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CIVIL ENGINEERING REPORT
INCORPORATING
WATER CYCLE MANAGEMENT
STRATEGY (INC. RTS RESPONSE)

SSD 10272349
LOTS 59 & 60 DP 259135, MAMRE ROAD
KEMPS CREEK NSW

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1 INTRODUCTION & SCOPE

Costin Roe Consulting Pty Ltd has been commissioned by The GPT Group to undertake a *Civil Engineering Report & Water Cycle Management Strategy* (WCMS) to accompany a State Significant Development Application (SSDA) with the NSW Department of Planning, Industry and Environment (DPIE) for an industrial estate comprising five development lots and construction of Buildings 3 & 5. This report presents a civil engineering assessment of a property bounded by Mamre Road, Lot 1 DP104956, Lots 56-58 DP259135 & Lots 34-37 DP258949. The development will be referred to *The Yiribana Logistics Estate* (YLE) in this report.

This report provides an assessment of the civil engineering characteristics of the development site and technical considerations of the following aspects:

- Earthworks & geotechnical considerations;
- Roads and Access;
- Water Cycle Management Strategy (WCMS).

The WCMS comprises several key areas of stormwater and water management which are provided below. These key areas have been established with the aim to reduce impacts from the YLE development on the surrounding environment and neighbouring properties. The water cycle management strategy identifies the management measures required to meet the targets set. The key water cycle management areas assessed in this report are:

- Storm Water Quantity;
- Storm Water Quality;
- Water Supply and Reuse;
- Flooding; and
- Erosion and Sediment Control

This engineering analysis is based on development for industrial warehouse and logistic facilities consistent with industrial estates in the surrounding areas and indicative Masterplan provided by GPT.

A request for SEAR's has been completed by Urbis. Reference to **Appendix C** should be made for SSD_10272349 SEAR's dated November 2020, and **Section 10** of this report for specific responses to civil engineering and water management related items included in the SEAR's.

Revision C of this report was prepared to include updated design and assessment for Response to Submission received from DPIE, specifically around their review of the Water Sensitive Urban Design modelling & Wianamatta Music Modelling Toolkit.

Revision D of this report was prepared to include updated intersection Functional Layout plans for the temporary access road and Mamre Road.

2 DEVELOPMENT SITE

2.1 Location

The proposed development is located in the suburb of Kemps Creek on Mamre Road on Lots 59 & 60 DP259135 as shown in **Figure 2.1**.

The site is bounded on the west by Mamre Road, semi-rural farmland to the north, south and east. We understand that the land to south is proposed to be developed by Mirvac, the land to the east by Frasers Property Australia, and the land bounded by the GPT site by Altis Property. Some consideration to this has been made in the assessment and design drawings included in the submission.

The land comprises a total area of approximately 33Ha. The current land-use is predominantly rural-commercial and rural-residential.

The site generally falls from north-east to south-west. The highest elevation on the land is RL84m AHD at the north-eastern corner of the site. The lowest levels are located at the Mamre Road frontage at RL 40m AHD. Grades over the land vary from 0.5% to 25% with the grades becoming flatter in the western portion of the land adjacent to Mamre Road.

The site is noted to be located within an area comprising rural/agricultural use, however nearby to existing and future industrial development areas, and noted as being recently rezoned by the NSW DPIE as IN1 General Industrial.

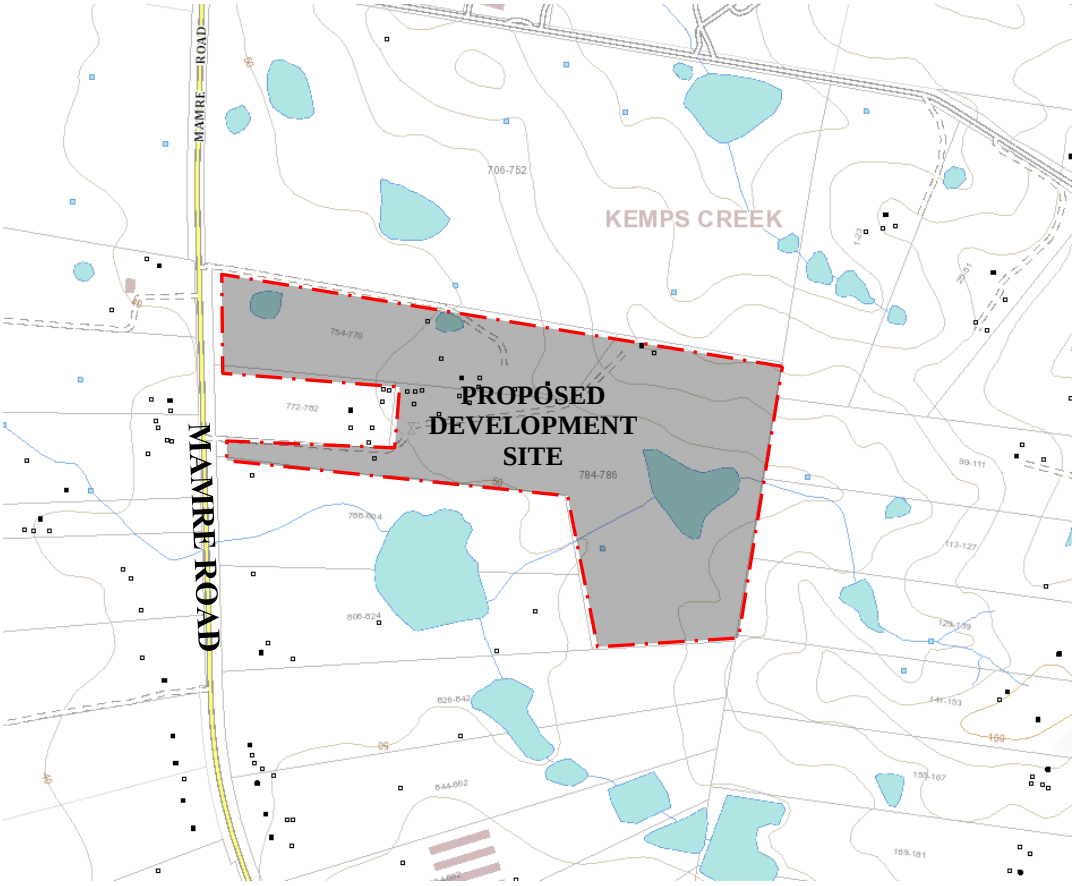


Figure 2.1 Locality Plan

2.2 Existing Site

The site is located on the eastern side of Mamre Road approximately 0.5km south of the intersection of Mamre Road and Bakers Lane, and 2.5km north of the intersection of Mamre Road and Abbotts Road. The nearest residential receivers are approximately 1.5km south-east of the site in Mount Vernon.

The property is currently comprising rural-commercial use. The existing semi-rural sheds are located in the central portion of the site and include several small dwelling-type buildings with detached sheds, carports and other minor structures. Two large, flat material storage areas are present in the northern portion of the site. Otherwise the majority of the site is undeveloped pasture and grassed fields.

The site is noted to be located within an area comprising rural/agricultural use, however nearby to existing and future industrial development areas, and noted as being recently rezoned by the NSW DPIE as IN1 General Industrial.

The site comprises a pistol-shaped block with two frontages on Mamre Road. The front (Mamre Road) boundary, with frontages of 180m & 40m, is less than half the width of the 498m wide rear boundary. The depth of the site is approximately 1,020m . The area of the development site is approximately of 33.15 Ha.

Two catchments are present on the property. *Catchment 1* is approximately defined by the Lot 59 boundary and falls to the south-west through the adjacent Lot 58 site at two distinct locations. One discharge point is located along the western boundary interface with Lot 58, the other fronting Mamre Road. *Catchment 2* is approximately defined by the Lot 60 site boundary and falls to the west to Mamre Road.

Lot 59 generally falls in a south-westerly direction, from RL 85.00m AHD in the north-east corner to RL 48.5m AHD along the south-western boundary interface with the Lot 58 property. The lot continues to fall towards Mamre Road at RL41.50m AHD. Falls are approximately 20% in the North-eastern portion of the lot , flattening to around 1-2% approaching Mamre Road.

Lot 60 generally falls in an east-to-west direction, from RL 78.00m AHD in the north-east corner to RL 41m AHD at the western frontage to Mamre Road. Falls are approximately 15% in the eastern third of the site, flattening to around 1-2% approaching Mamre Road. Two large, flat pads are present in the centre of the lot.

2.3 Proposed Development

The proposed development is for an industrial estate, earthworks and infrastructure for future industrial development over an area of 33 Ha. An indicative lot layout is shown in **Figure 2.2**. Infrastructure works will include bulk earthworks, provision of services, road & intersection construction, and stormwater management and has completed in accordance with the Development Masterplan.

The preliminary masterplan layout provided by The GPT Group shows development lots will vary between 4 Ha and 7.5 Ha in size. Siting of the development lots and levels will consider the topography of the land (understanding the constraint to develop large flat building pads), access, and flood planning requirements.

Access to all lots in the ultimate condition would be made via either the new North-South Access Road, or via the new East-West Local Industrial Road which feeds from the Access Road. The new access road and associated intersection will be constructed to The Final MRP DCP requirements (refer **Section 4**) and ownership transferred to Penrith City Council. Initial access to the site will be via a left in and out intersection with Mamre Road. This will be in place until such time that the internal precinct roads and permanent intersection to the south is constructed by the adjoining landowner, Mirvac.

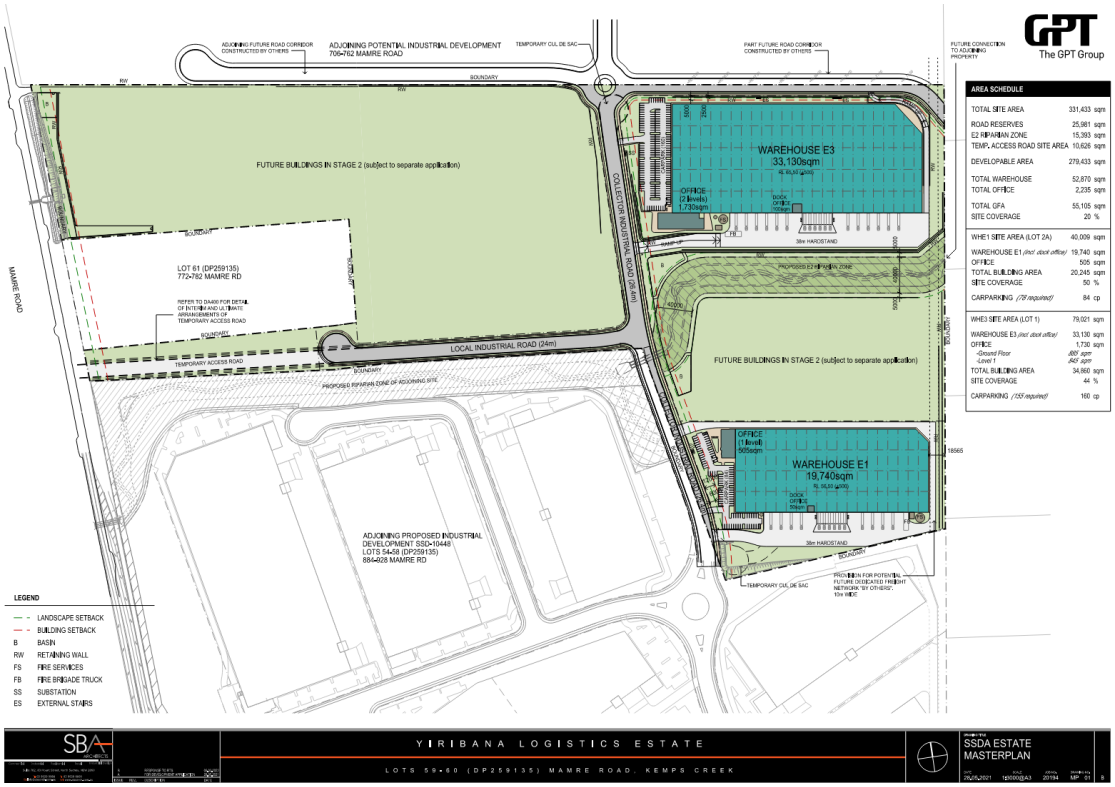


Figure 2.2. Development Masterplan (Source: SBA Architects)

3 SITE WORKS

3.1 Soil and Geological Conditions

The 1:100,000 Sydney Geological Map indicates the site is underlain by (Rwb) shale, carbonaceous claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff.

Investigations by PSM Geotechnical shows the soil profile to comprise residual clay soils with depths of 1-3m overlaying highly to medium weathered shale.

3.2 Bulk Earthworks and Benching Levels

Bulk earthworks will be required to facilitate the development of the estate for industrial use. The earthworks will be undertaken to provide large flat building pads, facilitate site access from Mamre Road and proposed estate roads, to drain the site stormwater via gravity, and to keep building levels above the 1% AEP (1 in 100-year ARI) flood level with a minimum freeboard of 500mm.

The development and proposed benching levels respond to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road.

Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by the adjacent landowners Mirvac and Altis Property Partners, has also been made. Consultation with the respective landowners/ developers (as noted) has been made throughout the development application design development.

Overall, it can be anticipated that, on a development site which has level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE and Council.

High level earthworks and volume estimates have been completed and are shown on drawing **Co13874.06-SSDA300** of **Appendix A**. The earthworks volume estimates are based on a lot layout with flat building pads. The earthworks analysis has been completed to a level of detail to enable general pad levels to be set and to obtain an order of magnitude cut and fill volume estimate. The primary drivers for the proposed earthworks levels are access and draining the site via gravity. This results in large amounts of fill import being required for the site.

The earthworks volume estimates are as follows in **Table 3.1**:

Item	Lower Bound (-15%)	Apparent Volume (m^3)	Upper Bound (+15%)
Cut	-367,285	-432,100	-496,915
Fill	+461,125	+542,500	623,875
Topsoil Strip	-56,270	-66,200	-76,130
Detailed Excavation	-56,270	-66,200	-76,130
Balance	**+37,570 Fill Over Cut**	**+44,200 Fill Over Cut**	**+50,830 Fill Over Cut**

Table 3.1. Earthwork Volume Estimates

The volume estimate is based on a 66,200m^3 topsoil strip (200mm over the site area) to be either removed from the site, blended or placed and used within non-developable vegetation zones. Given the large volume and associated cost this would impose to dispose the topsoil, geotechnical advice is recommended to confirm options for borrow pit arrangement or blending non-organic topsoil component with site won fill material, so disposal of topsoil is reduced. Consideration to the short- and long-term performance of the blended fill, including effect on settlement, soil modulus, CBR and bearing capacity should be made in any geotechnical advice. If high-bay or other settlement sensitive uses are proposed on the site, then topsoil blending should not be adopted.

A minor import of earthworks has been shown in the concept analysis to enable buildings to be sited above the 1% AEP event with 500mm of freeboard and to enable drainage of sites by gravity. Consideration to bulking of cut materials including rock and clay materials should be allowed for. Bulking of clay would normally be expected to be 4% of the removed volume and rock bulking can be expected in the range of 8-12%.

Further it is noted that import of fill is required (comprising around 15% of the total earthworks volumes). Imported fill would comprise Virgin Excavated Natural Material (VENM) or Excavated Natural Material (ENM), or other approved in writing by the EPA. Where possible any import or export would be sourced from within the precinct as recommended in the *Final Mamre Road Precinct DCP*.

Soil erosion and sediment control measures including sedimentation basins will also be provided for the development – please refer to the Soil and Water Management Plan in **Section 10** of this report. All Soil and Sediment Control measures will be performed in accordance with Penrith City Council requirements and *Landcom Managing Urban Stormwater, Soils and Construction (1998) – The Blue Book.*

3.3 Retaining Walls

The civil engineering objective is to minimise retaining walls within the constraints of the masterplan layout, levelling of the site to suit large format industrial buildings, allowable grading to suit industrial use external to the building footprint and batters in landscaped areas where possible.

Retaining walls will be required throughout the estate at site boundaries and between development lots. Location and indicative heights of retaining walls are shown on drawing **CO13874.06-SSDA600 & SSDA650**.

Retaining wall alignments, setbacks and tiering requirements have been completed in accordance with *Section 4.4* of the *Final MRP DCP* and include 1.5m tiers for walls greater than 3m fronting the public domain and a 2m setback of walls greater than 1m in height from public domain. It is noted that shallow soil planting (as opposed to deep soil planting) has been provided between successive tiers of walls. This would achieve an effective landscaping outcome and one similar to nearby industrial areas, including Eastern Creek Business Hub. Shallow soil planting over deep soil planting between tiers is required to ensure structural stability of retaining wall structures.

Level differences along the property frontage and fronting the realigned riparian corridor are noted to comprise a stepped arrangement, in conjunction with the proposed stormwater management plan.

3.4 Embankment Stability

To assist in maintaining embankment stability, permanent batter slopes will be no steeper than 3 horizontal to 1 vertical while temporary batters will be no steeper than 2 horizontal to 1 vertical. This is in accordance with the recommended maximum batter slopes for residual clays and shale which are present in the area.

Permanent batters will also be adequately vegetated or turfed which will assist in maintaining embankment stability.

Stability of batters and reinstatement of vegetation shall be in accordance with the submitted drawings and the *DRAFT Soil and Water Management Plan* in **Section 9**.

3.5 Supervision of Earthworks

All geotechnical testing and inspections performed during the earthwork's operations will be undertaken to Level 1 geotechnical control, in accordance with AS3798-1996.

3.6 Groundwater

A groundwater assessment has been undertaken by Arcadis (ref: 30081949_GMP_FINAL dated 30 April 2021) based on geotechnical assessments completed by PSM.

The geotechnical investigations undertaken by PSM Geotechnical encountered groundwater two of the test locations at a depth of approximately 3m depth. Groundwater was encountered in test pits situated in low-lying areas of the site. It could be expected that groundwater may be experienced at depth or around the normal dry weather water level of South Creek, and that this level would have some seasonal variation and variation associated with periods of high rainfall. In any event, groundwater if present would be at depth below the proposed filled pad levels and interaction with existing groundwater paths would be negligible.

We confirm that the development does not propose to utilise surface or groundwater water sources. An assessment of the impact on these items is not relevant for the warehouse distribution center construction.

Surface water management, including conveyance of surface runoff, management of water quantity (through on-site detention) and water quantity (through on-site and estate wide management systems using WSUD principles and best practice pollution reduction objectives) has been proposed in the design.

In relation to groundwater affectation, this is expected to be negligible. The geotechnical investigations undertaken by Arcadis encountered groundwater in two of the test locations. Further, the majority of the site and site earthworks involve filling, hence any interaction with existing groundwater or groundwater flow paths would negligible and hence not be impacted.

3.7 Acid Sulphate Soils

An assessment of the potential for acid sulphate soils has been requested as part of the SEAR's requirements.

Reference to the *NSW Land & Water Conservation Acid Sulphate Soils Map 92_Liverpool* shows the subject land clear of any known occurrence of acid sulphate soils.

An Acid Sulfate Soils assessment has been undertaken by JBS&G for the development – ref *JBS&G 60539-136377* dated 31 March 2021 – as included in the EIS. The JBS&G letter showed that the risk of acid sulphate soils were low and this site is not subject to any policies relating to acid sulfate soils. As such no specific requirements relating to management of these soils are considered necessary. Refer to the JBS&G report for more detail on acid sulfate soil management during construction.

3.8 SEPP (WSEA) Clause 33H, 33I and 33L

3.8.1 SEPP (WSEA) Clause 33H Earthworks

Consideration to the requirements of SEPP (WSEA) Clause 33H Earthworks has been made in the impact assessment. Review and confirmation specific matters included in Clause 33H(3) has been made for Items (a) through (j) as follows.

a) the likely disruption of, or detrimental effect on, existing drainage patterns and soil stability in the locality,

A detailed flood assessment has been completed in relation to flooding considerations – refer report **Section 8** and **Appendix E** of this report.
Refer **Sections 5, 6, 7 & 8** of this report and associated drawings in **Appendix A** which set out stormwater management for the site. The proposed strategy incorporates management of site runoff and upstream drainage paths managing quantity and quality and ensuring acceptable impacts in accordance with various council and NSW government policy.
Consideration to stability of soil has been made during and post construction.

b) the effect of the proposed development on the likely future use or redevelopment of the land,

The proposed development (being industrial warehouse distribution development) is consistent with the land zoning. Future redevelopment of similar industrial facilities would be able to be undertaken based on the current proposed works.

c) the quality of the fill or the soil to be excavated, or both,

Geotechnical and environmental assessments have been undertaken for the site and reviews and discusses suitability for use as engineered fill, foundations and other development requirements. The report shows that with due consideration to the design requirements that development would be able to be made over the development footprint.

d) the effect of the proposed development on the existing and likely amenity of adjoining properties,

Adjoining properties to the north, south, east and west are noted to comprise land zoned for industrial use, hence similar amenity to these frontages is achieved.

e) the source of fill material and the destination of excavated material,

There is no excavated material to be removed from the site. Import of fill is required and is expected to be sourced from a variety of locations which will need to be confirmed as part of the Construction Management Plan for the development during Construction Certificate stage of the development. Per the intent of the Final MRP DCP, the source of fill importation will first be considered from within the MRP.

f) the likelihood of disturbing relics,

A heritage and aboriginal impact study has been undertaken. Refer to separate reports and management measures relating to aboriginal heritage.

g) the proximity to and potential for adverse impacts on a waterway, drinking water catchment or environmentally sensitive area,

A detailed flood assessment has been completed in relation to flooding considerations and confirmation of acceptable impacts as included in this report. Assessments relating to discharge of water has been made in the report, based on the EES/DPIE Stream Health Targets as confirmed in the Final MRP DCP. Refer **Section 6, 7 &** 8 of this report for details of water quantity, water quality and flow duration assessments which confirm acceptable impacts relating to stormwater management.

h) appropriate measures proposed to avoid, minimise or mitigate the impacts of the development,

Appropriate measures during and following development have been made in relation to earthworks, erosion and sediment controls during construction/ earthworks per Landcom Blue Book. During operational period measures as set out in the Final MRP DCP have been adopted.

i) the proximity to and potential for adverse impacts on a heritage item, an archaeological site, or a heritage conservation area,

A heritage and aboriginal impact study has been undertaken. Refer to separate reports.

j) the visual impact of earthworks as viewed from the waterways.

Refer separate visual impact report in relation to visual amenity.

3.8.2 SEPP (WSEA) Clause 33I Development on Flood Prone Land

Consideration to the requirements of *SEPP (WSEA) Clause 33I Development on Flood Prone Land* has been made as part of this assessment. Review and confirmation specific matters included in Clause 33I(2) has been made for Items (a) through (h) as follows. We note that this site is clear of the South Creek floodplain to the PMF flood event. A local overland flow (within the riparian corridor) is present on the land. The below comments pertain to the local overland flow path.

Consent is not to be granted to the carrying out of development to which this clause applies unless the consent authority has taken into consideration whether or not—

a) the development will adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties, and

A comprehensive overland flow and flood assessment has been completed by Costin Roe Consulting and presented in **Section 8** and **Appendix E** of this report. The modelling and assessments considers a range of storm events, and confirms acceptable changes for the defined flood event, consistent with Councils Part C3 DCP ((and the proposed amendments in the *DRAFT South Creek Floodplain Risk Study*), which requires impact assessments to the 1% AEP, and those set out in *Section 2.5* of the *Final Mamre Road Precinct DCP* (noting these are generally consistent with Councils DCP).

b) the development will alter flow distributions and velocities to the detriment of other properties or the environment of the floodplain, and

The development has been confirmed in in **Section 8** and **Appendix E** of this report**,** as not altering flow distributions or velocities which result in the detriment of properties, the environment or the floodplain. The proposed realignment of the watercourse has been discussed and agreed with the downstream property owner (Mirvac) and NRAR.

c) the development will enable safe occupation of the flood prone land, and

The rezoned land would be considered to enable safe occupation of the land. We note a comprehensive assessment of flood safety has been included in in **Section 8** and **Appendix E** of this report**.** The report includes information and timing information to

enable time for persons to either move to parts of the precinct which are PMF free, or to remain on site refuge.

d) *the development will detrimentally affect the floodplain environment or cause avoidable erosion, siltation, salinity, destruction of riparian vegetation or a reduction in the stability of the riverbank/watercourse, and*

The proposed realignment of the watercourse has been discussed and agreed with the downstream property owner (Mirvac) and NRAR. All measures during the realignment are consistent with NRAR guidelines and Landcom Blue Book.
The proposed stormwater discharge measures (per DPIE/ EES) will ensure acceptable discharge and limited opportunity for stability changes to the riverbank or watercourses.
During construction a detailed erosion and sediment control plan and measures will be in place, completed in accordance with the Landcom Blue Book – refer **Section 5**.
During operation stormwater treatment measures are proposed which will limit pollution discharge from the development site to acceptable treatment target levels.

e) *the development will be likely to result in unsustainable social and economic costs to the flood affected community or general community, as a consequence of flooding, and*

The development is consistent with long term strategic plans for the area, and surrounding industrial developments. The flood assessments included in in **Section 8** and **Appendix E** of this report confirm appropriate outcomes for the development upon rezoning and construction.

f) *the development is compatible with the flow conveyance function of the floodway, and*

The overland flow assessments included in in **Section 8** and **Appendix E** of this report confirm appropriate outcomes for the development upon rezoning and construction.

g) *the development is compatible with the flood hazard, and*

The overland flow assessments included in **Section 8** and **Appendix E** of this report confirm appropriate outcomes for the development upon rezoning and construction.

h) *in the case of development consisting of the excavation or filling of land, the development—*

i. *will detrimentally affect the existing drainage patterns and soil stability in the locality, and*
ii. *will adversely impact or alter flood behaviour.*

The overland flow assessments included in in **Section 8** and **Appendix E** of this report confirm appropriate outcomes for the development upon rezoning and construction.

