

Table C1 – Rainfall-Runoff Parameters

Property	Units	Value
Rainfall Threshold (mm/day)	mm/day	1.0, 0.3 (Roof) & 1.5 (Sealed road)
Pervious Area Properties		
Soil Storage Capacity	mm	100
Initial Storage*	% of Capacity	25
Field Capacity	mm	87
Inifiltration Capacity Coefficient - a		250
Inifiltration Capacity Coefficient - b		1.3
Groundwater Properties		
Initial Depth*	mm	10
Daily Recharge Rate	%	60
Daily Baseflow Rate	%	45
Daily Deep Seepage Rate	%	0

Table C2 – Source Node Parameters

Surface / Landuse Type	TSS		TP		TN	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Base Flow						
General Urban, Residential, Commercial, Industrial	1.2	0.17	-0.85	0.19	0.11	0.12
Storm Flow						
Road	2.43	0.32	-0.3	0.25	0.34	0.19
General Urban, Residential, Commercial, Industrial	2.15	0.32	-0.6	0.25	0.3	0.19
Revegetated Land	1.95	0.32	-0.66	0.25	0.3	0.19
Unsealed Road	3	0.32	-0.3	0.25	0.34	0.19
Roof	1.3	0.32	-0.89	0.25	0.3	0.19

Bioretention

Bio-retention raingardens consist of a filtration bed with either gravel or sandy loam media and an extended detention zone typically from 100-300 mm deep designed to detain and treat first flush flows from the upstream catchment. They are typically located within bushland corridors or other open space areas but may also be formalised gardens within urban developments. The depth of the bio-retention raingarden media beds are typically 400-600 mm deep.
The bio-retention raingardens will also function to assist in reducing the frequency of discharge of stream forming flows from a development.

The bioretention input parameters that have been adopted for the MUSIC modelling are provided in Table C3 below.

Table C3 – Bioretention Input Parameters

Parameter	Value
Extended Detention Depth (m)	0.3
Unlined Filter Media Perimeter (m)	0.01
Saturated Hydraulic Conductivity (mm/h)	100
Filter Depth (m)	0.5
TN Content of Filter Media (mg/kg)	400
Orthophosphate Content of Filter Media (mg/kg)	40
Exfiltration Rate (mm/hr)	0

Grassed Swale

A grassed swale is a graded and engineered landscape feature appearing as a linear, shallow, open channel with trapezoidal or parabolic shape. The swale is vegetated with flood tolerant, erosion resistant plants.
Within the grassed swales storm water is drained at a slow and controlled rate and the swale acts as a treatment device in removing pollutants and allowing stormwater infiltration.
A well-designed grassed swale results in a significant improvement over the traditional drainage ditch in both detaining the flows and cleaning of stormwater. Collected stormwater is designed to drain out through the filter medium within several hours or days.

The general features of the grassed swale proposed for the site are indicated in Table C4 below.

Table C4 – Grassed Swale Input Parameters

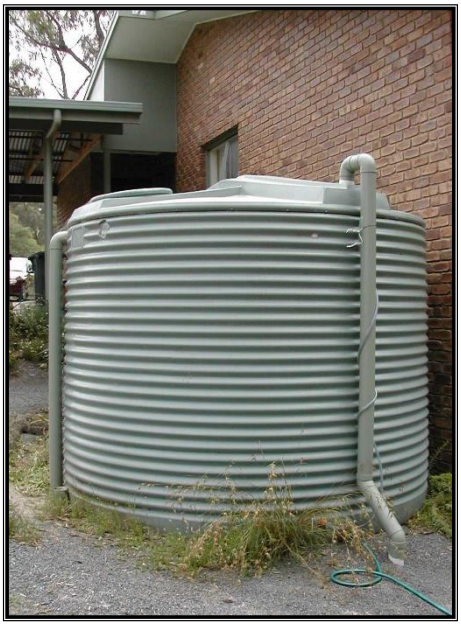
Parameter	Value
Bed Slope (%)	1.0
Base Width (m)	1.0
Top Width (m)	3.0
Depth (m)	0.2
Vegetation Height (m)	0.15
Exfiltration Rate (mm/hr)	3.6

Rainwater Tanks

Rainwater tanks are sealed tanks designed to contain rainwater collected from roofs. Rainwater tanks provide the following main functions:

- Allow the reuse of collected rainwater as a substitute for mains water supply, for use for toilet flushing, laundry, or garden watering
- Provide some on-site detention, thus reducing peak flows and reducing downstream velocities (when designed with additional storage capacity above the overflow)
- Can provide captured stormwater for internal hot water supply

Rainwater tanks can be above or below ground and can also be gravity fed or a pump pressure system to distribute the water.



Multiple rainwater tanks have been included to collect the roof water runoff for all of the existing and proposed buildings. Buildings Cat7, M1 and M2 are proposed to have a 10kL rainwater tank each and buildings M3 and M4 are proposed to have a 20kL rainwater tank. An irrigation demand of 20kL/year/1000m^2 and internal use demand of 0.1kL/day/1000m^2 has been used as the re-use requirement for the rainwater tanks.

The two (2) tanks that are capturing M1 and M2 roof water run-off are performing efficiently, with the re-use demand met (%) being in the order of 55% and 70%. The tank capturing M3 and M4 roof water run-off has a re-use demand met (%) of 23% and this is due to the large number of amenities being provided in the proposed accommodation in comparison to the runoff provided by the roof area. The rainwater tanks are assumed to capture 100% of the contributing roof catchments and provide irrigation for approximately 40% of the pervious area across the site.

Further details of the rainwater tank parameters are provided in Table C5.

Table C5 – Rainwater tank parameters

					Node Inputs						
					Rainwater Tanks						
Catchment	No. of Tanks	Roof Catchment Area (ha)	Toilets Serviced	Landscaped Area Serviced	Hi Flow Bypass	Equivalent Pipe dia (mm)	Daily Demand (kL/day)	Annual Demand (kL/yr)	Total Tank Volume (kL)	Useable Tank Volume (kL)	Tank Surface Area (m^2)
Cat 3	1	0.207	5	0.114	0.04467	100	0.21	23	10	8	5.0
Cat 4	1	0.182	10	0.288	0.03935	100	0.18	58	10	8	5.0
Cat 7	1	0.034		1.095	0.00725	100	0.03	219	10	8	5.0
Cat E	1	0.241	52	0.495	0.05202	100	0.24	99	20	16	10.0

	RWT Inputs	
Overflow Pipe Diameter	100	mm
PET - Rain for landscape area	20	kL/year/1000m2
Assumed Daily Demand	0.1	kL/day/1000m2
I5min/1yr	77.7	mm/hr

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