3.8.3 SEPP (WSEA) Clause 33L Stormwater

Consideration to the requirements of *SEPP (WSEA) Clause 33L Stormwater, Water Quality and water sensitive design* has been made as part of this assessment. Review and confirmation specific matters included in Clause 33L(2) has been made for Items (a) through (f) as follows.

a) water sensitive design principles are incorporated into the design of the development, and

WSUD elements have been incorporated into the design as set out in **Section 5.1** and subsequent **Sections 5.3** to 5**.8** of this report.

b) riparian, stormwater and flooding measures are integrated, and

Stormwater and flooding measures have been integrated into the design as set out in **Section 5** of this report and **Section 8** and **Appendix E** of this report. The design considers the riparian requirements of NRAR and realignment of the existing Strahler Order 1 watercourse.

c) the stormwater management system includes all reasonable management actions to avoid adverse impacts on the land to which the development is to be carried out, adjoining properties, riparian land, native bushland, waterways, groundwater dependent ecosystems and groundwater systems, and

The management systems for water quality and quantity provide best practice measures and meet local council policies and the requirements as agreed with council and the DPIE throughout the consultation period. Refer **Section 5.1** for details of proposed management systems.

d) if a potential adverse environmental impact cannot be feasibly avoided, the development minimises and mitigates the adverse impacts of stormwater runoff on adjoining properties, riparian land, native bushland, waterways, groundwater dependent ecosystems and groundwater systems, and

The management systems for water quality and quantity provide best practice measures and meet local council policies and the requirements as agreed with council and the DPIE throughout the consultation period.
Refer in **Section 5.1** and subsequent **Sections 5.3** to 5**.8** of this report.

e) the development will have an adverse impact on—

a. the water quality or quantity in a waterway, including the water entering the waterway, and

The management systems, and proposed adopted stormwater management objectives (**Table 5.1**) for water quality and quantity, and stream health, provide best practice measures and meet local council policies and the requirements as agreed with council and the DPIE throughout the consultation period.
Refer in **Section 5.1** and subsequent **Sections 5.3** to **5.8** of this report.

b. the natural flow regime, including groundwater flows to a waterway, and

The management systems, and proposed adopted stormwater management objectives (**Table 5.1**) for water quality and quantity, and stream health, provide best practice measures and meet local council policies and the requirements as agreed with council and the DPIE throughout the consultation period.
Refer in **Section 5.1** and subsequent **Sections 5.3** to 5**.8** of this report.

c. the aquatic environment and riparian land (including aquatic and riparian species, communities, populations and habitats), and

Refer ecologist assessment.

d. the stability of the bed, banks and shore of a waterway, and

Management of pre and post development flows to South Creek have incorporated the EES/ DPIE flow duration targets to ensure stream health, consistent with surrounding MRP DCP as set out in **Section 5.1.**
Discharge structures to are based on NSW Office of Water requirements for waterfront land and include natural energy dissipators and rock apron outlets.

f) the development includes measures to retain, rehabilitate and restore riparian land.

The development includes design to rehabilitate and restore the riparian corridor following realignment as agreed with NRAR.

4 ESTATE ROADS & ACCESS

4.1 Introduction

Integration with the broader transport strategy for the area will be required including the Mamre Road upgrade and Final MRP DCP. This includes the provision of signalised intersections with Mamre Road which will be required to be designed and constructed to the requirements of TfNSW.

The current posted speed limit for Mamre Road is 80kM/hr. Surrounding local road networks are confirmed in the Final MRP DCP to be posted at 50kM/hr. The corresponding design speeds for the two roads in the Yiribana Logistics Estate are 50kM/hr. A new unsignalised intersection is is contemplated for access into the development site from Mamre Road as part of this submission depending on timing of delivery of the surrounding road network.

The proposed road alignments will need to be designed to meet the Final MRP requirements (refer **Figures 4.1** to **4.3**). The proposed road layout will incorporate best practice for both horizontal and vertical alignments with empathy to the landform. Road layouts currently proposed are consistent with those proposed in the Final MRP DCP and per the Landowners Group (LOG) which have been consulted with Council and the DPIE.

4.2 Internal Roads

The estate road will need to be designed and constructed as an industrial road consistent with the agreed cross section and hierarchy in the Final Mamre Road Precinct DCP. The proposed road widths are noted to be greater than the Penrith City Council *Development Control Plan 2014, Part C10 Transport, Access and Parking*. The road cross section as adopted include 24.0m and 25.6m overall reserve widths as per the Local and Collector road hierarchy included in **Figure 4.1,** and arrangements shown in **Figure 4.2** & **Figure 4.3**.

Road Type & Traffic Volume	**Parking Lane Provision**	**Dedicated Travel Lanes**	**Verge Width (Footpath Pedestrian)**	**Total Road Reserve**	**Number of lanes**	**1.5m Footpath or 2.5m Shared Path**
Type 1 – Local Industrial Road	8.0m (2 x 4.00m)	7.0m (2 x 3.5m)	5.0m & 4.0m	24.0m	2 travel/ 2 parking lane	2.5m & 1.5m
Type 2 – Collector Road	8.4m (2 x 4.20m)	7.0m (2 x 3.5m)	5.6m & 4.6m	25.6m	2 travel/ 2 parking lane	2.5m & 1.5m

Table 4.1. Estate Road Cross Sections - MRP DCP2021

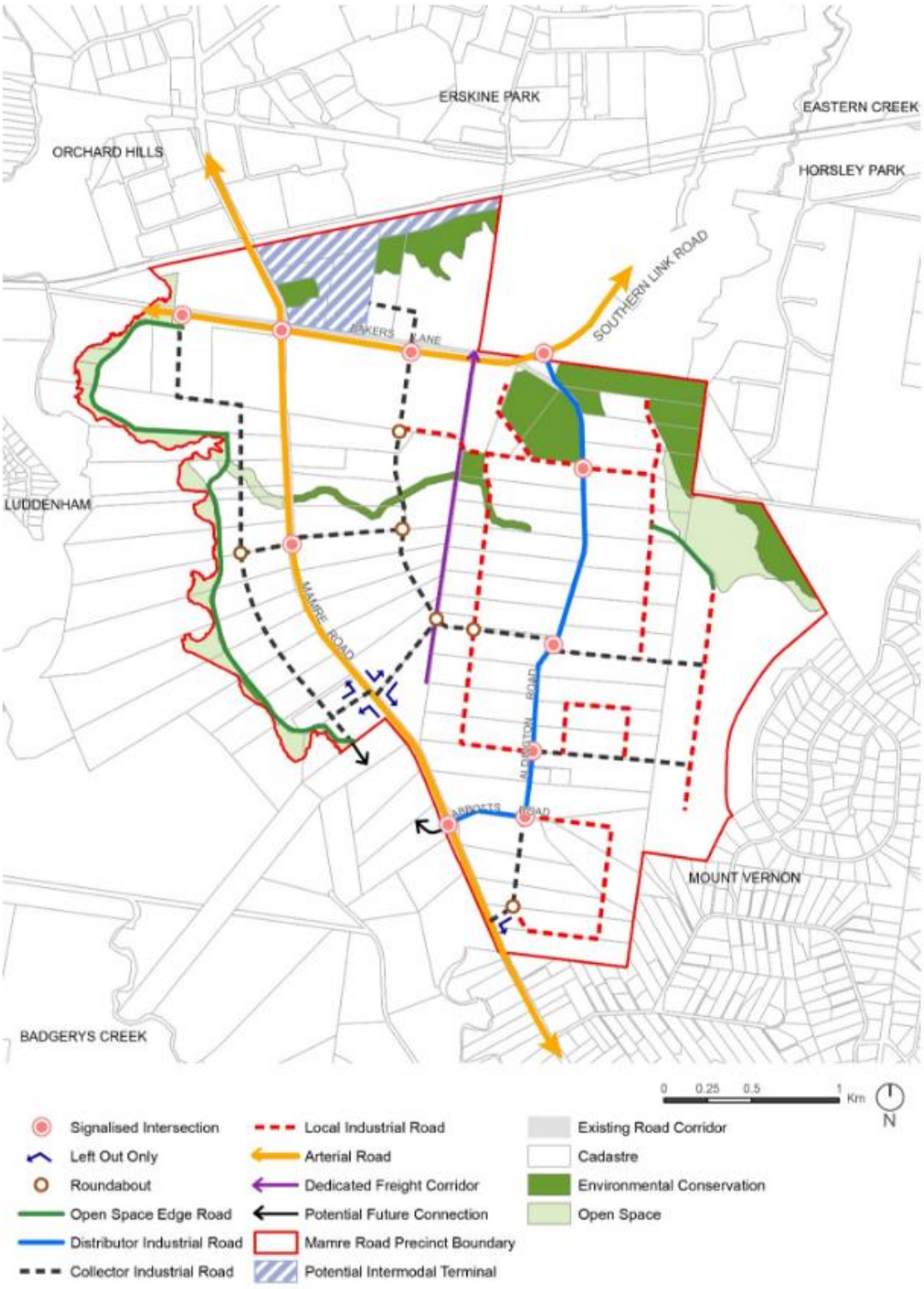


Figure 12. Road network hierarchy in the Mamre Road Precinct.

Figure 4.1. MRP DCP Road Heirarchy (source: MRP DCP 2021 Figure 12)

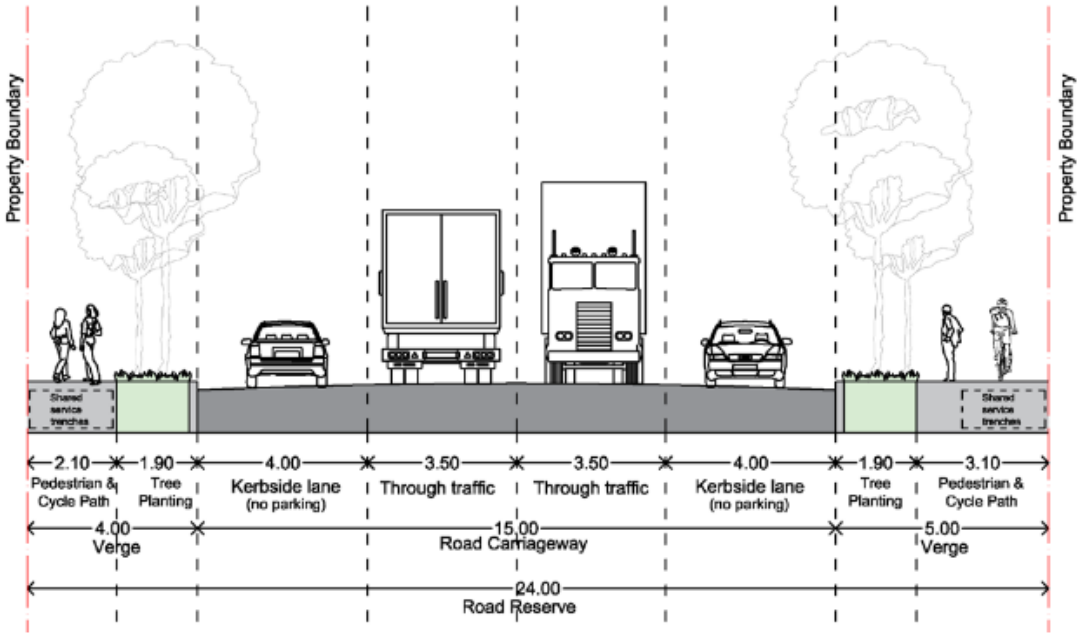


Figure 13. Typical Local Industrial Road (Type 1)

Figure 4.2. MRP DCP Local Road Cross Section

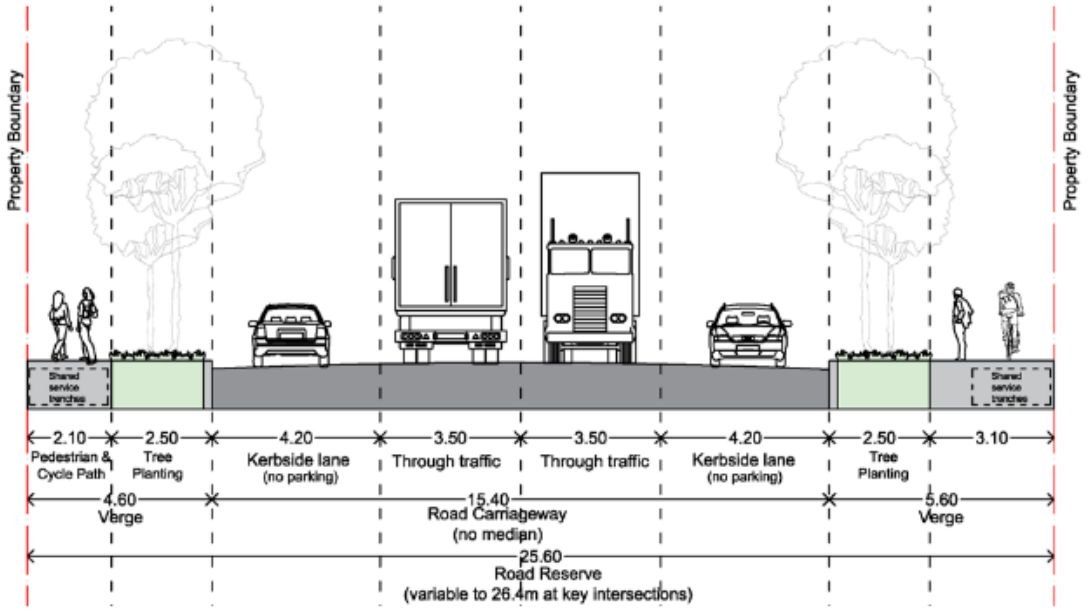


Figure 14. Typical Collector Road (Type 2)

Figure 4.3. MRP DCP Industrial Collector Road Cross Section

4.3 General Requirements

All roads will have concrete kerb and gutter and carriageway surface finished with asphaltic concrete as per the requirements of Penrith City Council.

The design for the proposed pavement for internal roads is to be based on *Austroads Pavement Design – A Guide to the Structural Design of Road Pavements.* Council DCP requires the pavement design to be based on a minimum traffic loading of $1x10^7$ ESA. This loading is typical of an industrial road and would meet the needs of the estate, depending on the final traffic studies being undertaken for the precinct DCP. The final adopted traffic loading will be based on the DCP.

We recommend that further review of the proposed pavement construction specification and design loading allowance be undertaken for the internal roads when this becomes available.

In accordance with the estate master plan and council requirements, a 1.5m pedestrian path will need to be located on one side of the road cross section with a 2.5m shared path on the other as included in **Table 4.1** and **Figure 4.2**.

4.4 Mamre Road Intersection

A temporary intersection may be required which provides access from the Yiribana Estate to Mamre Road. This intersection and access road will be utilised during the period prior to the internal precinct roads, and permanent intersection to the south of the subject land, are constructed by the adjoining landowner/ developer, Mirvac. Based on current anticipated construction timing for Mirvac and their amended RtS approval, the delivery of the temporary access may not need to be undertaken however inclusion is required to safeguard the Yiribana Estate if there is a delay or change to Mirvac's development and provision of the ultimate access arrangement is not available.

Access to all lots in the ultimate condition would be made via either the new North-South Access Road, or via the new East-West Local Industrial Road which feeds from the Access Road. Initial access to the site will be via a left in and out intersection with Mamre Road.

The intersection will need to align with either the proposed Mamre Road upgrade, or the existing road alignment depending on the timing of construction of both site access and Mamre Road upgrades, and will require consultation and agreement on the layout with TfNSW.

Reference to the Traffic Report by Ason Group provides details on performance of the intersections both pre and post development, and general arrangement for the intersections.

Functional layouts of the intersections based on the general arrangement defined in the Traffic Report, for current and ultimate Mamre Road construction conditions, have been prepared by our office as shown below in **Figure 4.4-4.5** and included as drawings in **Appendix A**.

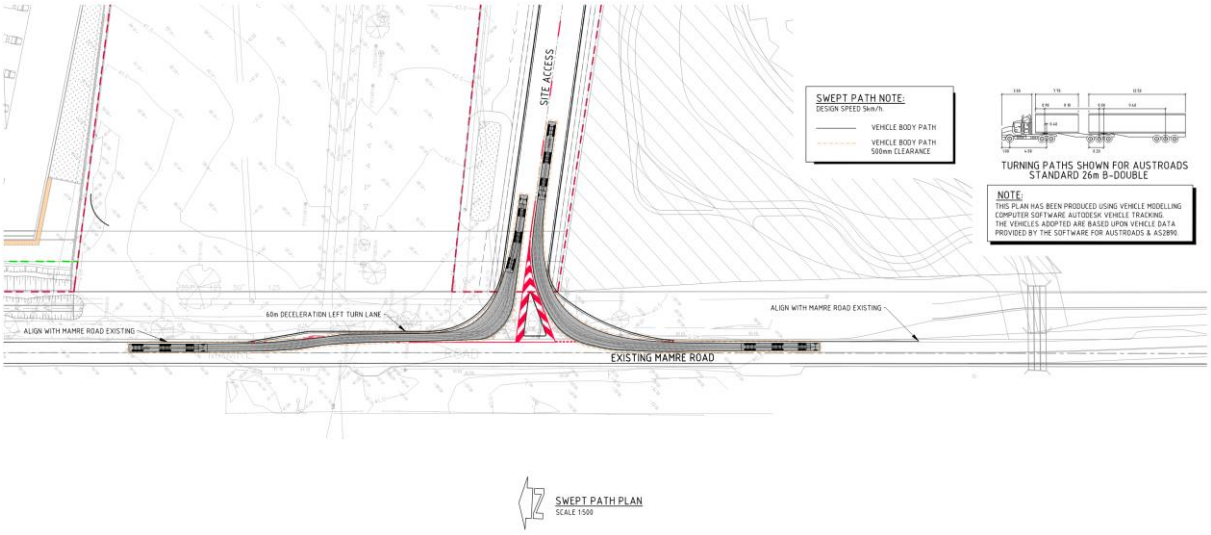


Figure 4.4. Functional Layout (existing Mamre Road conditions)

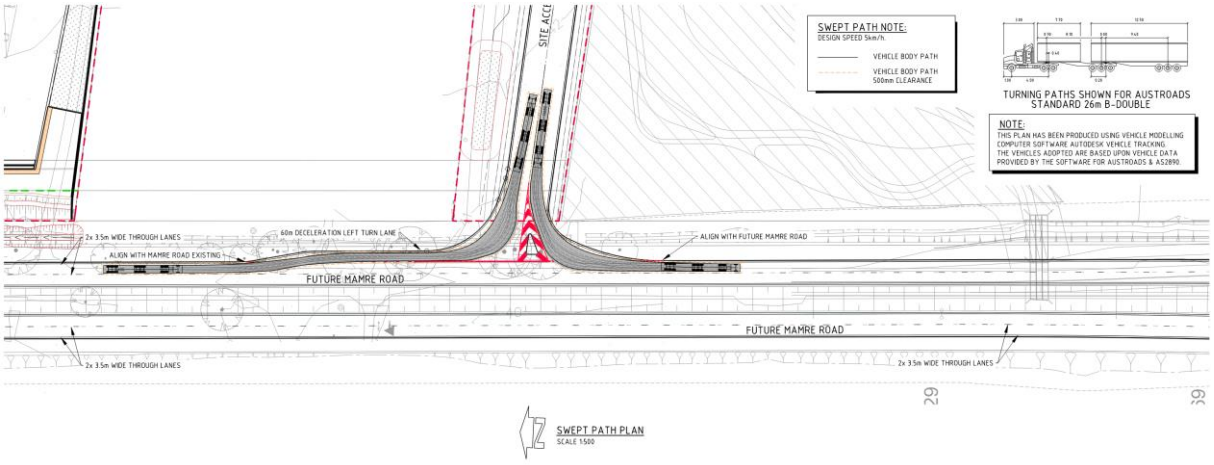


Figure 4.5. Functional Layout (ultimate Mamre Road Conditions)

5 WATER CYCLE MANAGEMENT STRATEGY & DRAINAGE METHODOLOGY

5.1 Key Areas and Objectives

Water Cycle Management (WCM) is a holistic approach that addresses competing demands placed on a region's water resources, whilst optimising the social and economic benefits of development in addition to enhancing and protecting the environmental values of receiving waters.

Developing a WCMS at the SSD stage of the land development process provides guidance on urban water management issues to be addressed for the estate and development as a whole. This assists urban rezoning and estate infrastructure planning for the industrial development proposed on the land.

This WCMS has been prepared to inform DPIE that the development is able to provide and integrate WCM measures into the stormwater management strategy for the estate and for future development sites in the estate. It presents guiding principles for WCM across the precinct which includes establishing water management targets and identifying management measures required for future building developments to meet these targets.

Several WCM measures have been included in the WCMS and engineering design, which are set out in this report and the attached drawings. The key WCM elements and targets which have been adopted in the design are included in **Table 5.1** following.

<table>
<tr><th>Element</th><th>Target</th><th>Reference</th></tr>
<tr><td>Water Quantity</td><td>Maintaining or improving the volume of stormwater and peak flows from this site.
“demonstrate that there will be no increase in runoff from the site as a result of the development for all storms up to and including the 100-year Average Recurrence Interval (ARI) event for all storm durations”.</td><td>Penrith Council - Stormwater Management Policy, Section 3.3.3</td></tr>
<tr><td>Water Quality</td><td>Load-based pollution reduction targets based on an untreated urbanised catchment <u>or</u> total resultant concentration per the Wianamatta MUSIC Modelling Toolkit:
<u>Opt1 or Opt2</u>
Gross Pollutants 90% <u>or</u> <16kg/ha/yr
Total Suspended Solids 90% <u>or</u> <80kg/ha/yr
Total Phosphorus 80% <u>or</u> <0.3kg/ha/yr
Total Nitrogen 65% <u>or</u> <3.5kg/ha/yr
Total Hydrocarbons 90%</td><td>Final MRP DCP2021
MUSIC Modelling Toolkit – Wianamatta-South Creek</td></tr>
<tr><td>Flooding</td><td>Buildings and road set 500mm above 1% AEP.
No affectation to upstream downstream or adjoining properties as a result of development</td><td>Penrith Council DCP Part C3.
NSW Floodplain Development Manual.
Penrith Council DCP Part C3</td></tr>
<tr><td>Water Supply</td><td>Reduce Demand on non-potable water uses.
Provide minimum 80% reduction of non-potable uses.</td><td>Penrith Council DCP Part C3.</td></tr>
<tr><td>Erosion and Sediment Control</td><td>Appropriate erosion and sedimentation control measures must be described in the environmental assessment for all stages of construction to mitigate potential impacts to surrounding properties.</td><td>Landcom Blue Book
Penrith City Council
DPI</td></tr>
<tr><td>Waterway and Stream Health</td><td>
<table>
<tr><th></th><th>Target</th></tr>
<tr><td colspan="2">Option 1: Mean Annual Runoff Volume (MARV) Approach</td></tr>
<tr><td>MARV</td><td>≤ 2 ML/ha/year at the point of discharge to the local waterway</td></tr>
<tr><td>90%ile flow</td><td>1000 to 5000 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>50%ile flow</td><td>5 to 100 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>10%ile flow</td><td>0 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td colspan="2">Option 2: Flow Duration Curve Approach</td></tr>
<tr><td>95%ile flow</td><td>3000 to 15000 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>90%ile flow</td><td>1000 to 5000 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>75%ile flow</td><td>100 to 1000 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>50%ile flow</td><td>5 to 100 L/ha/day at the point of discharge to the local waterway</td></tr>
<tr><td>Cease to flow</td><td>Cease to flow to be between 10% to 30% of the time</td></tr>
</table>
</td><td>Final MRP DCP2021 & MUSIC Modelling Toolkit - Wianamatta</td></tr>
</table>

Table 5.1. WCM Targets

A summary of the how each of the WCM objectives will be achieved are described below. Reference to the relevant sections of the report should be made for further and technical details relating to the WCM measures:

- *Stormwater Quantity Management (Refer **Section 6)***

  The intent of this criterion is to reduce the impact of urban development on existing drainage system by limiting post-development discharge within the receiving waters to the pre-development peak, and to ensure no affectation of upstream, downstream or adjacent properties.

  Attenuation of stormwater runoff from the development is proposed to be managed via three estate level basins. The intention is for no water quantity measures (other than rainwater reuse) to be provided on individual development lots. This will mean that future building developments can be assessed, approved and constructed without the need for site specific detention, based on the provision of the estate level detention basins. There are two proposed basins, the first of which is located at the downstream/ western end of the property adjacent to Mamre Road, and the second is at the downstream end of the riparian corridor waterway toward the east of the property (refer **Section 5.6** and **6.4** for discussion of attenuation).

  Sizing of the detention systems has been completed using DRAINS modelling software in accordance with the Penrith City Council Policy for the 50% AEP to the 1% AEP storm for various durations. The modelling accounts for the drainage system provided for the adjacent sites and conveyance of upstream catchments around the site.

  Refer to **Section 6** of the document for detailed sizing of detention systems.

- *Stormwater Quality Management (Refer **Section 7**)*

  There is a need to target pollutants that are present in stormwater runoff to minimise the adverse impact these pollutants could have on downstream receiving waters.

  The required pollutant reductions are included in **Table 5.1** of this document and MUSIC modelling has been completed to confirm compliance with the Wianamatta MUSIC Modelling Toolkit (Apr 2022) reduction objectives/allowable mean annual residual loads for the estate.

  A series of Stormwater quality improvement devises (SQID's) have been incorporated in the design of the estate. The proposed management strategy will include the following measures:

  - Primary treatment of the whole of the development catchment (including roads and development sites) will be made via one of two gross pollutant traps (GPT's). GPT's will be located upstream of each of the stormwater management basins.
  - Tertiary treatment of the whole of the development catchment will be made via one of two estate level bio-retention basins. Bio-retention treatment will be provided within the stormwater management basins and are sized to treat the whole of the estate catchment. Refer to drawings **Co13874.06-SSDA400, SSDA431, SSDA432.**

- Some treatment will also be present by provision of rainwater reuse tanks on development sites through reuse and settlement within the tanks. Allowance for this treatment is noted to not be included in MUSIC modelling produced for the development.
- Development sites will not require any lot specific treatment systems due to the estate wide management systems proposed.

Reference to **Section 7** of this document should be made for detailed Stormwater Quality modelling and measures.

- *Flood Management (refer **Section 8**)*

  The proposed development considered flooding and large rainfall events in relation to runoff from upstream properties primarily on the north-eastern overland flow path where a series of farm dams are currently present.

  Consideration to flood requirements has been made per Penrith City Council DCP and the proposed recommendations for DCP criteria included in the *DRAFT Exhibition South Creek Floodplain Management Study, and the requirements of Section 2.5 of the Final MRP DCP*. It is noted that this site is clear of the South Creek Floodplain however, forms part of a contributing catchment of South Creek. Refer **Section 8** for details.

  The following measures have been incorporated in the design:

  - All buildings are sited 500mm above the 1% AEP design flood level of South Creek.
  - Requirements of Penrith City Council DCP Part C3 have been met regarding works in and around flooding areas;
  - Stormwater detention measures have been included to manage pre and post development runoff as discussed above and in **Section 6**; and
  - Overland flow paths to manage runoff in large storm events have been made including achieving at least 500mm freeboard to building levels from the flow paths.
- *Water Demand Reduction/ Rainwater Reuse*

  Rainwater reuse measures will be provided as part of future building development designs. Rainwater reuse will be required to reduce demand on non-potable uses by at 80%. The reduction in demand will target non-potable uses such as toilet flushing and irrigation. **Refer Section 7.6**.

- *Waterway Health (Refer **Section 7.5**)*

  A MUSIC assessment for discharge from the development has been completed based the stormwater flow targets set out in Table 6 of the MRP DCP. The assessment has utilised the MUSIC modelling Toolkit provided by NSW EES to confirm the flow duration and mean annual runoff volumes objectives have been met.

  The assessment is explored further in **Section 7.5**. The assessment confirms the objectives have been achieved for the current level of proposed development (i.e. Buildings 1 and 3 and associated roadways) as agreed with DPIE.

We note that, given the recent announcement of Sydney Water as the waterway manager, it is anticipated that some documented measures (including additional storage and rainwater tanks) would be temporary only, and subject to either removal if constructed or future SSDA Modifications following Sydney Waters development scheme plans being exhibited and estate management measures and objectives being adjusted to suit the intended regional scheme.

5.2 Existing Drainage System & Overland Flows

The site is currently undeveloped rural land with undulating topography which has been described in **Section 2.2**. There is no formal drainage currently on the site however several local depressions, natural gullies and farm dams are present. There are also several dams which are used for the currently rural farming operations on the land which lie in relation to the natural gullies.

The site is affected by overland flow from minor upstream catchments to the east of the site. A catchment of approximately 24 Ha is conveyed through the site via existing farm dams to Mamre Road.

A smaller catchment currently drains through the site from the north.

Existing twin 1200x600 RCBC's are located at the low point on Mamre Road and drain runoff from the property west toward South Creek through existing gully within rural properties on the western side of Mamre Road. This has been shown on drawing **Co13874.06-SSDA401 and Figure 5.1** below. Conveyance of these flows has been included in the estate infrastructure stormwater design.

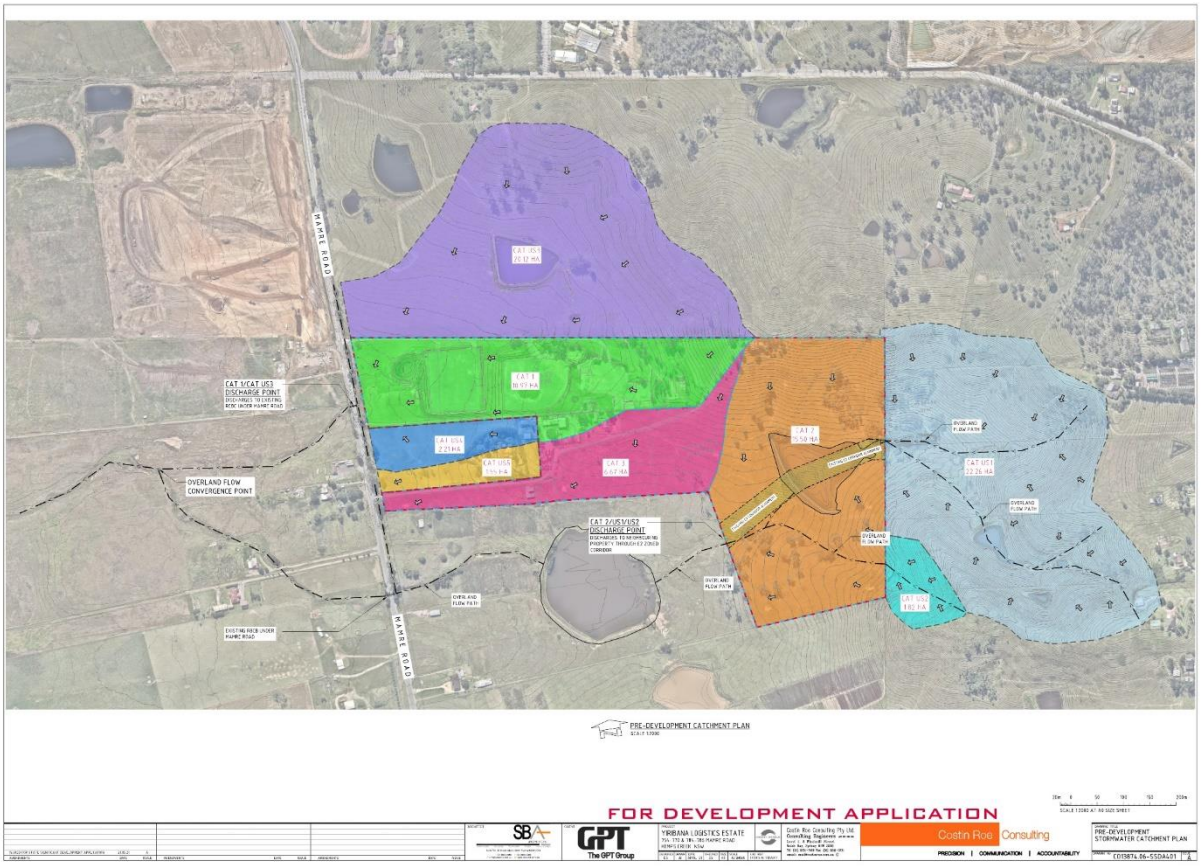


Figure 5.1. Existing Site Catchments and External Contributing Catchment.

5.3 Proposed Estate Drainage System

As per general engineering practice and the guidelines of PCC, the proposed stormwater drainage system for the estate development will comprise a minor and major system to safely and efficiently convey collected stormwater run-off from the development to the legal point of discharge.

The minor system is to consist of a piped drainage system which has been designed to accommodate the 1 in 20-year ARI storm event (Q20). This results in the piped system being able to convey all stormwater runoff up to and including the Q20 event. The major system will be designed to cater for storms up to and including the 1 in 100-year ARI storm event (Q100). The major system will employ the use of defined overland flow paths, such as roads and open channels, to safely convey excess run-off from the site.

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, the standards of PCC and accepted engineering practice. Runoff from buildings will generally be designed in accordance with AS 3500.3 National Plumbing and Drainage Code Part 3 – Stormwater Drainage. Overall site runoff and stormwater management will generally be designed in accordance with the Institution of Engineers, Australia publication "Australian Rainfall and Runoff" (1988 Edition), Volumes 1 and 2 (AR&R).

Water quality and re-use are to be considered in the design to ensure that any increase in the detrimental effects of pollution are mitigated, PCC Water Quality Objectives are met and that the demand on potable water resources is reduced.

The proposed drainage system will be required to convey the overland flow from upstream catchments east of the property through the site.

The legal point of discharge is a point specified by Council where stormwater from a property can be discharged. The legal point of discharge is usually Council's stormwater infrastructure (where available), the street kerb and channel for smaller developments or downstream receiving waters like an existing stream or gully, lake, pond or waterbody.

Legal discharge for the western portions of the site is via the existing culverts on Mamre Road. Legal point of discharge for the eastern portion of the site is via the existing gully and farm dam in the Stage 1 condition and in Stage 2 will be via precinct road drainage. Final coordination of drainage discharge will be required with Mirvac.

The drainage system proposed can be described as follows:

- Road drainage system designed to the 5% AEP (1 in 20yr ARI);
- Stub connections for all development lots connecting to road drainage.
- All road drainage and development site drainage directed to one of the two stormwater management basins;
- Stormwater management basins comprising stormwater detention to limit post development runoff to pre-development runoff and bio-retention system to complete final stormwater polishing.
- Inter-allotment drain to collect runoff from the northern external catchment, drains
- Inter-allotment drain to convey runoff through the north-eastern site portion, noting that the Stage 1 design allows for runoff to be conveyed through the site within an open channel.

It is noted that the design of stormwater management systems proposes integration of bio-retention elements within the stormwater detention basins. The bio-retention elements are noted to be sited such that a maximum depth of inundation of 1.2m occurs during infrequent major storms, and generally less than 0.6m during the majority of storm events.

The main detention storage areas are noted to be sited at a level approximately 1m below the bio-retention elements. This will ensure effective discharge of bio-retention filtration, however, also assists in ensuring maximum storage capacity can be realized within the basin area. Further, this enables depth of water over the bio-retention elements to be limited to less than 0.6m generally as noted above and below.

Based on the design, the water level over the bio-retention elements of the basin would have maximum ponding of 0.4m (being the extended detention depth) for >90% of all runoff events (i.e. events between the 6 month and 1yr ARI). The detention storage would be at 1.4m at the same time the ponding of the bio-retention elements are only 0.4m.

A maximum depth of 0.75m would be realised for all events up to the 5% AEP (1 in 20 ARI), and maximum depths between 0.75m to 1.2m only occur very infrequently for storms > 5% AEP to the 1% AEP event. Depths greater than 0.75m would be considered to occur only several times throughout the life of the system.

5.4 Hydrologic Modelling and Analysis

5.4.1 General Design Principles

The design of the stormwater system for this site will be based on relevant national design guidelines, Australian Standard Codes of Practice, Penrith City Council and accepted engineering practice.

Runoff from buildings will generally be designed in accordance with AS 3500.3 National Plumbing and Drainage Code Part 3 – Stormwater Drainage.

Overall site runoff and stormwater management will generally be designed in accordance with the Institution of Engineers, Australia publication "Australian Rainfall and Runoff" (1987 Edition), Volumes 1 and 2 (AR&R).

Storm events for the 2 to 100 Year ARI events have been assessed.

5.4.2 Minor/ Major System Design

The piped stormwater drainage (minor) system has been designed to accommodate the 20-year ARI storm event (Q20). Overland flow paths (major) which will convey all stormwater runoff up to and including the Q100 event have also been provided which will limit major property damage and any risk to the public in the event of a piped system failure.

5.4.3 Rainfall Data

Rainfall intensity Frequency Duration (IFD) data used as a basis for DRAINS modelling for the 2 to 100 Year ARI events, was taken from The Bureau of Meteorology Online IFD Tool.

5.4.4 Runoff Models

In accordance with the recommendations and standards of Penrith City Council, the calculation of the runoff from storms of the design ARI has been calculated with the catchment modelling software DRAINS for internal drainage only. Refer Section 8 for discussion pertaining to overland flow runoff models.

Detailed hydraulic assessment of the internal drainage system will be calculated at detail/ construction certificate stage.

The design parameters for the DRAINS model are to be based on the recommendations as defined by council and parameters for the area and are as follows:

Table 5.1. DRAINS Parameters

Model	Model for Design and analysis run	Rational method	
	Rational Method Procedure	ARR87	
	Soil Type-Normal	3.0	
	Paved (Impervious) Area Depression Storage	1	mm
	Supplementary Area Depression Storage	1	mm

	Grassed (Pervious) Area Depression Storage	5	mm
AMC	Antecedent Moisture Condition (ARI=1-5 years)	2.5	
AMC	Antecedent Moisture Condition (ARI=10-20 years)	3.0	
AMC	Antecedent Moisture Condition (ARI=50-100 years)	3.5	
	Sag Pit Blocking Factor (Minor Systems)	0	
	On Grade Pit Blocking Factor (Minor Systems)	0	
	Sag Pit Blocking Factor (Major Systems)	0.5	
	On Grade Pit Blocking Factor (Major Systems)	0.2	

5.5 Hydraulics

5.5.1 General Requirements

Hydraulic calculations will be carried out utilising DRAINS modelling software during the detail design stage to ensure that all surface and subsurface drainage systems perform to or exceed the required standard.

5.5.2 Freeboard

The calculated water surface level in open junctions of the piped stormwater system will not exceed a freeboard level of 150mm below the finished ground/ grate level, for the peak runoff from the Minor System runoff.

The calculated water surface for the peak runoff from the Major System runoff will not exceed a freeboard level of 300mm below the finished floor level of the building/ development pads.

5.5.3 Public Safety

For all areas subject to pedestrian traffic, the product (dV) of the depth of flow d (in metres) and the velocity of flow V (in metres per second) will be limited to 0.4, for all storms up to the 100-year ARI.

For other areas, the dV product will be limited to 0.6 for stability of vehicular traffic (whether parked or in motion) for all storms up to the 100-year ARI.

5.5.4 Inlet Pit Spacing

The spacing of inlets throughout the site will be such that the depth of flow, for the Major System design storm runoff, will not exceed the top of the kerb (150mm above gutter invert).

5.5.5 Overland Flow (development lots)

Dedicated flow paths have been designed to convey all storms up to and including the 100-year ARI. These flow paths will convey stormwater from the site to the detention systems prior to discharge.

5.6 External Catchments & Riparian Zone Realignment

With reference to **Figure 5.2** below, an E2 Environmental Conservation Zone is shown to bisect the eastern portion of the site, its alignment being based on an existing gully/ watercourse.

The existing watercourse is recognised by NSW Natural Resources Access Regulator (NRAR) as a first order watercourse, though not considered as waterfront land as defined by the Water Management Act 2000. This was confirmed by NRAR in a meeting held on 3 August 2020 and also in the Cumberland Ecology letter referenced 19200 – Let6 dated 16 July 2020.

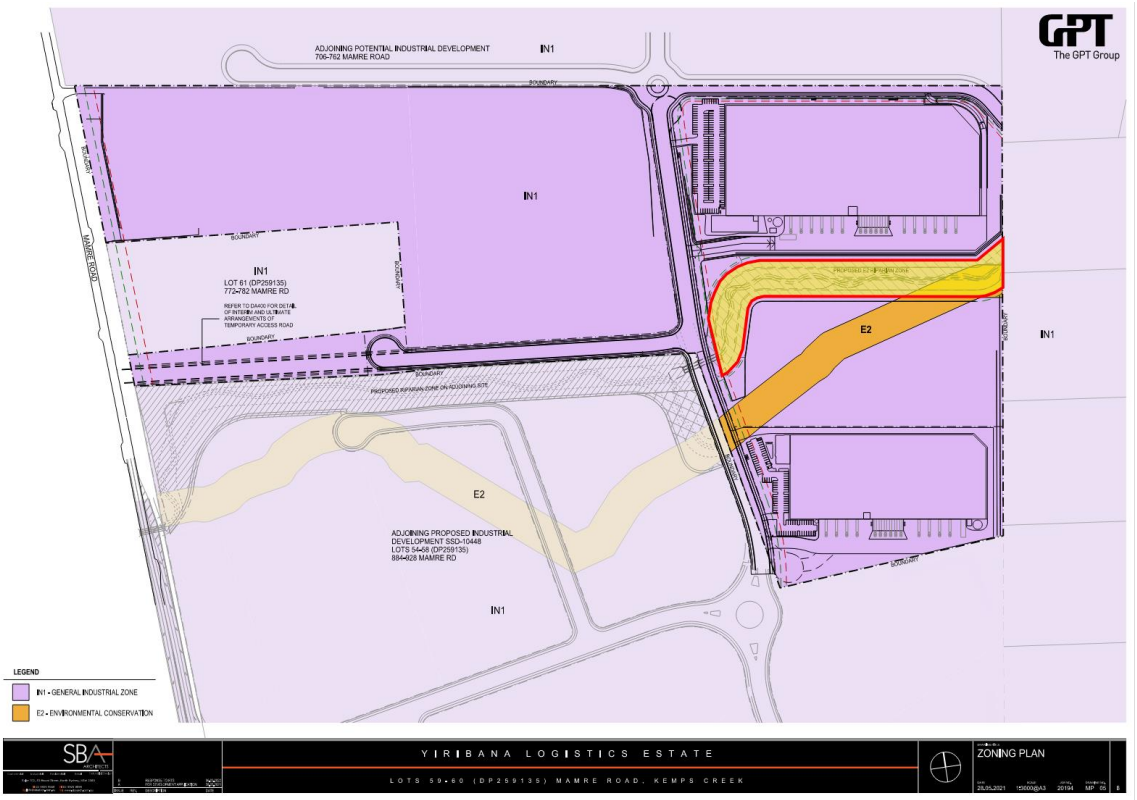


Figure 5.2. Existing E2 Conservation Zone & Proposed Realignment.

The watercourse is noted to have a contributing catchment of 22.2 Ha and subsequent 1% Average Exceedance Probability (AEP) design flow of approximately 4.4m^3/s. During dry weather there would be limited or no baseflow given the relatively small contributing catchment. The existing watercourse is noted to be located within land currently utilised in a rural capacity and is clear of trees, has several farm dams and limited to no ecological value as concluded by Cumberland Ecology.

It is proposed by The GPT Group to realign the E2 Zone currently shown by DPIE and watercourse as part of the proposed development. The E2 zoning will not apply to the re-aligned riparian corridor. With reference to drawing **Co13874.06-SSDA420** in **Appendix A**, flows from the contributing catchment are proposed to be conveyed within

a new engineered, though naturalised, channel. The channel concept and a typical cross section in shown on the drawing. The section is noted to contain a 5m wide channel, with a 3.8m base and natural rock line channel banks. A total width for the corridor of 40m is proposed which includes the Vegetated Riparian Zone (VRZ) and base channel. The 40m corridor and VRZ will comprise battered vegetated slope. An overall 40m zone for the Riparian Ccorridor and watercourse realignment is proposed, noting an additional 5m landscape buffer is also included bring the total width to 50m. The riparian corridor is also locally widened around the proposed water quality treatment basins. The total area of the riparian zone is consistent with a second-order stream (comprising a 5m drainage channel plus 20m VRZs either side of the channel) in accordance with the NRAR *Guidelines for Controlled Activities on Waterfront Land*.

In relation to conveyance capacity and stormwater management, as noted above, the calculated peak flow in the 1% AEP storm event is $4.4m^3/s$. This peak flow is noted to be able to be conveyed within the proposed cross section at a depth of approximately 0.7m. The advanced concept designs will ensure that the channel is maintained with a naturalised feel, per the recommendations of NRAR. Refer to detailed flood modelling included in **Section 8** and **Appendix E** of this report for confirmation of pre and post development flooding, hydrology and hydraulics of the watercourse.

A 90-degree change in direction, with a prolonged curved radius, is proposed through the lower portion of the channel and at the entry to the culvert. The curved radius is noted to be approximately 35m in length, and the corresponding radius at the entry to the culvert is 25m – refer **Figure 5.3**. The final design is anticipated to include a meandering low flow channel, stilling ponds, drop sills, scour protection measures as required to ensure improved ecological conditions in the system.

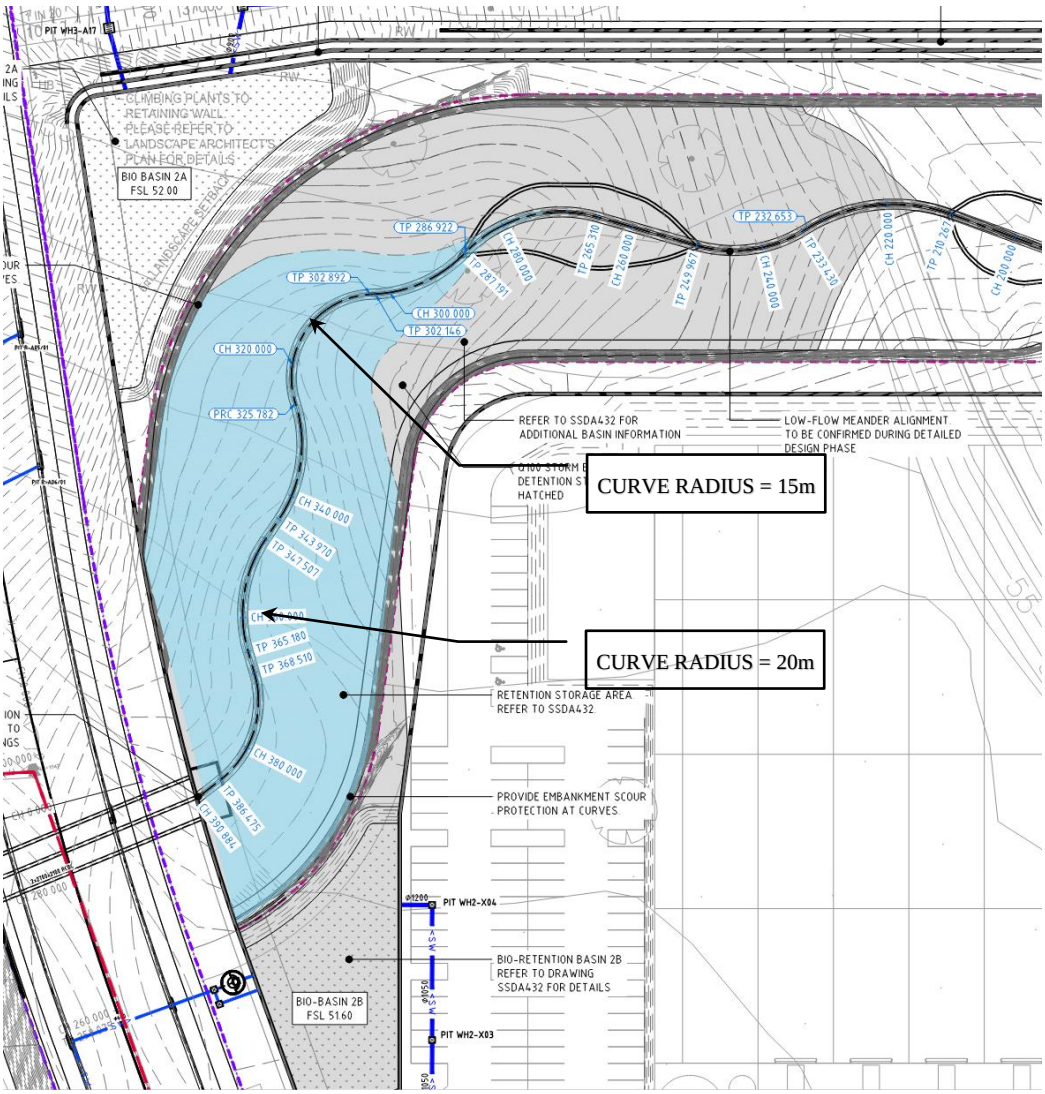


Figure 5.3. Proposed Channel Curves and Radius.

Review of recommended practice for naturalised creeks has been made using accepted industry methods for naturalised creek design, included in documents such as the *Queensland Urban Drainage Manual 2013*, and Brisbane City Councils *Natural Channel Design Guidelines 2003*. Within these documents recommended minimum radius of bends are recommended, based on the bank full width of the watercourse. The recommended minimum radius for a constructed bend is 3 times the bank full width.

For this project, noting the bank full width of 5m, the minimum acceptable design radius of curvature as such is 15m. As shown in **Figure 1**, the proposed minimum radius is 15m, and where the larger change in direction is proposed (20m radius) the radius is noted to be 1.3 times greater than the minimum recommended curve radius.

The proposed geometry allows for generous curvature at changes in direction that are considered acceptable based on the noted literature, accepted industry and naturalised channel design practices. As noted in this report, additional design elements would be included as the design progresses.

Consideration to a meandering low flow conveyance area will be integrated into the channel, and where changes in direction occur (including adjacent to the proposed road) consideration to additional scour protection via natural rock rip-rap and other suitable scour protection means will be made. Consideration to bio-diversity corridor (refer Cumberland Ecology letter) can be achieved in the 10m zone either side of the flow conveyance channel. Design progression of the naturalised channel would also include integration of naturalised watercourse elements such as a low flow channel, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice for a naturalised channel design. The realignment of the watercourse would be reflective of similar realignments in nearby industrial precincts including Upper Angus Creek (Eastern Creek Business Hub Stage 4) and Eskdale Creek, Eastern Creek Drive.

Temporary storage of stormwater is proposed upstream of the culverts which cross the north south road, in accordance with the Final MRP DCP Control 18 (refer below), to promote reduction in overall runoff volumes and to reduce post-development flows to predevelopment flow.

Reference to the *Final MRP DCP Section 2.4* should be made in relation to temporary storage areas within naturalised trunk drainage paths. Control 18 reads as such:

> *18) Raingardens and other temporary water storage facilities may be installed online in naturalised trunk drainage paths to promote runoff volume reductions.*

The capacity of the culvert allows for conveyance of flows to the 1% AEP (1 in 100year ARI). It is noted that the culverts are used to restrict flows from post development to predevelopment as recommended in the *Mamre Road Precinct Water Cycle Management Plan* by DPIE and Sydney Water, and the Final MRP DCP. We note that, due to the surrounding topography, road levels and development pad levels, the geometry of the area proposed for temporary stormwater storage would be consistent if designed as an unobstructed floodway (as requested by Council) or utilised for flow reductions as proposed.

The use of the area for stormwater management maximises the efficiency of the land and is consistent with the Final MRP DCP.

We note the proposed arrangement comprises bio-retention systems located outside of the riparian zone and formal corridor.

Refer to detailed flood modelling included in **Section 8** and **Appendix E** of this report for confirmation of pre and post development flooding, hydrology and hydraulics of the watercourse.

6 WATER QUANTITY MANAGEMENT

6.1 Water Quantity Management Objectives

Penrith City Council adopts the principles of water quantity management, also known as "On-site Detention (OSD)", to ensure the cumulative effect of development does not have a detrimental effect on the existing stormwater infrastructure and watercourses located within their LGA downstream from the particular site.

Section 3.3.3 of Councils draft stormwater management policy requires that "*it will be necessary to demonstrate that there will be no increase in runoff from the site as a result of the development for all storms up to and including the 100-year Average Recurrence Interval (ARI) event for all storm durations*".

6.2 Methodology

A hydrological analysis was undertaken to estimate the impact of the development of the site on peak flows at the downstream extent of the site. Modelling of stormwater runoff quantity was considered for the pre-existing case and for the operational phase of the development.

As the site is greater than 5000m^2, the simplified PSD/SSR method contained in *Section 3.3* of the Penrith Council document *Stormwater Drainage for Building Developments* has not been used in calculating the storage and discharge relationship for the site. Council's preferred modelling software, DRAINS has been used to assess the site detention discharge and storage relationship.

In order to assess the existing and operational phase peak discharges from the development site, a DRAINS hydrological model was used to estimate peak flows from catchments on the site for various storm durations for Q2 year ARI to Q100 year ARI events.

6.3 Existing & Post Development Peak Flows

Table 6.1 to Table 6.3 show the existing and developed flows at the downstream boundary for the three existing catchments on the property.

Table 6.1. Q2, Q20 & Q100 ARI Peak Flows from Catchment 1

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	1.31	3.36	**0.97**
	60	1.56	3.44	**1.14**
	120	1.37	2.98	**1.03**
20	30	4.84	8.28	**2.91**
	60	5.19	7.90	**3.17**
	120	4.59	7.12	**3.08**
100	30	7.61	11.53	**3.97**
	60	7.82	10.84	**5.03**
	120	6.96	9.73	**4.36**

Table 6.2. Q2, Q20 & Q100 ARI Peak Flows from Catchment 2

ARI	Design Storm Duration	Peak Flow (m3/s)		
		Undeveloped	Developed	
		Site	Site (no atten.)	**Site (+ atten.)**
2	30	2.44	3.86	**1.29**
	60	2.52	3.85	**1.47**
	120	2.39	3.34	**1.29**
20	30	7.93	9.19	**6.22**
	60	6.83	8.46	**6.32**
	120	7.11	7.87	**5.68**
100	30	10.70	12.79	**9.96**
	60	9.76	12.00	**9.76**
	120	10.10	10.85	**8.80**

The post development (with site attenuation) flows can be seen to be lower than the pre-developed flows. The required detention storage for the development site is discussed in the following section.

6.4 Proposed Water Quantity Management

As previously discussed, detention storage on the development site is required to reduce local outflows. The proposed site layout allows for provision of a combined OSD/Bio-Retention basin. The ultimate discharge location will be to the existing table drains along the Mamre Road frontage and upstream of the culverts which cross Road 1.

A number of combinations of storages and outlet arrangements have been modelled. The adopted arrangement models the two basin configurations (at Discharge Locations 1 and 2) are shown in **Table 5.3** and the proposed layout can also be observed on drawing **Co13874.06-SSDA431 & SSDA432**.

Table 5.3 OSD Detention Characteristics (Post Developed)

ARI	Duration (mins)	Peak Flow (m^3/s)					Depth (mm)	Storage (m^3)
		Discharge Location	No Atten.	With attenuation				
				Low	High	Total		
2	120	1	3.439	0.563	0	0.563	1560	1,975
		2	3.852	1.45	0	1.450	1610	2,025
20	60	1	7.901	.579	1.62	2.16	1960	3,090
		2	8.460	1.28	4.95	6.23	2000	3,950
100	60	1	8.37	0.543	3.10	3.64	2080	3,420
	30	2	10.70	1.308	8.309	9.62	2210	4,890

The hydrologic analysis shows that, with the provision of the on-site detention systems detailed above, the post development peak flows from the site will be attenuated to less than pre-development; hence the requirements of PCC and MRP DCP have been met.

As discussed in Section 5.6, temporary storage of stormwater is proposed upstream of the culverts which cross the north south road, in accordance with the Final MRP DCP Control 18 (refer below), to promote reduction in overall runoff volumes and to reduce post-development flows to predevelopment flow.

Reference to the *Final MRP DCP Section 2.4* should be made in relation to temporary storage areas within naturalised trunk drainage paths. Control 18 reads as such:

18) Raingardens and other temporary water storage facilities may be installed online in naturalised trunk drainage paths to promote runoff volume reductions.

The capacity of the culvert allows for conveyance of flows to the 1% AEP (1 in 100year ARI). It is noted that the culverts are used to restrict flows from post development to predevelopment as recommended in the *Mamre Road Precinct Water Cycle Management Plan* by DPIE and Sydney Water, and the Final MRP DCP. We note that, due to the surrounding topography, road levels and development pad levels, the geometry of the area proposed for temporary stormwater storage would be consistent if designed as an unobstructed floodway (as requested by Council) or utilised for flow reductions as proposed.

The use of the area for stormwater management maximises the efficiency of the land and is consistent with the Final MRP DCP.

We note the proposed arrangement comprises bio-retention systems located outside of the riparian zone and formal corridor.

7 STORMWATER QUALITY, REUSE AND MAINTENANCE

7.1 Stormwater Quality Objectives and Assessments

There is a need to provide a design which incorporates the principles of Water Sensitive Urban Design (WSUD) and to target pollutants that are present in the stormwater so as to minimise the adverse impact these pollutants could have on receiving waters and to also meet the requirements specified by PCC and the MRP DCP.

The requirements for stormwater quality to be performed on a catchment wide basis. The reduction objectives noted in **Section 5.1** and **Table 5.1** of this report are presented in terms of annual percentage pollutant reductions on a developed catchment based on the controls included in the *Final MRP DCP 2021*.

Assessment of compliance of the water quality objectives has been made using MUSIC as set out in the following sub-sections of the report.

7.2 Proposed Stormwater Treatment System

Developed impervious areas including roof, hardstand, car parking, roads and other extensive impervious areas are required to be treated by the Stormwater Treatment Measures (STM's). The STM's shall be sized according to the whole catchment area of the development. The STM's for the development shall be based on a treatment train approach to ensure that all the objectives above are met.

Components of the treatment train for the development are as follows:

- Primary treatment to development lots and proposed roads are via a vortech type GPT (Rocla CDS, OceanSave or similar approved) or pit inserts within development sites. Pre-treatment of the stormwater will assist in mitigating the potential for early onset sedimentation of the bio-retention systems;
- Tertiary treatment to the catchment will be provided by bio-retention system within each of the two proposed estate detention systems. As noted, the effective performance of bio-retention systems combined with on-site detention systems is described in detail in **Section 5.3** of this report.

7.3 Stormwater Quality Modelling

The MUSIC model was chosen to model water quality. By simulating the performance of stormwater management systems, MUSIC can be used to predict if the proposed systems and changes to land use are appropriate for their catchments and capable of meeting specified water quality objectives (CRC 2002). The water quality constituents modelled in MUSIC, of relevance to this report, include Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

The pollutant retention criteria set out in Section 2.4 of the Mamre Road Precinct DCP and Wianamatta MUSIC Modelling Toolkit nominated in **Section 5.1** of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The parameters used in the MUSIC model are presented in **Appendix B**. **Figure 7.1** below shows the MUSIC model layout.

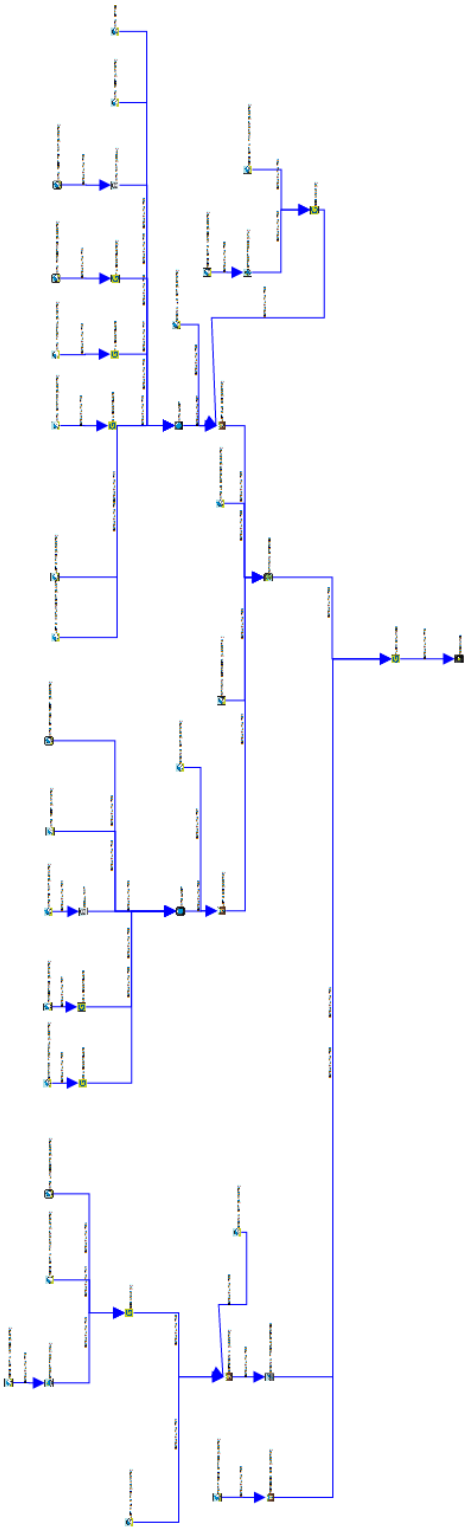


Figure 7.1. MUSIC model layout

Tables 7.1 & 7.2 shows the results of the MUSIC analysis and compares to the treatment targets described the Wianamatta MUSIC Modelling Toolkit. The toolkit provides two options for operational phase water quality targets – these are presented in *Table 2* & *Table 3* of the Toolkit. The toolkit requires one of the two options provided be met to demonstrate compliance. **Option 1** expresses targets as a percentage reduction, whereas **Option 2** expresses targets as a residual concentration. The tables compare the post-development pollutant loads without treatment versus post-development loads with treatment.

Table 7.1. MUSIC analysis results – Allowable Load Reduction

	Total Source Load (kg/yr)	**Total Residual Load** (kg/yr)	**Reduction Achieved** (%)
Total Suspended Solids (kg/yr)	16090	1031	93.48
Total Phosphorus (kg/yr)	30.52	6.577	78.11
Total Nitrogen (kg/yr)	196.3	65.14	65.14
Gross Pollutants (kg/yr)	2494	0	100

Table 7.2. MUSIC analysis results – Allowable Loads

	Total Source Load (kg yr)	**Total Residual Load** (kg/yr)	**Per Hectare Residual Load** (kg/ha/yr)	**Total Target Load** (kg/yr)	**Per Hectare Residual Load** (kg/ha/yr)
Total Suspended Solids (kg/yr)	16090	1031	31.1	2,651	<80
Total Phosphorus (kg/yr)	30.52	6.577	0.20	9.94	<0.3
Total Nitrogen (kg/yr)	196.3	65.14	1.97	116	<3.5
Gross Pollutants (kg/yr)	2494	0	0	16	<16

The MUSIC modelling has shown that the proposed treatment train of STM will provide stormwater treatment which will meet the allowable load target objective requirements described in *Table 3* of the *Music Modelling Toolkit (Operational Phase Stormwater Quality Targets – Option 2)* in an effective and economical manner. The modelling also demonstrates that the treatment train also meets all percentage-based treatment reduction targets, except for the reduction in Total Phosphorus (78.11% achieved, 80% target). The minor shortfall in the percentage-based TP reduction is attributed to the large area of landscaping present on the site (e.g. in the realigned riparian corridor), noting the residual load (per *Option 2*) is well below the required threshold. The water quality system and achieved outcomes are shown to be compliant with the Wianamatta MUSIC Modelling Toolkit, and as such the MRP DCP.

Given the expected low source loadings of hydrocarbons and oil/grease and removal efficiencies of the treatment devices we consider that the requirements of the MRP DCP have been met. Further discussion on hydrocarbons can be found in **Appendix B.**

7.4 Stormwater Harvesting

Stormwater harvesting refers to the collection of stormwater from the developments internal stormwater drainage system for re-use in non-potable applications. Stormwater from the stormwater drainage system can be classified as either rainwater, where the flow is from roof areas only, or stormwater where the flow is from all areas of the development.

Rainwater harvesting is proposed for the estate development, with water being stored within the estate basins for irrigation of landscaped areas. Future individual development lots will require re-use for non-potable applications. Internal uses include such applications as toilet flushing while external applications will be used for irrigation. The aim is to reduce the water demand for the development and to satisfy the requirements of PCC DCP2014. Objectives have been set out in **Section 5.1** of this document.

In general terms the rainwater harvesting system will be an in-line tank for the collection and storage of rainwater. At times when the rainwater storage tank is full rainwater can pass through the tank and continue to be discharged via gravity into the stormwater drainage system. Rainwater from the storage tank will be pumped for distribution throughout the development in a dedicated non-potable water reticulation system.

Rainwater tanks for future development lots and application will need to have harvesting systems sized with reference to the NSW Department of Environment and Conservation document *Managing Urban Stormwater: Harvesting and Reuse*, using either a simple water balance analysis to balance the supply and demand, based on the base water demands and the requirement of PCC DCP2014 Part C3, or via MUSIC.

The objectives, as included in **Section 5.1**, are to provide a reduction in non-potable water demand with a minimum demand reduction of 80% based on a rainwater balance assessment.

7.5 Stream Health/ Stormwater Discharge Assessment

7.5.1 Stream Health Introduction

Stream health has been assessed for this development based on the requirements set in *Section 2.4* of the Final MRP DCP. The assessment is based on the current development extent (Lot 2 building and surrounding estate roadways). The future precinct-wide system (wetland or similar), which is anticipated to be implemented by Sydney Water (the soon to be announced waterway manager for South Creek) has not currently been considered in the assessment.

A FDC/ MARV alternate proposed by EES in their MUSIC modelling Toolkit dated 20 April 2022 has been assessed in MUSIC.

It is also noted that the MARV for the precinct would be met for approximately five years when considering the anticipated development rate of 50 Ha/ Annum, which would allow for further development within the estate without additional measures. This is consistent with submission by the Mamre Landowners Group (LOG) and their submission by AT&L ("*LTR003-03-20-747 Final DCP Comments.docx*" dated 17 August 2021).

The proposed additional stream flow measures are included in **Table 7.2**, and achieved values (per MUSIC modelling), are included and compared with *Section 2.4* and *Table 6* of the *Final MRP DCP*.

We note that, given the recent announcement of Sydney Water as the waterway manager, it is anticipated that some documented measures (including additional storage and rainwater tanks) would be temporary only, and subject to either removal if constructed or future SSDA Modifications following Sydney Waters development scheme plans being exhibited and estate management measures and objectives being adjusted to suit the intended regional scheme.

7.5.2 MARV Assessment – Estate Solution

Assessment of estate discharge against the waterway discharge targets, based on *Alternate 2* (Flow Discharge Curve (FCC) in combination with Mean Annual Runoff Volume (MARV) – refer **Table 5.1**) target included in the *EES MUSIC Toolkit (April 2022)* can be met for the current proposed approval.

The model is based on the proposed application for approval of the estate and construction of Building 1 & Building 3 development. That is, based on construction of Buildings 1 & 3, the roadways and earthworks over the remainder of the estate. The estate basins are proposed to contain a long-term water storage volume which will store water for estate-level irrigation & trickle discharge. The discharge rate for the basins are noted on the drawings in **Appendix A**, while the irrigation/re-use demand is detailed below.

The external base water demand has been based on an allowance of 0.4kL/year/m^2 as PET-Rain for subsurface irrigation. The above regime for the landscaped & undeveloped area for the site gives the following yearly outdoor water demand:

Basin 1 Irrigated Area (0.4kL/year/m^2)	8,000m^2	3,200 kL/year
Basin 1 Dust Suppression Area (0.1kL/year/m^2)	131,450m^2	12,500 kL/year
Basin 2 Irrigated Area (0.4kL/year/m^2)	16,500m^2	6,600 kL/year

7.5.3 Re-use Tank Sizing

The use of rainwater reduces the mains water demand and the amount of stormwater runoff. By collecting the rainwater run-off from the site, storage basins provide a valuable water source suitable for landscape irrigation, and dust suppression of undeveloped pads.

Storage basins have been designed, using MUSIC software to balance the supply and demand, based on the calculated base water demands and proposed roof catchment areas. Allowances in the MUSIC model have been made for high flow bypass which will discharge surplus water into the stormwater drainage network. The final configuration, including the arrangement of downpipes shall be sized and confirmed by the hydraulic engineering consultant during the detailed design of individual warehouses.

Basin	Contributing Catchment (m^2)	Storage Volume in MUSIC (kL)
1	161,150	1,250
2	169,220	1,000

Table 7.3. Rainwater Reuse Requirements

We note that the final configuration and sizing of the rainwater tanks is subject to detail design considerations and optimum site utilisation.

Figure 7.5 shows the Flow Duration Curve for the estate MARV, while **Table 7.4** provides confirmation of target requirements and those achieved**.** The modelling suggests The distribution of flows in the lower frequency events reduces significantly as frequency increases. With reference to **Appendix F1**, the modelling indicates that the flow metric targets are met.

Targets Alternative 2			
Indice	Result	Comply	Target
MARV (ML/ha/yr)	1.56	Yes	≤ 2
90%ile	1885	Yes	1000 to 5000 L/ha/day
50%ile	72	Yes	5 to 100 L/ha/day
10%ile	0	Yes	0 L/ha/day

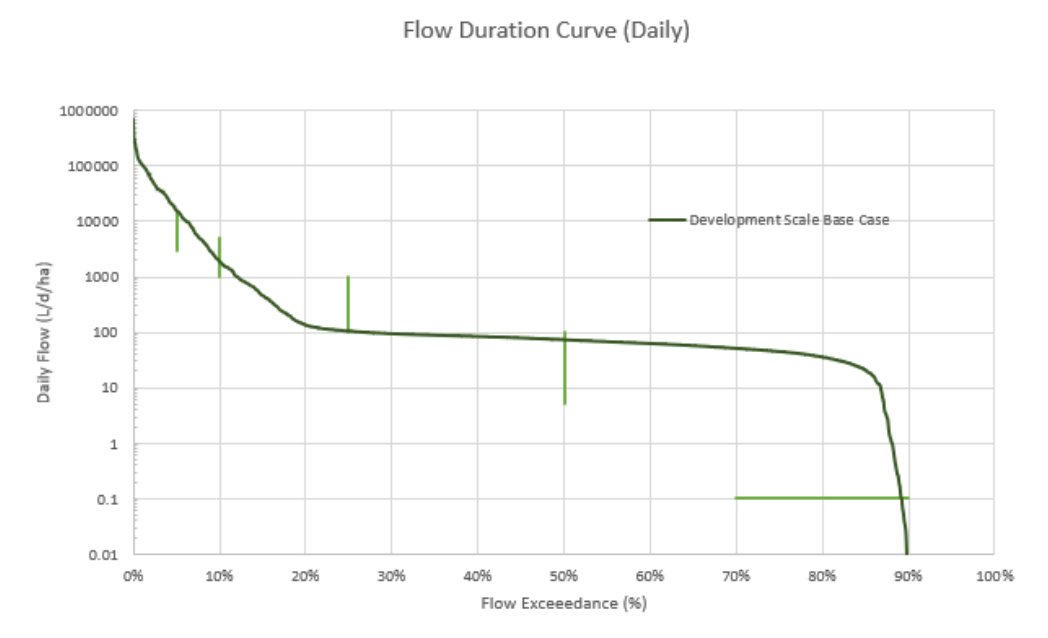


Figure 7.5. MUSIC Model Flow Duration Curve

Table 7.4. Confirmation of Estate MARV

Objective	Required Parameter	Achieved Parameter
Mean Annual Runoff Volume (MARV)	<=2.0 ML/ha/year	1.56 ML/ha/year
90%ile flow	1000 to 5000 L/ha/day	1885 L/ha/day
50%ile flow	5 to 100 L/ha/day	72 L/ha/day
10%ile flow	0 L/ha/day	0 L/ha/day

As demonstrated in **Table 7.3**, the requirements of EES have been met.

7.6 Maintenance and Monitoring

It is important that each component of the stormwater system and water quality treatment train is properly operated and maintained. In order to achieve the design treatment objectives, an indicative maintenance schedule has been prepared and included as **Appendix D** to assist in the effective operation and maintenance of the various water quality components.

Inspection frequency may vary depending on site specific attributes and rainfall patterns in the area. In addition to the below nominated frequency it is recommended that inspections are made following large storm events.

8 FLOODING AND OVERLAND FLOW

8.1 Introduction

The site has been identified by Penrith City Council as being affected by overland flow from the existing gully and series of farm dams on the north-east of the property

We note that the site is clear of the South Creek Floodplain however the site contributes to one of the sub-catchments of South Creek and ultimately runoff from the property drains to South Creek.

An overland flow and flood assessment has been completed for the development approval submission in relation to the north-eastern flow path. The following sections of the report describe the catchment description, flood description and proposed flood management.

Detailed technical information pertaining to the TUFLOW modelling and output completed by our office is included in **Appendix E**.

8.2 Catchment Description & Existing Flood Behaviour

The contributing upstream catchment to the east is approximately 22Ha and is shown below in **Figure 8.1** and also as **Figure E2.1**. A smaller catchment of approximately 18.6Ha enters the site from the north.

The catchment comprises rural land use and >90% pervious surfaces. Future development is noted to require detention and as such has been modelled as per existing impervious surface breakdown.

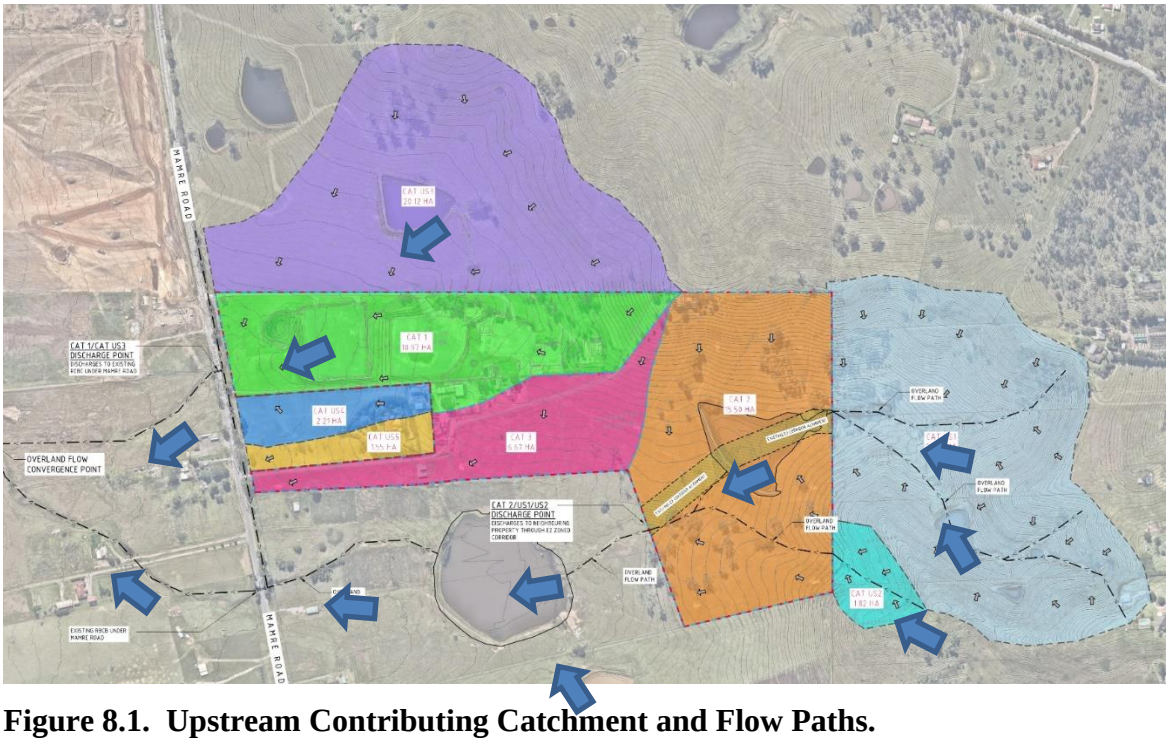


Figure 8.1. Upstream Contributing Catchment and Flow Paths.

Penrith Council is noted to have undertaken a regional assessment of local tributaries Penrith Overland Flow "*Overview Study – Flood Analysis for Central Urban (Zone 1),*

Northern Rural (Zone 2), Southern Rural (Zone 3)" – Cardno 2006. The site is located within the Southern Rural (Zone 3) and an excerpt of the flood model output is shown in **Figure 8.2 and also Figure E1.1 of Appendix E**. Councils' assessment shows overland flow is present along the series of farm dams in the north-eastern corner of the property. The modelling shows the flood extent to be limited to the gully and dams only, and not extending to areas away from the local watercourse. The area shown on the southern portion of the site as being flood affected in the PMF event is noted to comprise a farm dam only which is fully within the proposed development extent and as such has not been included in the current overland flow assessment.

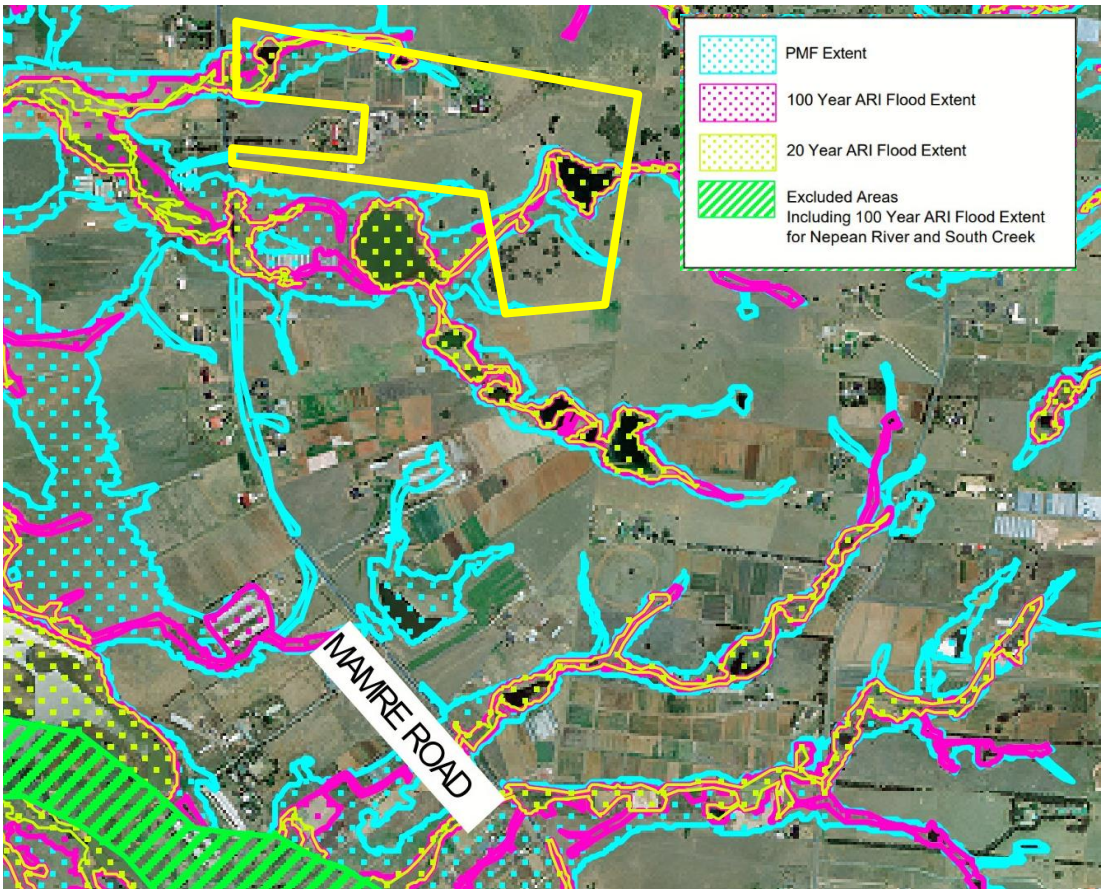


Figure 8.2. Excerpt of Figure 6.1k of Cardno 2006 Study

8.3 Proposed Overland Flow Management Strategy

Council requires an assessment of the pre and post development overland flow conditions for the 1% AEP storm event. Further that the overland flow from the upstream catchment is able to be conveyed through the site without affection of upstream, downstream or adjacent properties in the 1% AEP.

A TUFLOW model has been prepared for the assessment as set out in the following sections of the report. The proposed management strategy involves conveying overland flow from the eastern contributing through the development site within an open channel in the realigned riparian corridor (as discussed in Section 5) and the northern catchment

to be drained via an inter-allotment pipe (subject to the final agreed drainage with the northern property developer.

The final conveyance arrangement will be subject to the precinct layout and trunk drainage strategy for the precinct.

8.4 Costin Roe Consulting Modelling

8.4.1 Introduction

A detailed site specific TUFLOW model of the pre and post development conditions has been completed by Costin Roe Consulting. The assessment being completed with consideration to BCC policy and the *NSW Floodplain Development Manual*. Technical parameters and detail included in the TUFLOW model are included as **Appendix E.**

The pre-developed model has been prepared utilising the flood levels and hydrographs as completed by our office, with introduction of the proposed stage 1 development proposed by Mirvac in the post development conditions, in addition to the proposed GPT Group development layout. Validation of modelling was completed with comparison to Councils 2006 flood assessment.

8.4.2 Pre-Development 1% AEP

Reference to **Figure 8.4** shows the pre-developed 1% AEP output for depth and levels. **Figure 8.5** shows velocity and **Figure 8.6** show true hazard categorisation.

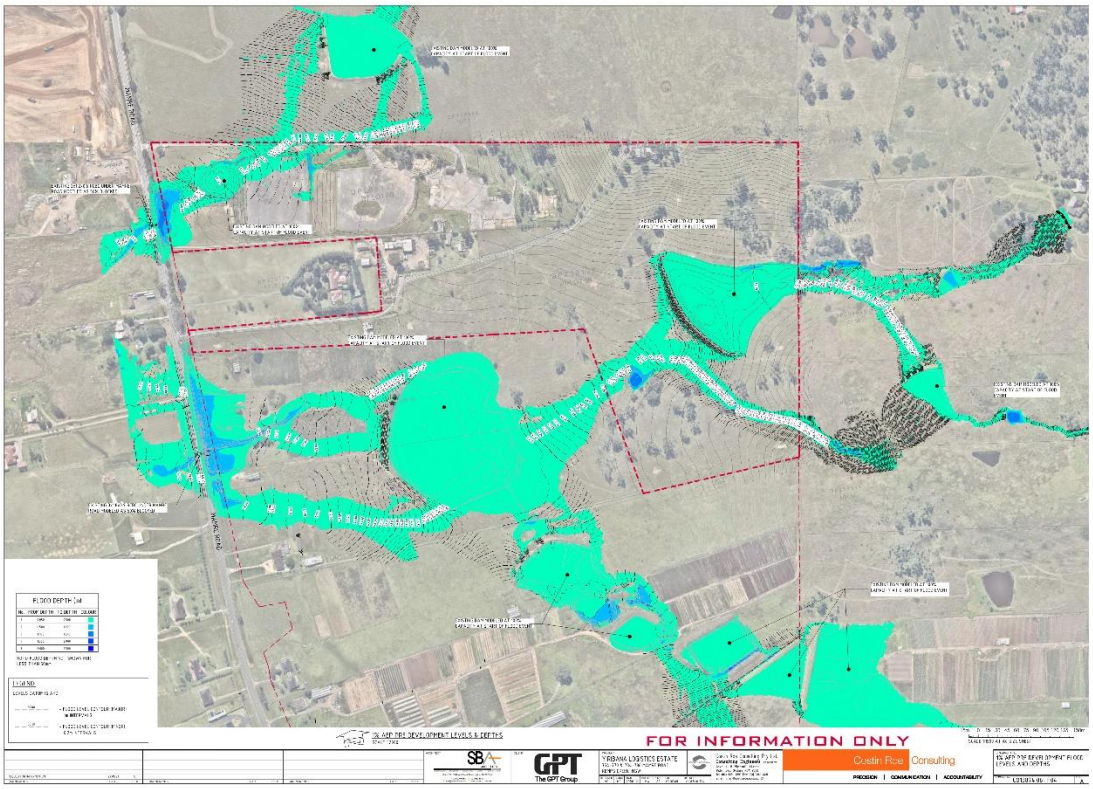


Figure 8.4: 1% AEP Pre-developed Level and Depth Output

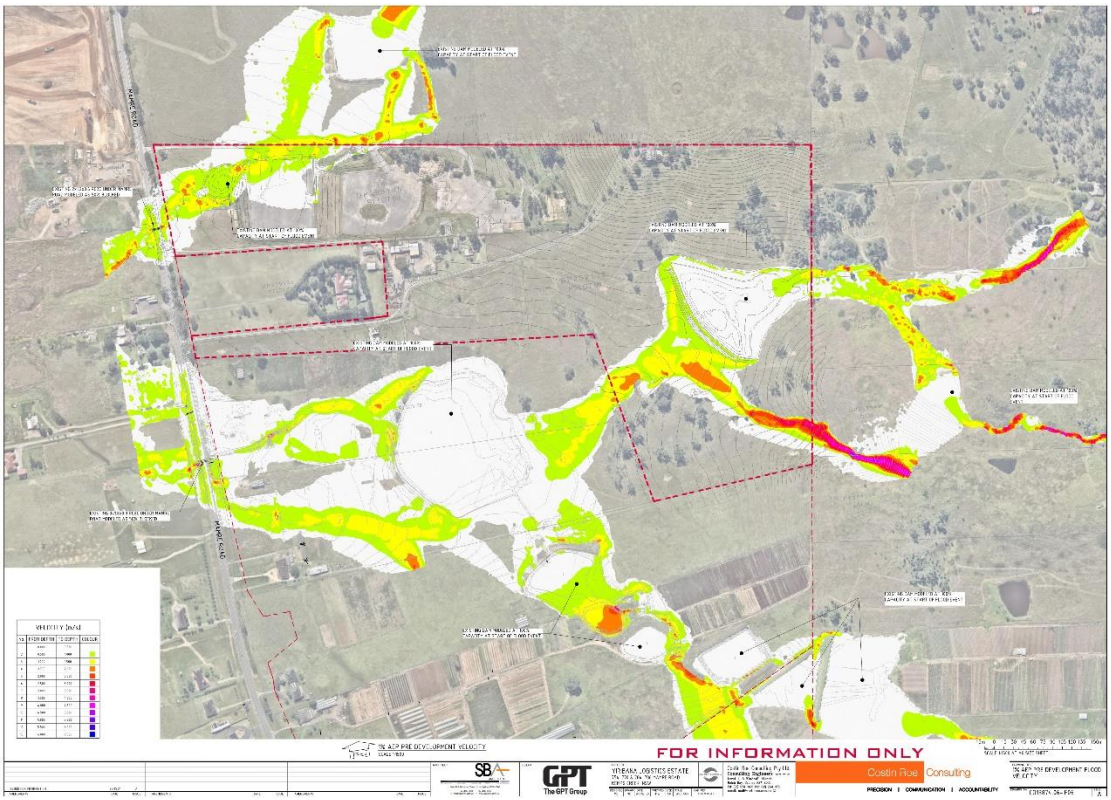


Figure 8.5: 1% AEP Pre-developed Velocity

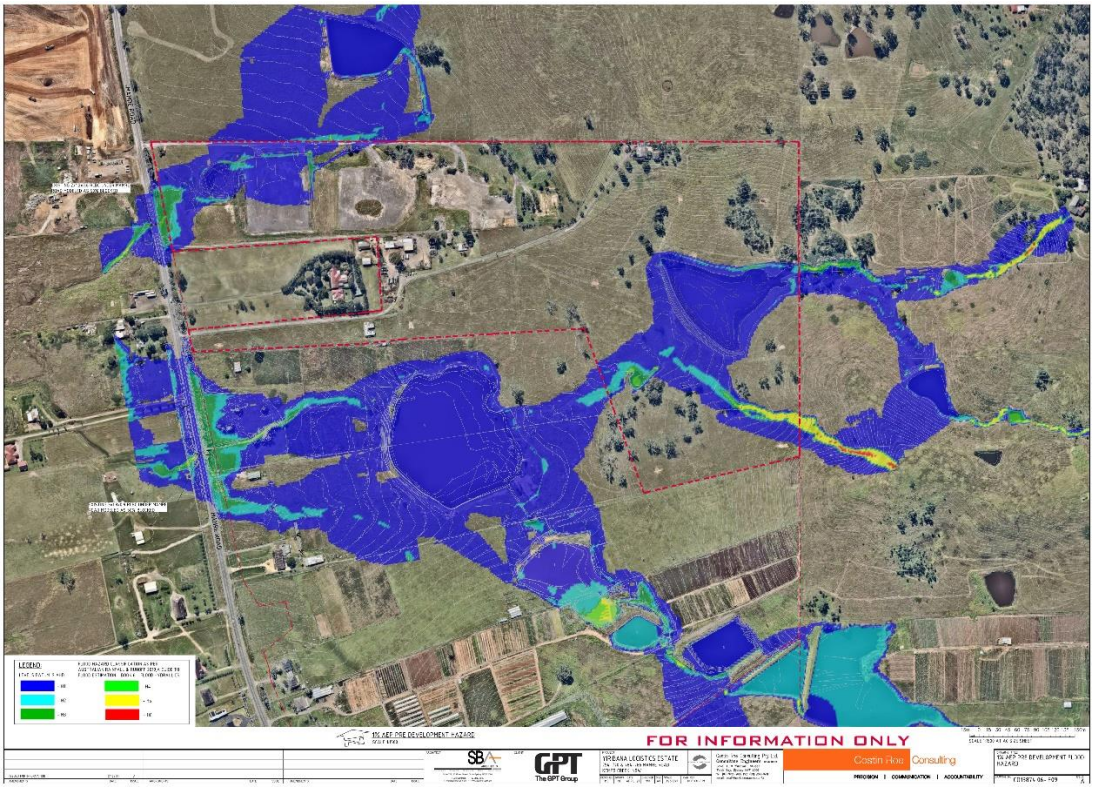


Figure 8.6: 1% AEP Pre-developed Flood Hazard Categorisation

8.4.3 Post-Development 1% AEP

Reference to **Figure 8.7** shows the post-developed 1% AEP output for depth and levels. **Figure 8.8** shows velocity and **Figure 8.9** show true hazard categorisation.

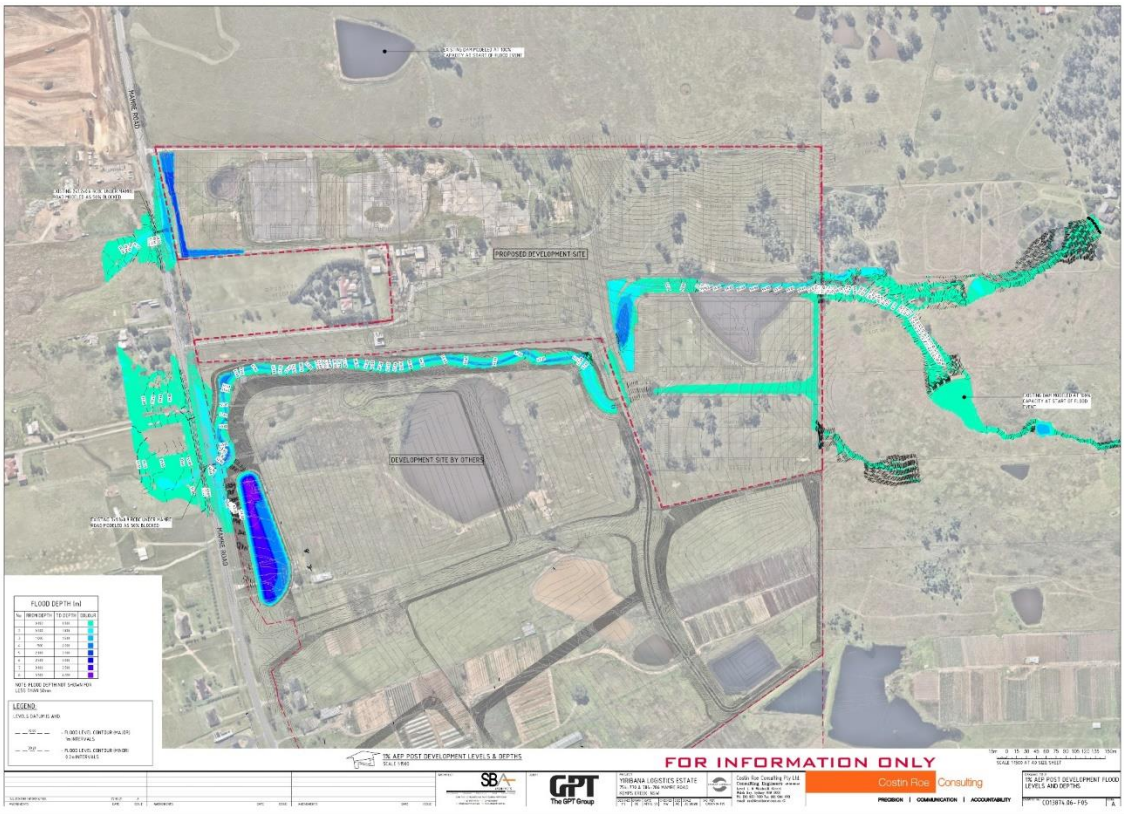


Figure 8.7: 1% AEP Post-developed Level and Depth Output

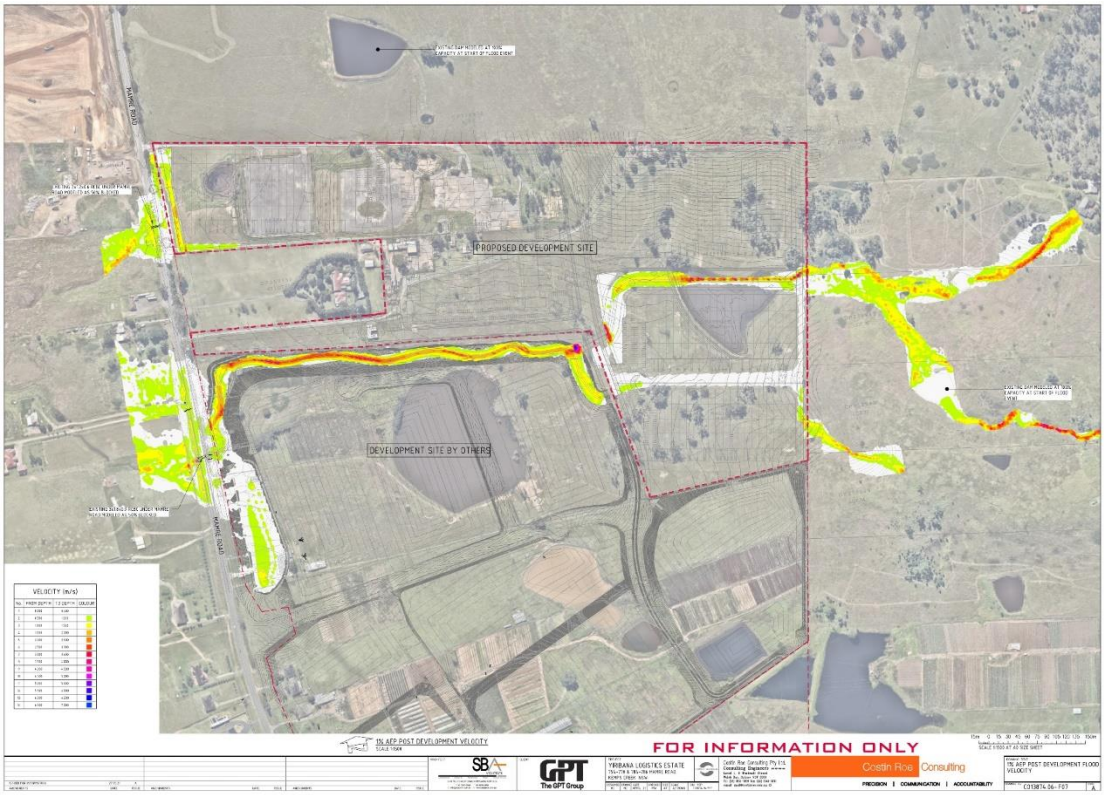


Figure 8.8: 1% AEP Post-developed Velocity

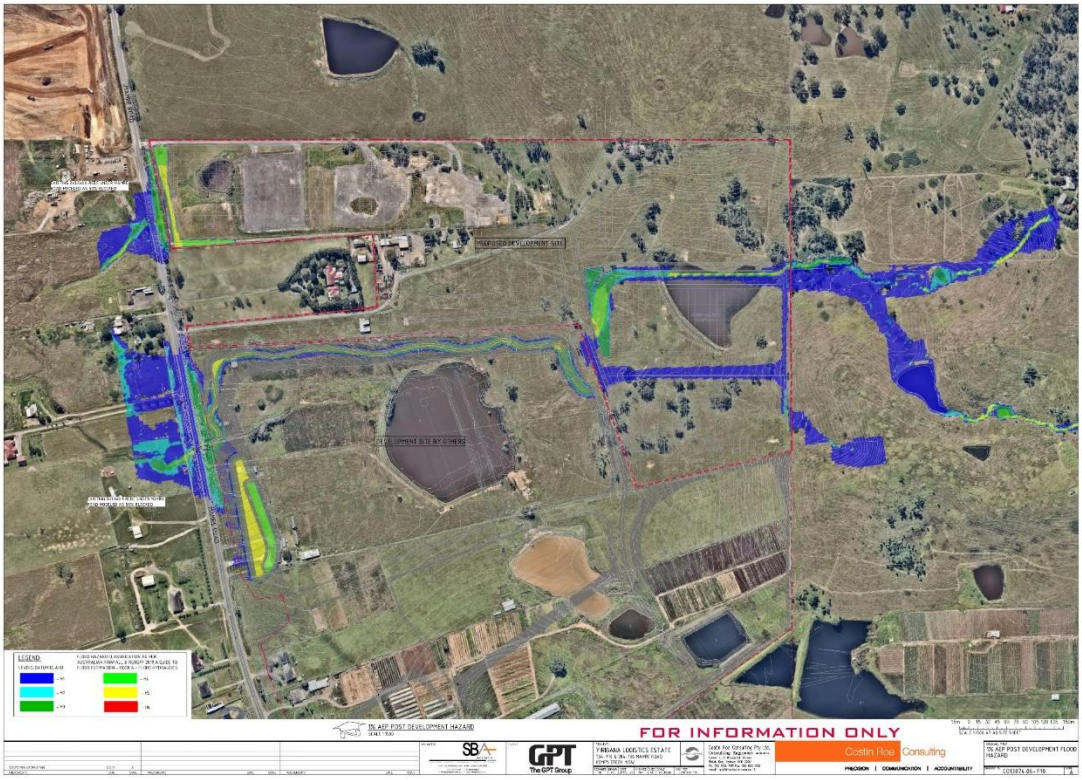


Figure 8.9: 1% AEP Post-developed Flood Hazard Categorisation

8.4.4 1% AEP Comparison

Figure 8.10 shows the 1% AEP flood level afflux (flood level difference) and **Figure 8.11** shows the 1% AEP velocity afflux, associated with the development.

The output for the 1% AEP storm event shows that:

- There is no upstream change to flood levels or velocity for any of the flow paths which enter the site;
- Flows within the riparian corridor are able to be conveyed within the proposed open channel and realigned riparian corridor within the Mirvac Property;
- At the culverts on Mamre Road adjacent to Lot 5, the output shows there is less than 20mm water level change; and
- Afflux at the culverts adjacent to Mirvac development are consistent with the flooding assessment submitted by Mirvac in their EIS, as completed by Cardno. Water levels changes at this location, although shown in our modelling, do not form part of the assessment and approval of the GPT Group development or submission.

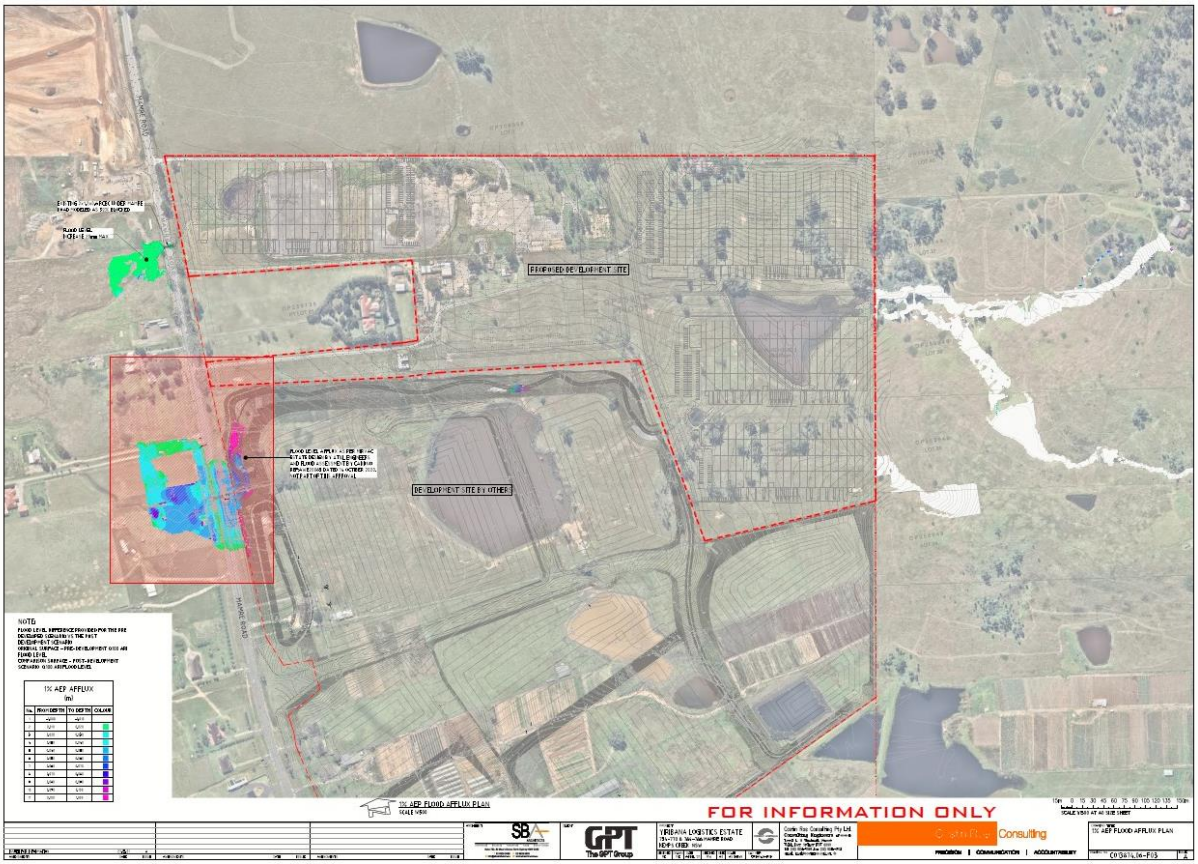


Figure 8.10: 1% AEP Post Developed Flood Level Afflux

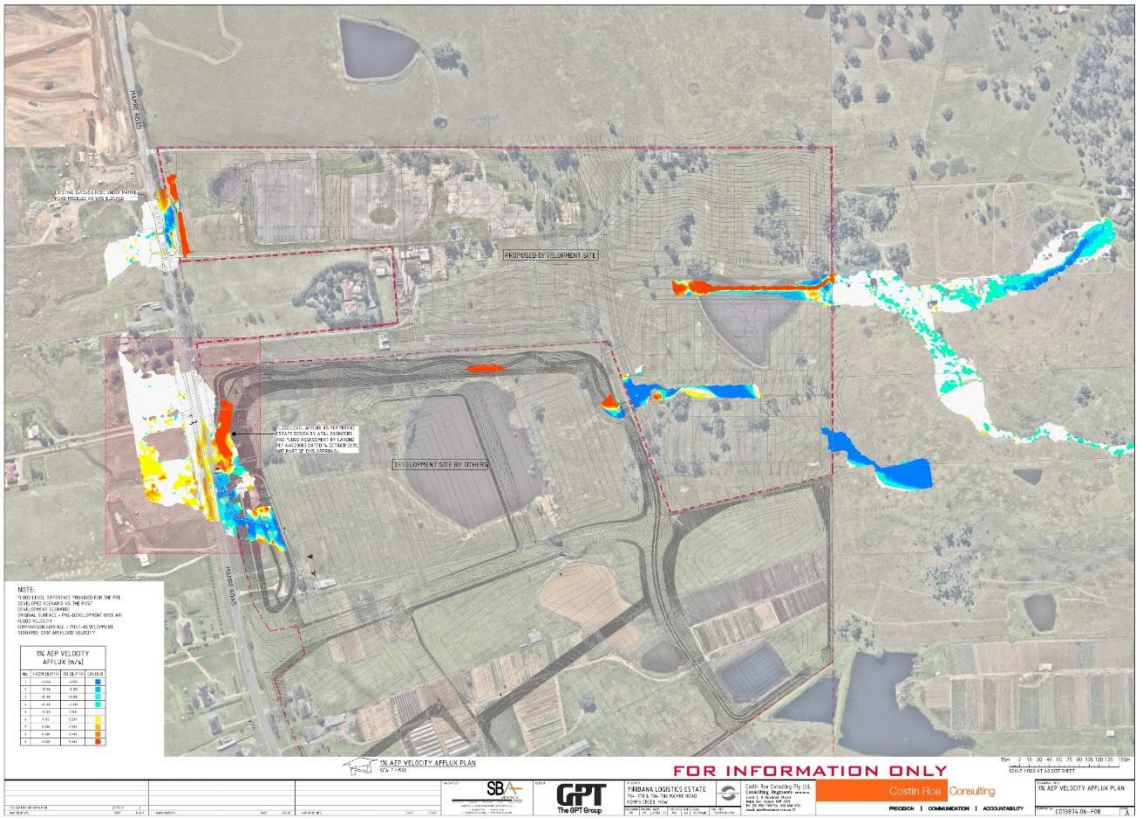


Figure 8.11: 1% AEP Post Developed Flood Velocity Afflux

8.5 Flood Planning and Hazard Categorisation

Penrith City Council has advised that the minimum floor level to be a minimum of 0.5m above 1% Annual Exceedance Probability flood level. The flood planning level (FPL) for the development is based on a minimum floor level of 1% AEP flood level plus 0.5m of freeboard.

For this site the proposed development requires a minimum FPL of RL 56.50m AHD, based on a 1% AEP level of 56.00m adjacent to the existing upstream catchment inflow point to the property on the east of the site.

Flood hazard categories are broken down into high and low hazard for each hydraulic category. High hazard areas are defined as those where there is a possible danger to personal safety and the potential for significant structural damage. Able-bodied adults would have difficulty in wading to safety. With low hazard areas, should it be necessary, a truck could evacuate people and their possessions, and able-bodied adults would have little difficulty in wading to safety.

Flood hazard criteria and mapping has been completed for the 1% AEP and PMF post development conditions as per criteria set out in the *Australian Rainfall and Runoff (2019), A Guide to Flood Estimation – Book 6 – Flood Hydraulics* and *Figure 6.7.9* as included as **Figure 8.12** below. Refer **Section 8.5** and **Appendix E** for hazard mapping.

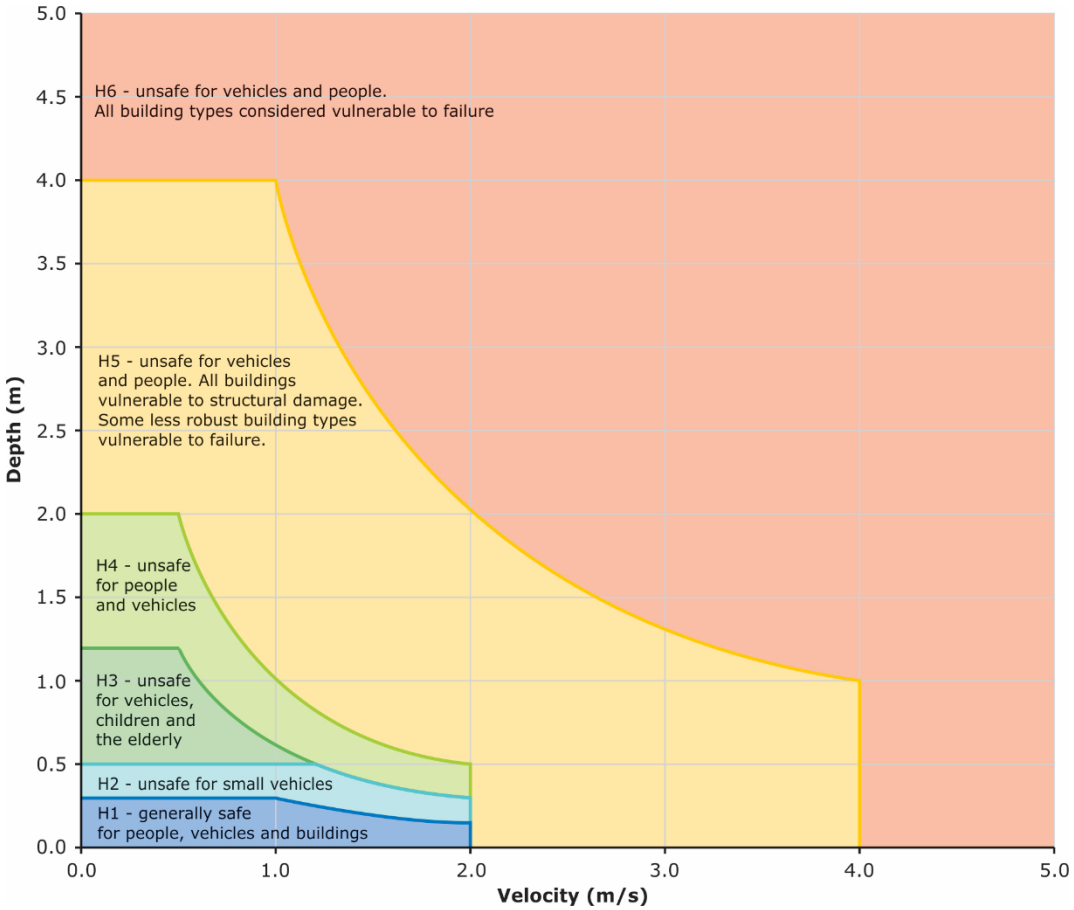


Figure 6.7.9. Combined Flood Hazard Curves (Smith et al., 2014)

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles. children and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

Hazard Vulnerability Classification	Classification Limit (D and V in combination)	Limiting Still Water Depth (D)	Limiting Velocity (V)
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

Figure 8.1. Adopted Hazard Criteria and Provisional Flood Hazard Chart (Australian Rainfall and Runoff 2019)

8.6 Confirmation of Councils Development Control Pan Part C3 Requirements

With reference to **Section 8.5** and modelling results contained in **Appendices E** we provide confirmation in **Table 8.1** that the criteria set out in the *Penrith Council Development Control Plan C3* (and listed in **Section 3.3**) for filling within flood affected land for the 1% AEP event.

We also provide, as **Table 8.2**, confirmation of Penrith Councils proposed adjusted DCP criteria as included in the Exhibition DRAFT of their *South Creek Floodplain Risk Management Plan Section 3.3* for the 1% AEP event.

8.6.1 Council DCP Part C3 (1% AEP Comparison)

Table 8.1. Confirmation of DCP Part C3 Criteria (1% AEP)

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Criteria 1 Flood levels are not increased by more than 0.1m by the proposed filling. *Post Note:* *As part of discussions with Council and the NSW DPE on recent nearby projects, Item i) above has been revised to ensure that no effect to upstream or downstream properties were to occur. The maximum offsite water level change confirmed for the assessment was to be 10-20mm or less. On-site changes would need to be within the 100mm as stipulated in Council DCP.*	The development proposes conveyance of flows up to the 1% AEP meeting councils limit on off-site affectation. Offsite water level changes resulting from this development are shown to be below councils threshold of 20mm in the 1% AEP event. Refer confirmation in **Section 8.5**. Flood level increase criteria is considered to be met.
Criteria 2 Downstream velocities are not increased by more than 10% by the proposed filling	Velocity assessment shows limited change to velocity offsite. Any increases in velocity are noted to be on site and generally around proposed drainage infrastructure and inlets where it would be anticipated that velocities would change. Velocity change criteria is considered to be met.

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Criteria 3 Proposed filling does not redistribute flows by more than 15%	Flow conveyance is based on meeting existing inlet and outlet positions for overland flow. As such there is no redistribution of flow proposed as a result of development. Flow distribution criteria is considered to be met.
Criteria 4 The potential for cumulative effects of possible filling proposals in that area is minimal	The development ensure that there is no offsite impacts. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential for cumulative impacts as part of this development. Cumulative effect criteria is considered to have been met.
Criteria 5 There are alternative opportunities for flood storage.	The overland flow is noted to be confined to existing gully and farm dams, without limited flood storage. All assessments have been completed based on the existing farm dams being full at the start of the storm event. The proposed development includes for detention storage for all catchments which could act as flood storage for some events. Generally as a conveyance area, flood storage is not required, however as noted above some storage will be available. Flood storage criteria is considered to have been met.
Criteria 6 The development potential of surrounding properties is not adversely affected by the filling proposal	The development ensures that there is limited and has demonstrated acceptable offsite changes. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential

DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
	for adverse effect on future development potential of surround properties as a result of the proposed development.
Criteria 7 The flood liability of buildings on surrounding properties is not increased	The flood liability of surrounding developments is not affected by the development proposal. surrounding buildings or properties.
Criteria 8 No local drainage flow/runoff problems are created by the filling	We confirm that no local drainage flow/runoff problems are created by the proposed filling. All local tributaries and flow paths will either operate in a similar manner to the existing regime or form part of the overall stormwater management system for the estate.
Criteria 9 The filling does not occur within Floodway Corridor	There is no floodway corridor defined or required to be considered for flows within the existing gully. The existing gully on site is noted to be a first order watercourse that only conveys runoff during periods of rainfall and runoff which currently flows in the watercourse is considered in the estate drainage system.
Criteria 10 The filling does not occur within the drip line of existing trees	Filling is proposed within the development land. It is expected that trees within development land will be affected by the civil works and future industrial development, consistent with the nature of the future development and zoning of the land. This is also noted to be consistent with the zoning of the land and discussion with Council.

8.6.2 South Ck Floodplain Risk Management Plan Recommended DCP Criteria (1% AEP Comparison)

Table 8.2. Confirmation of DCP Part C3/ South Creek Floodplain Risk Management Plan Recommended Criteria (1.0% AEP)

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	**Post Development Scenario Confirmation (1% AEP Event)**
Recommended Criteria 1 Flood levels are not increased by more than 0.02m (20mm) outside of the development site.by the proposed filling.	The development proposes conveyance of flows up to the 1% AEP meeting councils limit on off-site affectation. Refer confirmation in **Section 8.5**. Offsite water level changes resulting from this development are shown to be below councils threshold of 20mm in the 1% AEP event. Flood level increase criteria is considered to be met.
Recommended Criteria 2/ 3 On the development site itself, flood hazard is not increased to greater than "low" based on current ARR criteria for hazard. Low hazard zones are defined in ARR as where D.V < 0.4 m^2/s for children and D.V < 0.6 m2/s for adults and should be applied depending on the type of development. Isolated areas of high hazard may be considered at Council's discretion where people are prevented from entering the area i.e. dedicated flow paths. Hazard should never increase to exceed 0.8 m2/s as this is the limiting working flow for experienced personnel such as trained rescue workers. Flood hazard should be assessed for the duration of the event and is not necessarily the flood hazard at the time of the peak flood level. Flood hazard on surrounding properties should not increase.	Flood hazard and velocity mapping has been included in **Section 8.5** of this report. The assessment shows acceptable hazard ratings and limited change in existing hazard rating. Velocity and flood hazard change criteria is considered to be met.

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
Recommended Criteria 4 The potential for cumulative effects of possible development proposals in that area is minimal	The development ensures that there is limited and acceptable offsite changes. Further, future developments proposed to coordinate conveyance of flows within dedicated precinct drainage systems. There is limited or no potential for adverse effect on future development potential of surround properties as a result of the proposed development. Cumulative effect criteria is considered to have been met.
Recommended Criteria 5 Where possible, any losses in floodplain storage are to be offset by compensatory cut at the same or a similar elevation.	The overland flow is noted to be confined to existing gully and farm dams. The proposed development includes for detention storage for all catchments which could act as flood storage for some events. Generally as a conveyance area, flood storage is not required, however as noted above some storage will be available. Flood storage criteria is considered to have been met.
Recommended Criteria 6/7 The flood liability and flood hazard of surrounding land is not adversely affected by the filling proposal	The flood liability of surrounding developments is not affected by the development proposal. surrounding buildings or properties.
Recommended Criteria 8 No local drainage flow/runoff problems are created by the development.	We confirm that no local drainage flow/runoff problems are created by the proposed development. All local tributaries and flow paths will either operate in a similar manner to the existing regime or form part of the overall stormwater management system for the estate.
Recommended Criteria 9 The filling does not occur within Floodway Corridor	There is no floodway corridor defined or required to be considered for flows within the existing gully.

South Creek Floodplain Risk Management Plan Recommended DCP Criteria	Post Development Scenario Confirmation (1% AEP Event)
	The gully is noted to be a first order watercourse that only conveys runoff during periods of rainfall.
Recommended Additional Criteria (i) Additional controls for critical facilities (eg schools, hospital, aged care facilities). (ii) Requirements for Flood Impact Asssessment (FIA) and Flood Risk Assessments (FRA) commensurate to development size, type and flood risk. (iii) Climate Change	(i) The proposed development is for industrial use and not considered to involve critical facilities. (ii) This report provides the necessary FIA and FRA. (iii)Given the limited catchment and site being located at the top of the catchment climate change assessment is not considered necessary for this development.

8.7 Climate Change Sensitivity Assessment

An assessment has been undertaken for the effect of climate change on the development. The assessment takes into consideration potential effect from increased rainfall intensity and sea level rise.

An assessment of the 0.2% AEP and 0.5% AEP was included as a proxy for the effect of climate change and is considered a conservative assessment for a 10% increase in flow to the 1% AEP event. Modelling has been undertaken for the 0.2% AEP and 0.5% AEP and flood afflux results are shown in **Figures 8.12 & 8.13**. Afflux results show minimal flood level change on the western side of the Mamre Road in the 0.5% AEP and 0.2% AEP when compared to the 1% AEP event. There is minor increase in flood afflux within. This assessment shows that the proposed stormwater drainage system and existing overland flow paths would have sufficient capacity to manage the increased peak flows and water volume with minor increase in peak water level at areas surrounding the Mamre Road culvert crossing. We confirm the increase in rainfall intensities will achieve the required minimum 0.5m freeboard to the proposed development levels in relation to overland flow paths from external & local catchments.

Overall, flood immunity of the proposed development sites would not be compromised given a large available freeboard amount much larger than minimum 0.5m values generally adopted.

The site is situated well upstream from any tidally influenced receiving waters including expected potential sea level rise of 0.4m. We confirm the development will not affect or be affected by potential sea level rise.

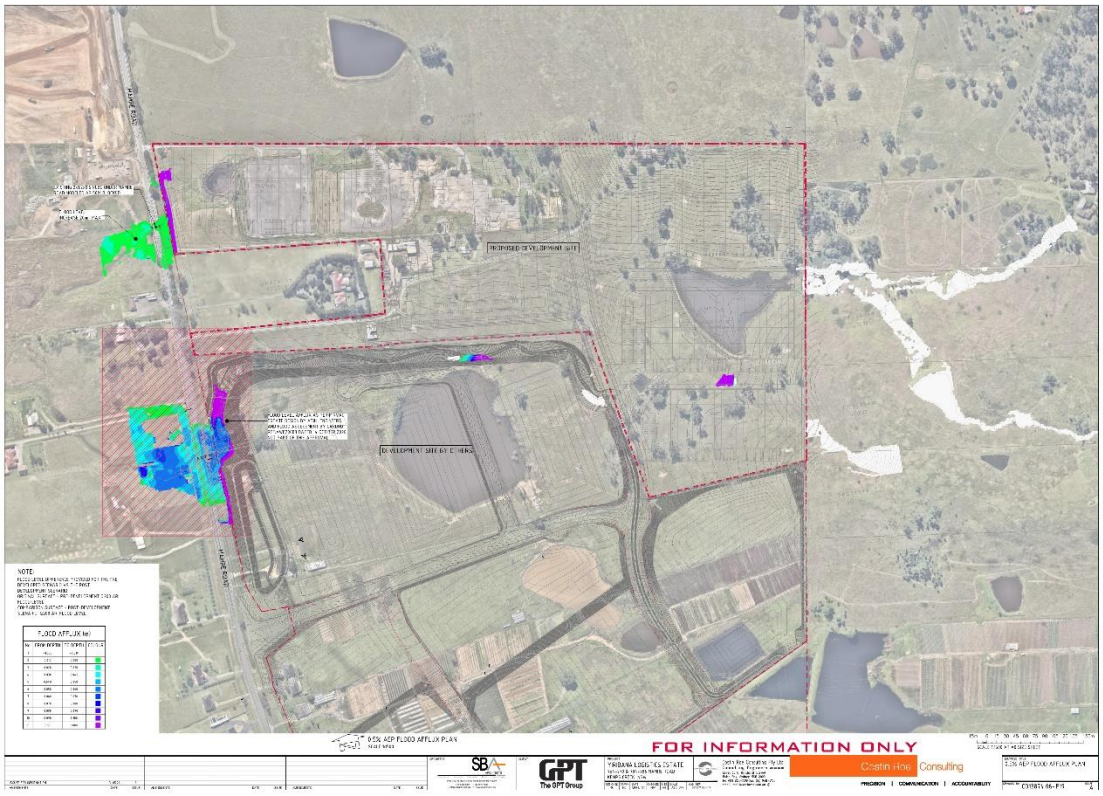


Figure 8.12: 0.5% AEP Post Developed Flood Level Afflux

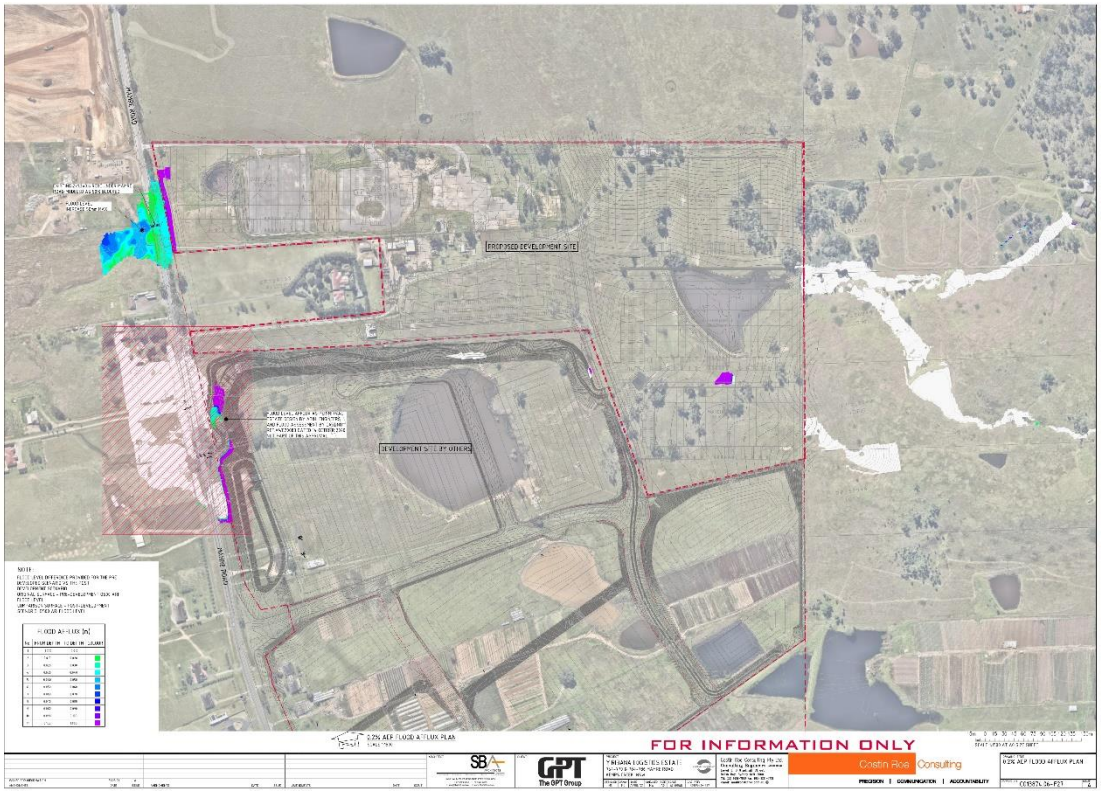


Figure 8.13: 0.2% AEP Post Developed Flood Level Afflux

8.8 Flood Assessment Conclusion

A TUFLOW hydrodynamic flood model has been completed and the pre and post development flood events assessed for flooding as a result of a 1% AEP rainfall event within the catchment.

The assessment of the 1% AEP event confirms that conveyance paths are available to the eastern and northern side of the proposed estate development. There is negligible effect on flood water local to the development. The TUFLOW Modelling completed by Costin Roe Consulting and confirmation of MRP DCP Criteria in **Section 8.7** confirms there is no affectation of upstream, downstream or adjoining properties.

9 SOIL AND WATER MANAGEMENT

9.1 Soil and Water Management General

Section 1 provides a summary of the construction works for the Proposal. While all construction activities have the potential to impact on water quality, the key activities are:

- Erosion and sediment control installation.
- Grading of existing earthworks to suit building layout, drainage layout and pavements.
- Stormwater and drainage works.
- Service installation works.
- Building construction works.

Without any mitigation measures and during typical construction activities, site runoff would be expected to convey a significant sediment load. A *Soil and Water Management Plan* (SWMP) and *Erosion and Sediment Control Plan* (ESCP), or equivalent, would be implemented for the construction of the Proposal. The SWMP and ESCPs would be developed in accordance with the principles and requirements of *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*.

In accordance with the principles included in the Blue Book, a number of controls have been incorporated into a preliminary ESCP (refer to accompanying Drawings in **Appendix A**) and draft SWMP in **Appendix C**.

The sections below outline the proposed controls for management of erosion and sedimentation during construction of the Proposal.

9.2 Typical Management Measures

Sediment Basins

Sediment basins have been sized (based on 5 day 85th percentile rainfall) and located to ensure sediment concentrations in site runoff are within acceptable limits. Preliminary basin sizes have been calculated in accordance with the Blue Book and are based on 'Type F' soils. These soils are fine grained and require a relatively long residence time to allow settling.

Sediment basins for 'Type F' soils are typically wet basins which are pumped out following a rainfall event when suspended solids concentrations of less than 50 mg/L have been achieved.

Sediment Fences

Sediment fences are located around the perimeter of the site to ensure no untreated runoff leaves the site. They have also been located around the existing drainage channels to minimise sediment migration into waterways and sediment basins.

Stabilised Site Access

For the proposal, stabilised site access is proposed at one location at the entry to the works area. This will limit the risk of sediment being transported onto Mamre Road and other public roads.

9.3 Other Management Measures

Other management measures that will be employed are expected to include:

- Minimising the extent of disturbed areas across the site at any one time.
- Progressive stabilisation of disturbed areas or previously completed earthworks to suit the proposal once trimming works are complete.
- Regular monitoring and implementation of remedial works to maintain the efficiency of all controls.

It is noted that the controls included in the preliminary ESCP are expected to be reviewed and updated as the design, staging and construction methodology is further developed for the Proposal.

10 SEAR's & AGENCY RESPONSE ITEMS

10.1 SEARS Introduction

The following sections of the report include responses to items included in the NSW Department of Planning and Environment SEARS letter dated November 2020, reference SSD_10272349, and the associated agency response letters from Penrith City Council, NSW Department of Primary Industries (DPI) and NSW Office of Environment & Heritage (OEH).

Further reference to the EIS prepared by Urbis Planning should be made for confirmation of how the SEAR's have been addressed for non-civil engineering or WCM related items.

10.2 SEAR's Response Items

SEARS – General Requirements
A topographic assessment and justification of the proposed earthworks are site responsive and contextually appropriate Response The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by adjoining landowner/ developers Mirvac and Altis Property Partners, through consultation with these respective developers has also been made. Overall, it can be anticipated that, on a development site which has a level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE. Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**.
An assessment of potential impacts to soil and water resources, topography, hydrology, groundwater, groundwater dependent ecosystems, drainage lines, downstream assets such as warragamba pipelines corridor, watercourses and riparian lands on or nearby to the site. This will include mapping and a description of existing background conditions and cumulative impacts and measures proposed to reduce and mitigate impacts. Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology, watercourses and riparian lands.

Refer to **Section 3** for assessment of soil resources. Refer to **Section 2 & 3** for background conditions. Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems. The development is noted to be approximately 1km south of the Warragamba Pipeline. There are no watercourses which drain toward or through the Warragamba Pipeline from the subject land. The proposed development has no impact or works associated with the Warragamba Pipeline and no additional assessments are required in relation to the development and the pipeline.
Consideration of the NSW Aquifer Interference Policy (2012) and the guidelines for Controlled Activities on Waterfront Land (2018) Response Consideration to the guidelines for Controlled Activities on Waterfront Land (2018) has been made in relation to the riparian corridor and watercourse which is present on the land, including consultation with NRAR. It is proposed that the watercourse be realigned, in conjunction with the adjoining land developer, Mirvac. The design of the realigned watercourse has been completed in accordance with the noted guidelines as discussed in detail in **Section 5.6** and documented on Civil Design Drawings included in **Appendix A**.
A detailed Site water balance including identification of water requirements for the life of the project, measures that would be implemented to ensure an adequate and secure water supply is available for the development, and a detailed description of the measures to minimize the water use at the site. Response Water supply for the development will be provided by Sydney Water, an adequate and secure supplier. Measures including rainwater reuse are proposed for non-potable water use with the demand on non-potable being reduced by 80%. We note that, given the recent announcement of Sydney Water as the waterway manager, it is anticipated that some documented measures (including additional storage and rainwater tanks) would be temporary only, and subject to either removal if constructed or future SSDA Modifications following Sydney Waters development scheme plans being exhibited and estate management measures and objectives being adjusted to suit the intended regional scheme.
Demonstrate satisfactory arrangements for drinking water, wastewater, and if required, recycled water services have been made. Response Reference to the services infrastructure reporting should be made pertaining to drinking water and wastewater supply.

Characterization of water quality at the point of discharge to surface and/or groundwater against the relevant water quality criteria (including proposed mitigation measures to manage any impacts to receiving waters and monitoring activities and methodologies)

Response

Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report.

Section 7 provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.

A site- specific integrated water management strategy with details of a stormwater/ wastewater management system including how it will be designed, operated and maintained, including the capacity of onsite detention system(s)

Response

A stormwater management assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report.

Section 6 provides demonstration of the water quantity management, including on-site detention system storage capacity operation, hydrology and hydraulics.

Section 7 provides demonstration of the key water quality criteria being met, based on MUSIC modelling. Also included in **Section 7** is stormwater harvesting (via rainwater reuse), stream health and maintenance and monitoring requirements. Further detail on maintenance and monitoring can be found in **Appendix D**.

Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.

A description of the measures to minimize water usage

Response

Refer to **Section 7.4** for stormwater harvesting (via rainwater reuse).

Refer to EIS for other measures specific to building and site measures

A detailed flooding impact assessment is provided.

Response

Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment.

A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have

been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP, the Final MRP DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Descriptions of the proposed erosion and sediment controls during construction are provided, as well as consideration of salinity and acid sulphate soil impacts. Response Refer to **Section 9** for soil and water management measures, drawings in **appendix A** for associated erosion and sediment control drawings, and **Appendix C** for a Draft Soil and Water Management Plan. These sections show proposed measures, based on the Landcom document *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*, are proposed during the construction of the development. Measures proposed will limit potential for offsite impact associated with water runoff and soils during construction. Consideration to management of salinity and acid sulphate has been made based on the recommendations of the geotechnical investigations and noted Landcom document.

10.3 Agency Responses

DPIE (Water) – ref: OUT20/13032
The SEARS should include: *The identification of an adequate and secure water supply for the life of the project. This includes confirmation that water can be sourced from an appropriately authorised and reliable supply. This is also to include an assessment of the current market depth where water entitlement is required to be purchased.* Response Water supply for the development will be provided by Sydney Water, an adequate and secure supplier. No water entitlements are required to be purchased.
A detailed and consolidated site water balance. Response Reference to **Sections 5, 6** and **7** of this report should be made for surface water assessments.

Assessment of impacts on surface and ground water sources (both quality and quantity), related infrastructure, adjacent licensed water users, basic landholder rights, watercourses, riparian land, and groundwater dependent ecosystems, and measures proposed to reduce and mitigate these impacts. Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands. Refer to **Section 3** for assessment of soil resources. Refer to **Section 2 & 3** for background conditions. Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems. There are no proposed water licenses and adjacent properties are noted to be contemplating similar developments.
Proposed surface and groundwater monitoring activities and methodologies. Response There are no proposed or required surface and groundwater monitoring activities.
Consideration of relevant legislation, policies and guidelines, including the NSW Aquifer Interference Policy (2012), the Guidelines for Controlled Activities on Waterfront Land (2018) and the relevant Water Sharing Plans (available at https://www.industry.nsw.gov.au/water). Response Consideration to the guidelines for Controlled Activities on Waterfront Land (2018) has been made in relation to the riparian corridor and watercourse which is present on the land, including consultation with NRAR. It is proposed that the watercourse be realigned, in conjunction with the adjoining land developer, Mirvac. The design of the realigned watercourse has been completed in accordance with the noted guidelines as discussed in detail in **Section 5.6** and documented on Civil Design Drawings included in **Appendix A**.

DPIE (EES) – ref:DOC20/892052	
Water & Soils	
Item 6	***The EIS must map the following features relevant to water and soils including:***

Item 6a	*Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map).* Response Refer separate geotechnical investigation for mapping, and **Section 3.7** of this report for discussion on acid sulfate soils.
Item 6b	*Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method).* Response There are no rivers, streams, wetlands or estuaries (as described in s4.2 of the Biodiversity Assessment Method) within the study area. A first order water course is noted to be present on the site, within the riparian corridor as discussed in **Section 5.6** and shown on Civil Engineering Drawings included in **Appendix A**.
Item 6c	*Wetlands as described in s4.2 of the Biodiversity Assessment Method.* Response There are no wetlands within the study area.
Item 6d	*Groundwater.* Response Refer separate report by Arcadis which includes the groundwater assessment and recommendations. **Section 3.6** of this report confirms how the civil engineering design includes the recommendations of the groundwater assessment.
Item 6e	*Groundwater dependent ecosystems* Response Refer separate report by Arcadis which includes the groundwater assessment and recommendations. **Section 3.6** of this report confirms how the civil engineering design includes the recommendations of the groundwater assessment.
Item 6f	*Proposed intake and discharge locations* Response There are proposed intake or discharge locations on the project.
Item 7	***The EIS must describe background conditions for any water resource likely to be affected by the development, including:***
Item 7a	*Existing surface and groundwater.*

	Response Refer **Sections 2, 5, 6, 7 & 8** for assessment of surface stormwater management including assessments of hydrology, watercourses, and drainage lines.
Item 7b	*Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations.* Response Refer **Sections 2, 5, 6, 7 & 8** for assessment of surface stormwater management including assessments of hydrology, watercourses, and drainage lines.
Item 7c	*Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters* Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 7d	*Indicators and trigger values/criteria for the environmental values identified at (c) in accordance with the ANZECC (2000) Guidelines for Fresh and Marine Water Quality and/or local objectives, criteria or targets endorsed by the NSW Government* Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 7e	*Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* *http://www.environment.nsw.gov.au/research-and-publications/publications-search/risk-based-framework-for-*

	considering-waterway-health-outcomes-in-strategic-land-use-planning Response Stormwater assessment including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria, have been set out in **Section 5.1** and **Section 7.1** of the report. **Section 7** provides demonstration of the key criteria being met, based on MUSIC modelling. Configuration of the proposed measures are shown on the Civil Design Drawings included in **Appendix A**.
Item 8	***The EIS must assess the impact of the development on hydrology, including:***
Item 8a	*Water balance including quantity, quality and source.* Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands.
Item 8b	*Effects to downstream rivers, wetlands, estuaries, marine waters and floodplain areas.* Response Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with best practice and consideration of the 9 stream health metrics recommended for assessment of stream health.
Item 8c	*Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems.* Response Refer to separate report, completed by Arcadis, in relation to groundwater and groundwater dependent ecosystems.
Item 8d	*Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches).* Response Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with

	best practice and consideration of the 9 stream health metrics recommended for assessment of stream health. Refer to ecological report in relation to aquatic connectivity, habitat and other ecological related assessments.
Item 8e	*Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water.* Response No changes to environmental water availability are proposed as part of the development.
Item 8f	*Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options* Response Refer to **Section 5, 6 & 7** for assessment of water resources, hydrology (including quality and quantity), watercourses and riparian lands during operation. Refer to **Section 9** for soil and water management measures during construction, drawings in **appendix A** for associated erosion and sediment control drawings, and **Appendix C** for a Draft Soil and Water Management Plan. These sections show proposed measures, based on the Landcom document *Managing Urban Stormwater – Soils & Construction Volume 1 ('Blue Book')(Landcom, 2004)*, are proposed during the construction of the development. Measures proposed will limit potential for offsite impact associated with water runoff and soils during construction. Consideration to management of salinity and acid sulphate has been made based on the recommendations of the geotechnical investigations and noted Landcom document.
Item 8g	*Identification of proposed monitoring of hydrological attributes.* Response Refer **Appendix D** for DRAFT Maintenance and Monitoring requirements associated with the specified drainage system and water quality measures.

Flooding & Coastal Areas	
Item 9	*The EIS must map the following features relevant to flooding as describes in the floodplain development manual 2005 (NSW Government 2005) Including:* *a) Flood prone land,* *b) Flood planning areas, and the areas below the flood planning level,* *c) Hydraulic Categorization (floodways and flood storage areas) and lastly,* *d) Flood hazards.* Response Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item10	*The EIS must describe flood assessment and modelling undertaken in determining the design flood levels for events, including a minimum of the 5% Annual Exceedance Probability (AEP), 1% AEP, flood levels and the probable maximum flood, or an equivalent extreme event.* Response Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment.

	A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 11	*The EIS must model the effect of the proposed development (including fill) on the flood behaviour under the following scenario:* *a) Current flood behaviour for a range of design events as identified 14 above. This includes the 0.5% and 0.2% AEP year flood events as proxies for assessing sensitivity to an increase in rainfall intensity of flood producing rainfall events due to climate change.* <u>Response</u> Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low hazard to the development and future occupants of the development site.

	The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 12a	*Modelling in the EIS must consider and document:* *The existing council flood studies in the area and examine consistency to the flood behaviour documented in these studies.* <u>Response</u> The modelling contemplates existing studies including Penrith Councils *South Creek Flood Study (Advisian 2014)* and Penrith Council *Overview Study – Flood Analysis for Central Urban (Zone 1), Northern Rural (Zone 2), Southern Rural (Zone 3)*" – Cardno 2006
Item 12b	*The impact on existing flood behavior for a full range of flood event including up to the probable maximum flood, or an equivalent extreme flood.* <u>Response</u> The assessment includes a range of storms for pre and post development conditions with modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP. The 0.5% AEP, 0.2% AEP events assessed as proxies for climate change.
Item 12c	*The impacts of the development on flood behaviour resulting in detrimental changes in potential flood affection of other developments or land. This may include redirection of flow, flow, velocities, flood levels, hazard categories and hydraulic categories.* <u>Response</u> The assessment includes a range of storms for pre and post development conditions with modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP. The 0.5% AEP, 0.2% AEP events assessed as proxies for climate change.

Item 12d	*Relevant provisions of the NSW Floodplain Development on flood behaviour.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13a	***The EIS must assess the impacts on the proposed development on flood behaviour, including:*** *Whether there will be detrimental increases in the potential flood affection of other properties, assets and infrastructure.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*. The assessment confirms there will be no detrimental increase in the flood potential of other properties, assets and infrastructure.
Item 13b	*Consistency with council floodplain risk management plans.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13c	*Consistency with any rural floodplain management plans.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.

Item 13d	*Compatibility with the flood hazard of the land.* Response The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13e	*Compatibility with the hydraulic functions of flow conveyance in floodways and storage in flood storage areas of the land* Response The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the RIPARIAN corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Item 13f	*Whether there will be adverse effect to beneficial inundation of the floodplain environment, on, adjacent to or downstream of the site.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.

Item 13g	*Whether there will be direct or indirect increase in erosion, siltation, destruction of riparian vegetation or a reduction in the stability of riverbanks or watercourses.* Response The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*. Refer to **Section 7.5** which discusses, assesses, and provides demonstration of acceptable stream health outcomes, consistent with best practice and consideration of the 9 stream health metrics recommended for assessment of stream health. This includes consideration and management of erosion, stability of watercourses and riverbanks.
Item 13h	*Any impacts the development may have upon existing community emergency management arrangements for flooding. These matters are to be discussed with the NSW SES and Council.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13i	*Whether the proposal incorporates specific measures to manage risk to life from flood. These matters are to be discussed with the NSW SES and Council.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site

	refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13j	*Emergency management, evacuation and access, and contingency measures for the development considering the full range of flood risk (based upon the probable maximum flood or an equivalent extreme flood event). These matters are to be discussed with and have the support of the Council and the NSW SES.* Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the watercourse within the riparian corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.
Item 13k	*Any impacts the development may have on the social and economic costs to the community as consequence of flooding.* Response It is confirmed there is no change in flooding conditions, social or economic cost to community as a result of the development.

TfNSW – ref:CD20/08907
The EIS shall provide a flood impact assessment to understand the potential impacts of the development on flood evacuation is to be carried out. The EIS will assess the impacts of the proposed development, information for pre and post- development scenarios including modelling of the local overland flows are to be provided to allow assessment of the impact of the development. Response Refer to **Section 8**. The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the RIPARIAN corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level

roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.

DPIE (Urban Design) – ref: Melissa Rassack email Dated 5 Nov 2020

The SSD will need to Address

the E2 Environmental Conservation zoning through the site. There is an important ecological/ riparian corridor connecting Wianamatta- South Creek and Ropes Creek that runs through the site. NRAR should be consulted on design of this corridor.

In line with the previous DPIE advice, the riparian corridor should be designed (width and vegetation) to ensure there is sufficient are provided to support the requirements of the local ecosystem. A riparian corridor of 40 metres width should be provided and designed in accordance with the principles of the Water Management Act

Response

Refer to **Section 5.6** for detailed discussion on the RIPARIAN zone and riparian corridor.

NRAR has been consulted throughout the design development period, with initial meetings held on 3 August 2020 and subsequent email and letter correspondence (refer Costin Roe Consulting Letters 18 August 2020 and 27 October 2020 and Cumberland Ecology letter referenced 19200 – Let6 dated 16 July 2020).

It has been confirmed that the watercourse within the subject land is a first order watercourse (per the Strahler system), and NRAR has confirmed that the watercourse is not considered waterfront land under the definition of the act. The width of the riparian corridor is proposed as 40m total, allowing for a core riparian corridor either side of a 5m channel. Additional landscape setbacks are included either side of the riparian corridor as required of the MRP DCP.

Figure 1. The riparian corridor

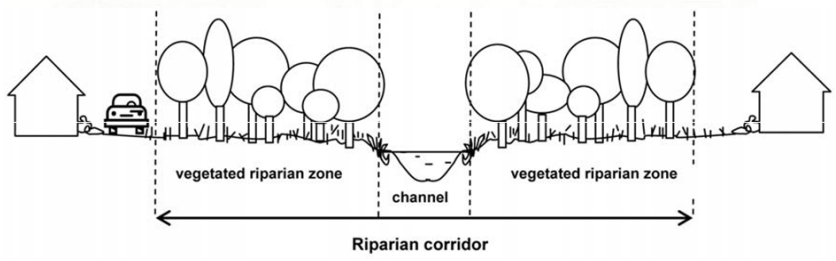


Table 1. Recommended riparian corridor (RC) widths

Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 metres + channel width
2nd order	20 metres	40 metres + channel width
3rd order	30 metres	60 metres + channel width
4th order and greater (includes estuaries, wetlands and parts of rivers influence by tidal waters)	40 metres	80 metres + channel width

Note: Where a watercourse does not exhibit the features of a defined channel with bed and banks, the NRAR may determinethat the watercourse is not waterfront land for the purposes of the WM Act.

Demonstration that the proposed geometry changes to the riparian corridor will address adequate flow of the watercourse. A softer geometry angle may be required to improve this issue.

Response

The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel.

A 90-degree change in direction, with a prolonged curved radius, is proposed through the lower portion of the channel and at the entry to the culvert. The curved radius is noted to be approximately 55m in length, and the corresponding radius at the entry to the culvert is 25m.

Recommended practice for naturalised creeks has been made using accepted industry methods for naturalised creek design, included in documents such as the *Queensland Urban Drainage Manual 2013*, and Brisbane City Councils *Natural Channel Design Guidelines 2003*. Within these documents recommended minimum radius of bends are recommended, based on the bankfull width of the watercourse. The recommended minimum radius for a constructed bend is 3 times the bankfull width.

For this project, noting the bankfull width of 5m, the minimum acceptable design radius of curvature as such is 15m. The proposed minimum radius is 25m, and where

the larger change in direction is proposed (55m radius) the radius is noted to be 3.6 times greater than the minimum recommended curve radius. Conveyance capacity for the calculated peak flow in the 1% AEP storm event is 4.4m^3/s. This peak flow is noted to be able to be conveyed within the proposed 5m wide main channel cross section at a depth of approximately 0.8m. Further capacity is available based on overbank flows.
The design treatment of the interface between industrial development and the E2 corridor is important. The design and location of the hardstand areas need to avoid negative impacts on the riparian corridor including addressing noise and vibrations from vehicle movements, stormwater runoff and spillage of pollutants. Response The interface with the riparian zone includes additional 5m landscape setback as required of the Final MRP DCP. An integrated approach of stepped and landscaped retaining structures, in addition to the vegetation of battered riparian corridors allows for effective separation of the watercourse with the developed areas of the site. Stormwater runoff from within the developments sites will be contained within each site then treated for pollutants (per objectives set out in **Section 5.1** and demonstrated in **Section 7**) prior to discharge from the site into trunk drainage systems or the noted watercourse.
The SSD will also need to address the riparian corridor alignment and its connections to adjoining properties. It Is noted that the applicant is seeking relocate the zoned E2 area. This will only be considered if the above matters are satisfied and NRAR and the Department's Resilient Planning team agree to the approach. Response The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.
The design of proposed retaining walls will need to allow for soft landscape transitions. Response Retaining walls provide landscaped and tiered arrangement, as defined in the Final MRP DCP.
The layout and connections to the proposed network, including the Intermodal Terminal and Western Sydney freight line.

Response Consideration to the freight network has been made as defined in the Final MRP DCP.
The road design and widths, including application of the indicative precinct wide road network Response Consideration to the road design and network has been made as defined in the Final MRP DCP. Refer **Section 4** and ASON Group traffic impact assessment.
how bulk earthworks and the road pattern have been prepared to connect to adjoining sites to enable their feasible development for industrial purposes (as proposed in the WSEA SEPP amendment and structure plan.). Response The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels and road networks on the adjacent sites to the south and west, contemplated by Mirvac and Altis Property Partners, through consultation with the respective developers has also been made. Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**.
Bulk earthworks flooding impacts Response Refer **Section 8** for flooding and flood impact assessments.
conservation and protection of areas with heritage and aboriginal heritage significance Response Refer heritage and aboriginal heritage assessments by the relevant consultants.
and the building heights in relation to ridgelines and adjoining rural -residential views Response Refer visual assessment by SBA.

Any Infrastructure, including roads and drainage infrastructure, should be located on industrial land (i.e., not SP2 or E2). Response Infrastructure has not been located in SP2 or E2 corridors. Integration of water attenuation has been made in the watercourse at the junction of the watercourse and the proposed road culvert, as recommended in the DRAFT Mamre Precinct Integrated Water Cycle Management Plan (Sydney Water/ DPIE 2020).
The SSD must consider the draft Mamre Road Precinct DCP. This includes building controls such as setbacks, built form, landscaping and height controls. Should the SSD progress prior to the finalisation of a precinct wide DCP for the Mamre Road Precinct, a site specific DCP will be required to be prepared. The DCP will need to be prepared in accordance with the existing requirements of the WSEA SEPP and the Precinct Structure Plan, in close consultation with the Department. Matters to be addressed are identified in Schedule 4 of WSEA SEPP as well as particular site characteristics such as (but not limited to) landscaping and setback controls, building design. Alternatives to this approach may be considered through ongoing consultation with DPIE. Response The requirements of the Final MRP DCP have been included throughout the civil engineering design and reporting, and within the whole of the estate master planning.

Authority Information Requests	*Response*
Penrith City Council	
The site's topography is undulating and the proposed large and level warehouse building pads will need to be considered in the context of broader drainage requirements and integration with adjoining land which are also likely to be developed for employment land uses. The development must avoid large expanses and/or high retaining walls/batters.	The development responds to the topography by providing development pads which step from progressively from the existing high point on the east of the development site, to the lowest part of the site on the west adjacent to Mamre Road. Consideration to the anticipated development levels on the adjacent sites to the south and west, contemplated by Mirvac and Altis Property Partners, through consultation with the respective developers has also been made. Overall, it can be anticipated that, on a development site which has a level differences of approximately 44m, and proposed large format industrial warehouse (as zoned) that level changes and retaining structures will be required to facilitate flat building pads and benching suitable for logistics and distribution. This is a fundamental requirement for the effective development over the entire Mamre Road Precinct and a point that has been discussed with DPIE.

Authority Information Requests	*Response*
	Refer to **Section 3.2** and **3.3,** and drawings included in **Appendix A**..
The stormwater drainage for the site must be in accordance with the council's Development Control Plan, as well as the Stormwater Drainage Specification for Building Development policy, and the Water Sensitive Urban Design Policy and Technical Guidelines.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council and the Final MRP DCP), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.

Authority Information Requests	*Response*
A stormwater concept plan, accompanied by a supporting report and calculations, shall be submitted with the application.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council and the Final MRP DCP), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
The application shall demonstrate that downstream stormwater systems have adequate capacity to accommodate stormwater flows generated from the development. This may require the provision of on-site detention to reduce stormwater flows or upgrade of stormwater infrastructure to increase capacity.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council and the Final MRP DCP), have

Authority Information Requests	*Response*
	been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
Any on-site detention system must be within common property and accessible from the street.	Detention systems are noted to be accessible and within common property of the estate. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
A water sensitive urban design strategy prepared by a suitably qualified person is to be provided for the site. The strategy shall address water conservation, water quality, water quantity, as well as operation and maintenance.	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The stormwater strategy has been completed by Costin Roe Consulting, being professional engineers with demonstrated experience in similar industrial projects within Kemps Creek and Penrith City Council LGA.

Authority Information Requests	*Response*
	The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council and the Final MRP DCP), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**.
The application shall include MUSIC modelling (.sqz file) demonstrating compliance with councils adopted water urban design policy and technical guidelines.*	Refer **Section 6** and **Appendix B** for MUSIC modelling and demonstration of meeting the nominated objectives.
On lot treatment is to be provided to meet all water quality and water quantity targets. Full details are to be submitted with the application. Penrith City Council will not maintain any estate basins nor accept the dedication of any land for the provision of estate basins.	Configuration of the proposed measures and stormwater layout concept are shown on the Civil Design Drawings included in **Appendix A**. Management of basins will be completed by the proponent.
The flood impact assessment report submitted with the application, shall address the site is categorised as being flood affected by local overland flow flooding.	Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting

Authority Information Requests	*Response*
Furthermore, the application must demonstrate that the development proposal is consistent with Councils Development Control Plan for Flood Liable Land.	information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP, the Final MRP DCP and the

Authority Information Requests	*Response*
	proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
Overland flows shall be managed safely through the site and not diverted onto adjoining properties. The development shall not have any adverse impact upon adjoining properties through the damming, concentration or diversion of overland flows. All habitable floor levels shall be a minimum of 0.5m above the 1% AEP water surface level.	Refer to **Section 8** for detailed flood assessment and **Appendix E** for technical supporting information relating to the flood assessment. A flood assessment has been undertaken using the two-dimensional TUFLOW modelling engine. Assessment includes pre and post development modelling of the 5% AEP, 1% AEP, 0.5% AEP, 0.2% AEP and the PMF events. Impact assessments have been included for the 1% AEP, and the 0.5% AEP, 0.2% AEP events assessed as proxies for climate change. The assessment includes mapping of flood prone land, flood planning areas, hydraulic categorization and flood hazards. It is noted that the site is not within the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the first order watercourse within the riparian corridor. This watercourse presents low

Authority Information Requests	*Response*
	hazard to the development and future occupants of the development site. The assessment shows acceptable outcomes which meet the objectives of the NSW Floodplain Development Manual, Penrith City Council DCP. Final MRP DCP and the proposed amendments to the Penrith City Council DCP proposed in the *Exhibition Draft South Creek Floodplain Management Plan 2020*.
The Civil plans shall address that no retaining walls or filling is permitted for this development which will impede, divert or concentrate stormwater runoff passing through the site. Furthermore, Earthworks and retaining walls must comply with Council's Development Control Plan.	The civil engineering design allows for conveyance of all upstream flows as demonstrated through the overland flow assessment in **Section 8** and Civil Engineering drawings in **Appendix A**. Earthworks and wall designs have been completed based on the arrangements proposed in the Final MRP DCP.
The application is to be supported by a geotechnical report prepared by a suitably qualified person for the site and shall address, but not be limited to ground water movement, salinity, and contamination.	Geotechnical investigations have been completed by PSM. Refer to separate reports by PSM and **Section 3** of this report.
Regarding Traffic considerations, the Council require adjusted road cross sections including verge widths in the draft Mamre Precinct DCP. *The council also considers that there should be no driveway access along Mamre Road or along major internal precinct*	Consideration to the road design and network has been made as defined in the Final MRP DCP. Refer **Section 4** and ASON Group traffic impact assessment.

Authority Information Requests	*Response*
link roads, however this SSD has driveway access and a temporary road access here.	Temporary access (left in and left out) is proposed from Mamre Road until such time that internal precinct roads are constructed. Separate discussions with TfNSW has been undertaken in this regard.
A Stormwater management Strategy will need to be prepared by suitably qualified professional in support of the development. The strategy shall outline how Water Sensitive Urban Design is being incorporated into the design of the development as well as outline how the receiving waters and environment will be safeguarded from the proposed works. The strategy should address the entire site. This should include details into proposed sedimentation and erosion controls as well as the management of stormwater more generally including, as to how increased volumes, peak flows and pollutants in the increased runoff that is likely to increase as a result of the development, will be managed. *The water and Soil Management Strategy needs to demonstrate and outline how both surface and groundwater resources as well as dependent ecosystems will be safeguarded for both the construction stages and for the operational stages of the development. The strategy should also outline what is proposed in relation to the dams located on the site.* *In developing the strategy, consideration Council's WSUD Policy, WSEA SEPP and the liveability and water management principles, that have been identified in the Western City District Plan including the planning priority to* ***protect and improve the health and enjoyment of the District's waterways*** *should be considered.*	Stormwater assessment and management strategy, including surface water runoff, water quality and water quantity has been completed. The stormwater strategy has been completed by Costin Roe Consulting, being professional engineers with demonstrated experience in similar industrial projects within Kemps Creek and Penrith City Council LGA. The key stormwater objectives, based on relevant water quality criteria (including those of Penrith City Council), have been set out in **Section 5, 6 & 7** of the report. **Section 6** provides demonstration of water quantity requirements being met. **Section 7** provides demonstration of the key water criteria being met, based on MUSIC modelling. Configuration of the proposed measures and stormwater layout concept are shown on the Civil

Authority Information Requests	*Response*
	Design Drawings included in **Appendix A**.
With regards to the riparian corridors, any changes to existing drainage lines and streams on the site will need to be in accordance with the requirements of the NSW Natural Resources Assess Regulator. However, a focus on the retention of existing drainage lines including any dams is preferred. Further to this, a vegetation management plan which meets the Department's guidelines should be prepared which provides detailed guidance on the management requirements for these areas.	The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.
Any Impacts to existing creeks should be minimised and where possible the preference should be to retain the natural creek lines and dams as well as restore them to the standards recommended by the Natural Resources Assess Regulator.	The design of the realigned engineered channel includes integration of naturalised watercourse elements such as a low flow channel, channel meander, pools and riffles, bank scour protection, rock deflectors, and other elements recommended in industry practice documents for a naturalised channel as consulted with NRAR. Refer **Section 5.6**.
Sydney Water	
The proponent of development should determine service demands following servicing investigations and demonstrate that satisfactory arrangements for drinking water, wastewater, and recycled water (where required) services have been made.	Refer to separate water and wastewater servicing report.
TfNSW – ref:CD20/08907	

The EIS shall provide a flood impact assessment to understand the potential impacts of the development on flood evacuation is to be carried out. The EIS will assess the impacts of the proposed development, information for pre and post- development scenarios including modelling of the local overland flows are to be provided to allow assessment of the impact of the development.

Response

Refer to **Section 8**.

The site is noted to be outside of the South Creek floodplain (being at higher elevation than the South Creek PMF flood extent), however is affected by overland flow associated with the watercourse within the riparian corridor. The development sites are noted to be above the 1% AEP and PMF levels related to overland flow in the watercourse and as such this presents low hazard to the development and future occupants of the development site. If surrounding low level roadways are affected during flooding, on site refuge is available. The development presents low/ no risk to existing community emergency management arrangements.

11 CONCLUSION

This Civil Engineering Report has been prepared to support the State Significant Development Application for a Proposed Development at Lots 59 & 60 DP 259135, Mamre Road, Kemps Creek, NSW.

A civil engineering strategy for the site has been developed which provides a best practice solution within the constraints of the existing landform and proposed development layout. Within this strategy a stormwater quantity and quality management strategy has been developed to reduce both peak flows and pollutant loads in stormwater leaving this site. The stormwater management for the development has been designed in accordance with Penrith City Council and with consideration to the *Final Mamre Road Precinct DCP 2021*.

The hydrological assessment proves local post development flows from the site will be less than pre-development flows and demonstrates that the site discharge will not adversely affect any land, drainage system or watercourse as a result of the development.

During the construction phase, a Sediment and Erosion Control Plan will be in place to ensure the downstream drainage system and receiving waters are protected from sediment laden runoff.

During the operational phase of the development, a treatment train incorporating the use of a proprietary filtration system is proposed to mitigate any increase in stormwater pollutant load generated by the development. MUSIC modelling results indicate that the proposed STM are effective in reducing pollutant loads in stormwater discharging from the site and meet the requirements of Council's pollution reduction targets. Best management practices have been applied to the development to ensure that the quality of stormwater runoff is not detrimental to the receiving environment.

It is confirmed that the EES flow duration and volumetric discharge controls have been met for the current proposed development extent. We note that, given the recent announcement of Sydney Water as the waterway manager, it is anticipated that some documented measures (including additional storage and rainwater tanks) would be temporary only, and subject to either removal if constructed or future SSDA Modifications following Sydney Waters development scheme plans being exhibited and estate management measures and objectives being adjusted to suit the intended regional scheme.

Detailed responses to the SEARS and associated agency requirements has been included in **Section 10** of this report, demonstrating how each requirement has been met.

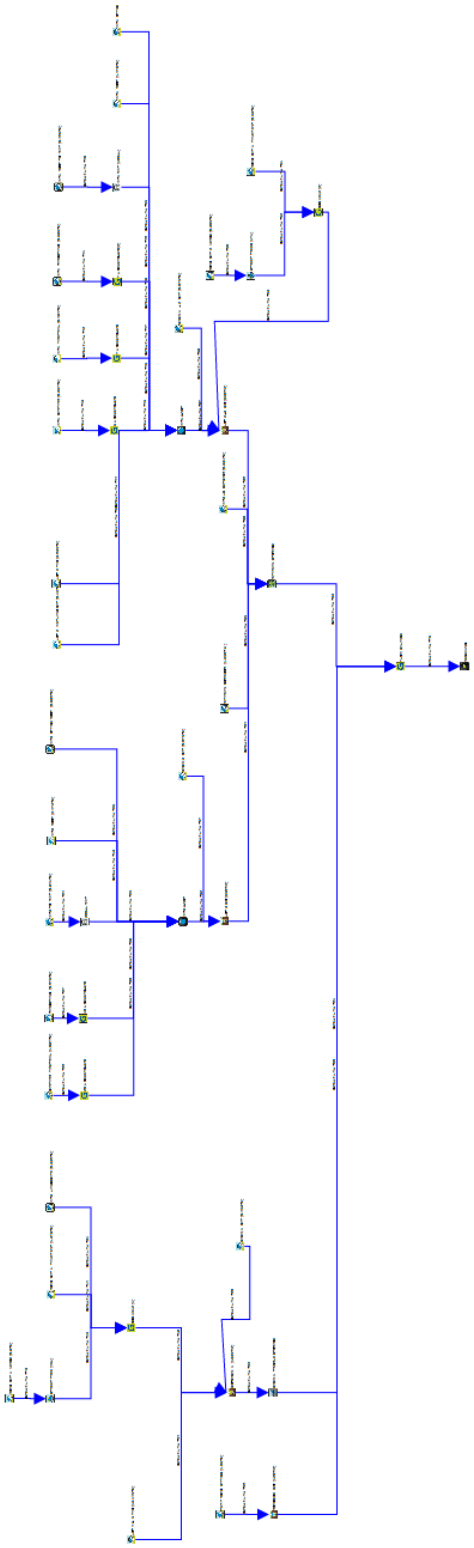
It is recommended the management strategies in this report be approved and incorporated into the future detailed design.

REFERENCES

- NSW Government (2005). *Floodplain Development Manual.*
- Managing Urban Stormwater: Harvesting and Reuse – 2006 (NSW DEC);
- Managing Urban Stormwater: Source Control – 1998 (NSW EPA);
- Managing Urban Stormwater: Treatment Techniques – 1997 (NSW EPA);
- Landcom (2004). *Managing Urban Stormwater – Soils and Construction* – 4th Edition.
- Penrith City Council – DCP 2013 (Part C3); and
- Water Sensitive Urban Design – "Technical Guidelines for Western Sydney" by URS Australia Pty Ltd, May 2004

Appendix B

MUSIC MODEL CONFIGURATION & PARAMETERS



B.1 Introduction

The MUSIC model was chosen to model water quality. This model, released by the Cooperative Research Centre for Catchment Hydrology (CRCCH), is a standard industry model for this purpose. MUSIC (the Model for Urban Stormwater Improvement Conceptualisation) is suitable for simulating catchment areas of up to 100 km^2 and utilises a continuous simulation approach to model water quality.

By simulating the performance of stormwater management systems, MUSIC can be used to predict if the proposed systems and changes to land use are appropriate for their catchments and capable of meeting specified water quality objectives (CRC 2002). The water quality constituents modelled in MUSIC, of relevance to this report, include Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN).

The pollutant retention criteria set out in Section 2.4 of the Final MRP DCP and nominated in **Section 7.1** of this report were used as a basis for assessing the effectiveness of the selected treatment trains.

The MUSIC model "*13874.06-Rev1.sqz*" was set up to examine the effectiveness of the water quality treatment train and to predict if Council's requirements have been achieved.

Modelling parameters used are based on those nominated in the Sydney Catchment Management Authority (SCA) document *Using Music in Sydney's Drinking Water Catchment – A Sydney Catchment Authority Standard (2012)* and *Draft NSW MUSIC Modelling Guidelines (2011).*

B.2 Rainfall Data

As per the recommendation of Table 3-1 of *Draft NSW MUSIC Modelling Guidelines (2011),* six-minute pluviographic data for the Sydney Meteorological Office Station was sourced from the Bureau of Meteorology (BOM) as nominated below. Evapo-transpiration data for the period was sourced from the Sydney Monthly Areal PET data set supplied with the MUSIC software.

Input	**Data Used**
Rainfall Station	67113 Penrith Lakes AWS
Rainfall Period	1999 – 2008 (10 years)
Mean Annual Rainfall (mm)	712
Evapo- transpiration	Sydney Monthly Areal PET
Model Time step	6 minutes

B.3 Rainfall Runoff Parameters

Parameter	**Value**
Rainfall Threshold	1.40
Soil Storage Capacity (mm)	105
Initial Storage (% capacity)	30
Field Capacity (mm)	70
Infiltration Capacity Coefficient a	150

Infiltration Capacity exponent b	3.5
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	10
Daily Seepage Rate (%)	0

B.4 Pollutant Concentrations & Source Nodes

Pollutant concentrations for source nodes are based on parameters adopted by the SCA as per **Table B.1**.

Flow Type	Surface Type	TSS (log_{10} values)		TP (log_{10} values)		TN (log_{10} values)	
		Mean	Std Dev.	Mean	Std Dev.	Mean	Std Dev.
Baseflow	Roof	NA	NA	NA	NA	NA	NA
	Roads	1.20	0.17	-0.85	0.19	0.11	0.12
Stormflow	Roof	1.30	0.32	-0.89	0.25	0.30	0.19
	Roads	2.43	0.32	-0.30	0.25	0.34	0.19

Table B.1. Pollutant Concentrations

The MUSIC model has been setup with a treatment train approach based on the pollutant concentrations in **Table B.1** above.

The relevant stormwater catchment sizes are listed below in **Table B.2** and their configuration within the MUSIC model.

Catchment	Area (Ha)	Source Node	% Impervious	Stormwater Treatment
Roof	14.69	Roof	100	Bio-Retention
Carpark	2.57	Sealedroad	90	GPT & Bio-Retention
Hardstand	5.40	Sealedroad	100	GPT & Bio-Retention
Firetrail	2.53	Sealedroad	100	GPT & Bio-Retention
On-Site Detention Basin	2.29	Revegetatedland	0	-
Landscaping	2.26	Revegetatedland	0	GPT & Bio-Retention
Road Network	2.60	Sealedroad	80	GPT & Bio-Retention
Temporary Road	1.06	Revegetatedland	60	Swale & Bio-Retention
Total	33.40			

Table B.2. Music Model Source Nodes

B.5 Treatment Nodes

Bio-Retention system and Ocean Protect OceanGuard (GPT) nodes have been used in the modelling of the development.

It is noted that the bio-retention node, within the flood storage basin, has been modelled in MUSIC to simulate treatment during low flow and non-flood scenario. The bio-retention node allows for a high flow bypass which would operate when flows from the site are greater than 100 l/s. This flow is based on the 1 in 3-month flow from the site and would simulate a conservative model for the site during the period when the flood basin operates and would not provide treatment to the site. It is noted that the model is conservative in that the flood basin is not expected to operate until flood events which are greater than 1 in 5-year ARI which would mean that possible higher treatment of stormwater from the site. This is considered a suitable and conservative modelling approach for the treatment of stormwater from this site.

B.6 Results

Table B.3 shows the results of the MUSIC analysis. The site treatment effectiveness is expressed as a residual concentration and compares the post-development pollutant loads without treatment versus post-development loads with treatment.

	Total Source Load (kg yr)	**Total Residual Load** (kg/yr)	**Per Hectare Residual Load** (kg/ha/yr)	**Total Target Load** (kg/yr)	**Per Hectare Residual Load** (kg/ha/yr)
Total Suspended Solids (kg/yr)	16090	1031	31.1	2,651	<80
Total Phosphorus (kg/yr)	30.52	6.577	0.20	9.94	<0.3
Total Nitrogen (kg/yr)	196.3	65.14	1.97	116	<3.5
Gross Pollutants (kg/yr)	2494	0	0	16	<16

Table B.3. MUSIC analysis results

The model results indicate that, through the use of the STM in the treatment train, pollutant residual load for Total Suspended Solids, Total Phosphorous, Total Nitrogen and Gross Pollutants will meet the requirements of Section C3 of the Mamre Road *DCP 2021* and Wianamatta MUSIC Modelling Toolkit requirements on an overall catchment basis.

B.7 Modelling Discussion

MUSIC modelling has been performed to assess the effectiveness of the selected treatment trains and to ensure that the pollutant retention requirements of C3 of PCC's DCP2014 have been met.

The MUSIC modelling has shown that the proposed treatment train of STM will provide stormwater treatment which will meet PCC requirements in an effective and economical manner.

Hydrocarbon and oil & grease removal cannot be modelled with MUSIC software. As an industrial estate with users for individual development sites not known, the exact levels of hydrocarbons would not be known however given the expected use of the site as a warehouse distribution centre these pollutants would not be expected to be large. Potential sources of hydrocarbons and/or oil & grease which drain to the stormwater system would be limited to leaking engine sumps or for accidental fuel spills/leaks and leaching of bituminous pavements (car parking only). The potential for these pollutants is low and published data from the CSIRO indicates that average concentrations from industrial sites are in the order of 10mg/L and we would expect source loading from this site to be near to or below this concentration.

Given the expected low source loadings of hydrocarbons and oil/grease and removal efficiencies of the treatment devices and bio-retention systems we consider that the requirements of the Penrith City Council have been met.

Appendix C

DRAFT

CONSTRUCTION SOIL AND WATER MANAGEMENT PLAN

C.1 Introduction

An erosion and sediment control plan (ESCP) is shown on drawing **Co13874.06-DA200** with details on **DA250**. These are conceptual plans only providing sufficient detail to clearly show that the works can proceed without undue pollution to receiving waters. A detailed plan will be prepared once consent is given and before works start.

C.2 General Conditions

1. The ESCP will be read in conjunction with the engineering plans, and any other plans or written instructions that may be issued in relation to development at the subject site.
2. Contractors will ensure that all soil and water management works are undertaken as instructed in this specification and constructed following the guidelines stated in *Managing Urban Stormwater, Soils and Construction (1998) "The Blue Book"* and Penrith City Council specifications.
3. All subcontractors will be informed of their responsibilities in minimising the potential for soil erosion and pollution to down slope areas.

C.3 Land Disturbance

1. Where practicable, the soil erosion hazard on the site will be kept as low as possible and as recommended in Table C.1.

Land Use	Limitation	Comments
Construction areas	Limited to 5 (preferably 2) metres from the edge of any essential construction activity as shown on the engineering plans.	All site workers will clearly recognise these areas that, where appropriate, are identified with barrier fencing (upslope) and sediment fencing (downslope), or similar materials.
Access areas	Limited to a maximum width of 5 metres	The site manager will determine and mark the location of these zones onsite. They can vary in position so as to best conserve existing vegetation and protect downstream areas while being considerate of the needs of efficient works activities. All site workers will clearly recognise these boundaries.
Remaining lands	Entry prohibited except for essential management works	

Table C.1 Limitations to access

C.4 Erosion Control Conditions

1. Clearly visible barrier fencing shall be installed as shown on the plan and elsewhere at the discretion of the site superintendent to ensure traffic control and prohibit unnecessary site disturbance. Vehicular access to the site shall be limited to only those essential for construction work and they shall enter the site only through the stabilised access points.
2. Soil materials will be replaced in the same order they are removed from the ground. It is particularly important that all subsoils are buried and topsoils remain on the surface at the completion of works.
3. Where practicable, schedule the construction program so that the time from starting land disturbance to stabilisation has a duration of less than six months.
4. Notwithstanding this, schedule works so that the duration from the conclusion of land shaping to completion of final stabilisation is less than 20 working days.
5. Land recently established with grass species will be watered regularly until an effective cover has properly established and plants are growing vigorously. Further application of seed might be necessary later in areas of inadequate vegetation establishment.
6. Where practical, foot and vehicular traffic will be kept away from all recently established areas
7. Earth batters shall be constructed in accordance with the Geotechnical Engineers Report or with as law a gradient as practical but not steeper than:
    - 2H:1V where slope length is less than 7 metres
    - 2.5H:1V where slope length is between 7 and 10 metres
    - 3H:1V where slope length is between 10 and 12 metres
    - 4H:1V where slope length is between 12 and 18 metres
    - 5H:1V where slope length is between 18 and 27 metres
    - 6H:1V where slope length is greater than 27 metres
8. All earthworks, including waterways/drains/spillways and their outlets, will be constructed to be stable in at least the design storm event.
9. During windy weather, large, unprotected areas will be kept moist (not wet) by sprinkling with water to keep dust under control. In the event water is not available in sufficient quantities, soil binders and/or dust retardants will be used or the surface will be left in a cloddy state that resists removal by wind.

C.5 Pollution Control Conditions

1. Stockpiles will not be located within 5 metres of hazard areas, including likely areas of high velocity flows such as waterways, paved areas and driveways. Silt/ sediment fences and appropriate stabilisation of stockpiles are to be provided as detailed on the drawings.
2. Sediment fences will:
   a) Be installed where shown on the drawings, and elsewhere at the discretion of the site superintendent to contain the coarser sediment fraction (including aggregated fines) as near as possible to their source.
   b) Have a catchment area not exceeding 720 square meters, a storage depth (including both settling and settled zones) of at least 0.6 meters, and internal dimensions that provide maximum surface area for settling, and
   c) Provide a return of 1 metre upslope at intervals along the fence where catchment area exceeds 720 square meters, to limit discharge reaching each section to 10 litres/second in a maximum 20-year t_c discharge.
3. Sediment removed from any trapping device will be disposed in locations where further erosion and consequent pollution to down slope lands and waterways will not occur.
4. Water will be prevented from directly entering the permanent drainage system unless it is relatively sediment free (i.e. the catchment area has been permanently landscaped and/or likely sediment has been treated in an approved device). Nevertheless, stormwater inlets will be protected.
5. Temporary soil and water management structures will be removed only after the lands they are protecting are stabilised.

C.6 Waste Management Conditions

Acceptable bind will be provided for any concrete and mortar slurries, paints, acid washings, lightweight waste materials and litter. Clearance service will be provided at least weekly.

C.7 Site Inspection and Maintenance

1. A self-auditing program will be established based on a Check Sheet. A site inspection using the Check Sheet will be made by the site manager:
   - At least weekly.
   - Immediately before site closure.
   - Immediately following rainfall events in excess of 5mm in any 24-hour period.

   The self-audit will include:
   - Recording the condition of every sediment control device
   - Recording maintenance requirements (if any) for each sediment control device

- Recording the volumes of sediment removed from sediment retention systems, where applicable
- Recording the site where sediment is disposed
- Forwarding a signed duplicate of the completed Check Sheet to the project manager/developer for their information

2. In addition, a suitably qualified person will be required to oversee the installation and maintenance of all soil and water management works on the site. The person shall be required to provide a short monthly written report. The responsible person will ensure that:
   - The plan is being implemented correctly
   - Repairs are undertaken as required
   - Essential modifications are made to the plan if and when necessary

   The report shall carry a certificate that works have been carried out in accordance with the plan.
3. Waste bins will be emptied as necessary. Disposal of waste will be in a manner approved by the Site Superintendent.
4. Proper drainage will be maintained. To this end drains (including inlet and outlet works) will be checked to ensure that they are operating as intended, especially that,
   - No low points exist that can overtop in a large storm event
   - Areas of erosion are repaired (e.g. lined with a suitable material) and/or velocity of flow is reduced appropriately through construction of small check dams of installing additional diversion upslope.
   - Blockages are cleared (these might occur because of sediment pollution, sand/soil/spoil being deposited in or too close to them, breached by vehicle wheels, etc.).
5. Sand/soil/spoil materials placed closer than 2 meters from hazard areas will be removed. Such hazard areas include and areas of high velocity water flows (e.g. waterways and gutters), paved areas and driveways.
6. Recently stabilised lands will be checked to ensure that erosion hazard has been effectively reduced. Any repairs will be initiated as appropriate.
7. Excessive vegetation growth will be controlled through mowing or slashing.
8. All sediment detention systems will be kept in good, working condition. In particular, attention will be given to:
   a) Recent works to ensure they have not resulted in diversion of sediment laden water away from them
   b) Degradable products to ensure they are replaced as required, and
   c) Sediment removal, to ensure the design capacity or less remains in the settling zone.
9. Any pollutants removed from sediment basins or litter traps will be disposed of in areas where further pollution to down slope lands and waterways should not occur.

10. Additional erosion and/or sediment control works will be constructed as necessary to ensure the desired protection is given to down slope lands and waterways, i.e. make ongoing changes to the plan where it proves inadequate in practice or is subjected to changes in conditions at the work site or elsewhere in the catchment.
11. Erosion and sediment control measures will be maintained in a functioning condition until all earthwork activities are completed and the site stabilised
12. Litter, debris and sediment will be removed from the gross pollutant traps and trash racks as required.

EROSION AND SEDIMENT CONTROL
WEEKLY SITE INSPECTION SHEET

LOCATION .....
INSPECTION OFFICER ..... **DATE** .....
SIGNATURE .....

Legend: □ OK □ Not OK N/A Not applicable

Item	Consideration	Assessment
1	Public roadways clear of sediment.	.....
2	Entry/exit pads clear of excessive sediment deposition.	.....
3	Entry/exit pads have adequate void spacing to trap sediment.	.....
4	The construction site is clear of litter and unconfined rubbish.	.....
5	Adequate stockpiles of emergency ESC materials exist on site.	.....
6	Site dust is being adequately controlled.	.....
7	Appropriate drainage and sediment controls have been installed prior to new areas being cleared or disturbed.	.....
8	Up-slope "clean" water is being appropriately diverted around/through the site.	.....
9	Drainage lines are free of soil scour and sediment deposition.	.....
10	No areas of exposed soil are in need of erosion control.	.....
11	Earth batters are free of "rill" erosion.	.....
12	Erosion control mulch is not being displaced by wind or water.	.....
13	Long-term soil stockpiles are protected from wind, rain and stormwater flow with appropriate drainage and erosion controls.	.....
14	Sediment fences are free from damage.	.....
15	Sediment-laden stormwater is not simply flowing "around" the sediment fences or other sediment traps.	.....
16	Sediment controls placed up-slope/around stormwater inlets are appropriate for the type of inlet structure.	.....
17	All sediment traps are free of excessive sediment deposition.	.....
18	The settled sediment layer within a sediment basin is clearly visible through the supernatant prior to discharge such water.	.....
19	All reasonable and practicable measures are being taken to control sediment runoff from the site.	.....
20	All soil surfaces are being appropriately prepared (i.e. pH, nutrients, roughness and density) prior to revegetation.	.....
21	Stabilised surfaces have a minimum 70% soil coverage.	.....
22	The site is adequately prepared for imminent storms.	.....
23	All ESC measures are in proper working order.	.....

Appendix D

DRAFT

STORMWATER SYSTEM MAINTENANCE SCHEDULE

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
SWALES/ LANDSCAPED AREAS			
Check density of vegetation and ensure minimum height of 150mm is maintained. Check for any evidence of weed infestation	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Inspect swale for excessive litter and sediment build up	Six monthly	Maintenance Contractor	Remove sediment and litter and dispose in accordance with local authorities' requirements.
Check for any evidence of channelisation and erosion	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed swale profile is maintained
Weed Infestation	Three Monthly	Maintenance Contractor	Remove any weed infestation ensuring all root ball of weed is removed. Replace with vegetation where required.
Inspect swale surface for erosion	Six Monthly	Maintenance Contractor	Replace top soil in eroded area and cover and secure with biodegradable fabric. Cut hole in fabric and revegetate.
INLET & JUNCTION PITS			
Inside of pits	Six Monthly	Maintenance Contractor	Remove grate and inspect internal walls and base, repair where required. Remove any collected sediment, debris, litter.
Outside of pits	Four Monthly/ After Major Storm	Maintenance Contractor	Clean grate of collected sediment, debris, litter and vegetation.
PROPRIETARY TREATMENT DEVICES (OceanSave GPT)			
Refer to Manufacturers Operation and Maintenance Manuel	Annually	Maintenance Contractor	Refer to Manufacturers Operation and Maintenance Manuel

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
BIORETENTION BASIN			
Check all items nominated for SWALES/ LANDSCAPED AREAS above	Refer to SWALES/ LANDSCAPED AREAS section above	Refer to SWALES/ LANDSCAPED AREAS section above	Refer to SWALES/ LANDSCAPED AREAS section above
Check for sediment accumulation at inflow points	Six monthly/ After Major Storm	Maintenance Contractor	Remove sediment and dispose in accordance with local authorities' requirements.
Check for erosion at inlet or other key structures.	Six monthly/ After Major Storm	Maintenance Contractor	Reinstate eroded areas so that original, designed profile is maintained
Check for evidence of dumping (litter, building waste or other).	Six monthly	Maintenance Contractor	Remove waste and litter and dispose in accordance with local authorities' requirements.
Check condition of vegetation is satisfactory (density, weeds, watering, replating, mowing/ slashing etc)	Six monthly	Maintenance Contractor	Replant and/or fertilise, weed and water in accordance with landscape consultant specifications
Check for evidence of prolonged ponding, surface clogging or clogging of drainage structures	Six monthly/ After Major Storm 5-10 years	Maintenance Contractor	Remove sediment and dispose in accordance with local authorities' requirements. Replace filter media & planting – refer to appropriately qualified engineer or stormwater specialist
Check stormwater pipes and pits	Six monthly/ After Major Storm	Maintenance Contractor	Refer to INLET/ JUNCTION PIT section.
FUTURE RAINWATER TANK			
Check for any clogging and blockage of the first flush device	Monthly	Maintenance Contractor	First flush device to be cleaned out

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Check for any clogging and blockage of the tank inlet - leaf/litter screen	Six monthly	Maintenance Contractor	Leaves and debris to be removed from the inlet leaf/litter screen
Check the level of sediment within the tank	Every two years	Maintenance Contractor	Sediment and debris to be removed from rainwater tank floor if sediment level is greater than the maximum allowable depth as specified by the hydraulic consultant
STORMWATER SYSTEM			
General Inspection of complete stormwater drainage system	Bi-annually	Maintenance Contractor	Inspect all drainage structures noting any dilapidation in structures and carry out required repairs.
OSD SYSTEM			
Inspect and remove any blockage from orifice	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen to inspect orifice.
Inspect trash screen and clean	Six Monthly	Maintenance Contractor/ Owner	Remove grate and screen if required to clean it.
Inspect flap valve and remove any blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate. Ensure flap valve moves freely and remove any blockages or debris.
Inspect pit sump for damage or blockage.	Six Monthly	Maintenance Contractor/ Owner	Remove grate & screen. Remove sediment/ sludge build up and check orifice and flap valve are clear.
Inspect storage areas and remove debris/ mulch/ litter etc likely to block screens/ grates.	Six Monthly	Maintenance Contractor/ Owner	Remove debris and floatable materials.
Check attachment of orifice plate and screen to wall of pit	Annually	Maintenance Contractor	Remove grate and screen. Ensure plate or screen mounted securely, tighten fixings if required. Seal gaps if required.

MAINTENANCE ACTION	FREQUENCY	RESPONSIBILITY	PROCEDURE
Check orifice diameter is correct and retains sharp edge.	Five yearly	Maintenance Contractor	Compare diameter to design (see Work-as-Executed) and ensure edge is not pitted or damaged.
Check screen for corrosion	Annually	Maintenance Contractor	Remove grate and screen and examine for rust or corrosion, especially at corners or welds.
Inspect overflow weir and remove any blockage	Six monthly	Maintenance Contractor/ Owner	Ensure weir is free of blockage.
Inspect walls for cracks or spalling	Annually	Maintenance Contractor	Remove grate to inspect internal walls, repair as necessary.
Check step irons	Annually	Maintenance Contractor	Ensure fixings are secure and irons are free from corrosion.

Appendix F

AUTHORITY CONSULTATION

Natural Resources Access Regulator

Meeting

FILE NOTE

Re: Meeting – GPT Site – Mamre Road Precinct

The subject development was discussed at a VC meeting chaired by Bruce Colman (Urbis) on 3/08/2020.

During the meeting the proposed treatment of the mapped watercourse as detailed in the Cumberland Ecology report dated 16/07/2020 was discuss. Figure 1 – proposed watercourse realignment

Key advice provided by NRAR

- The mapped watercourse within the subject site was previously assessed by NRAR and it was determined that it was not considered to be waterfront land as defined by the Water Management Act 2000.
- The reconstruction of a post development channel and establishment of a riparian corridor as per the DPE rezoning plan and DCP was and is supported by NRAR.
- NRAR is in general agreement that the proposed reconstructed watercourse within the GTP site can be realigned. Realignment should not include 90 degree sharp meanders. The alignment should mimic natural stream design.
- Realignment is to minimise impact to remnant vegetation areas upstream of the site.
- NRAR requires details of the realignment on up and down stream sites prior to signing off on final realignment.
- NRAR does not support the reduction in the corridor width from 40m to 20m in the upstream reach within the GPT site. It is noted that the reduction of stream ordering due to the removal of upstream 1st order watercourses is contrary to the requirements of the NRAR CAA Guidelines for riparian corridors.
- NRAR recommended that flood detention requirements be considered and suitable locations for basins be allocated early in the planning process.
- During the meeting it was confirmed that the development on the site was to be lodged through the State Significant Development process and therefore would be exempt for the need to obtain a Controlled Activity Approval.

Jeremy Morice
Water Regulation Officer

4/08/2020

Figure 2. Proposed re-aligned E2 zone

Figure 1 – Cumberland Ecology Report plan

Appendix G

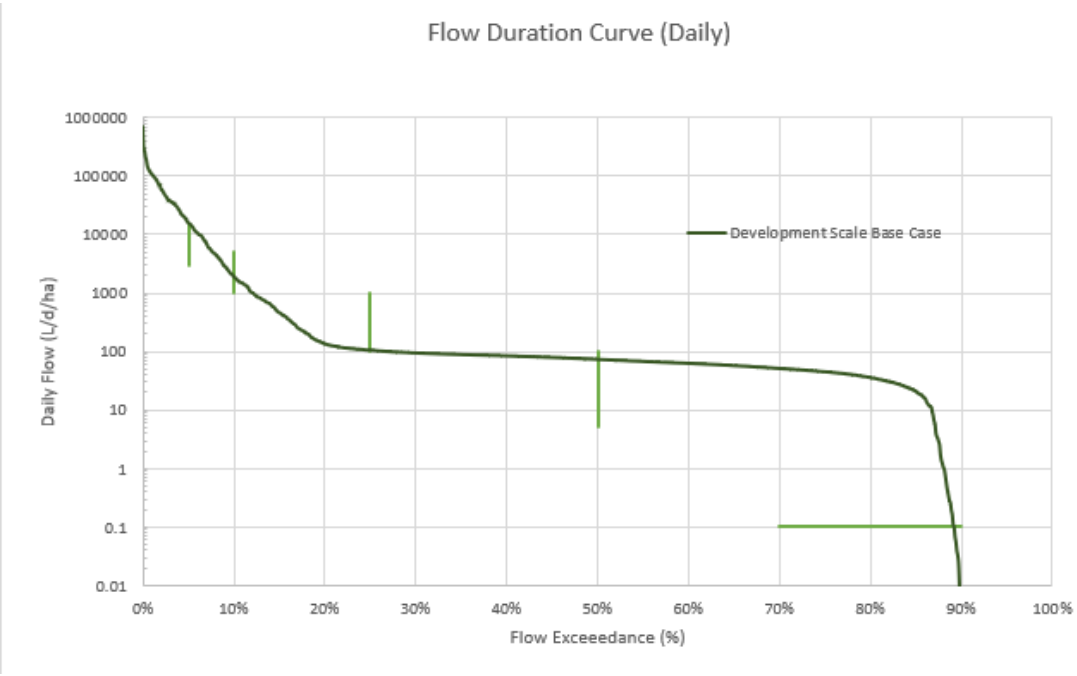
COSTIN ROE CONSULTING LETTERS

DATED 18 August 2020 & 27 October 2020

TO NRAR

Appendix H
EES MUSIC MODELLING TOOLKIT RESULTS
ESTATE MODEL

Targets Alternative 2			
Indice	Result	Comply	Target
MARV (ML/ha/yr)	1.56	Yes	≤ 2
90%ile	1885	Yes	1000 to 5000 L/ha/day
50%ile	72	Yes	5 to 100 L/ha/day
10%ile	0	Yes	0 L/ha/day



Percentile	Flow (L/ha/day)
0.0%	696744.6831
0.1%	297726.3466
0.2%	268996.7436
0.3%	212853.2966
0.4%	186580.1655
0.5%	149683.0103
0.6%	134123.6576
0.7%	124115.4667
0.8%	119376.4024
0.9%	111528.9419
1.0%	107006.98
1.1%	102002.1727
1.2%	97253.91858
1.3%	93888.54649
1.4%	88830.91288
1.5%	86597.93134
1.6%	79782.52337
1.7%	74023.80814
1.8%	69559.69306
1.9%	68475.9197
2.0%	59942.49948
2.1%	57843.95749
2.2%	54747.60103
2.3%	51645.23032
2.4%	47628.78899
2.5%	45855.84159
2.6%	43701.48447
2.7%	41496.40687
2.8%	37829.11433
2.9%	37513.9694
3.0%	37057.21844
3.1%	36111.69717
3.2%	35305.14069
3.3%	34629.9537
3.4%	33291.2232
3.5%	32864.64424
3.6%	31201.60916
3.7%	30282.82305
3.8%	28965.85515
3.9%	27688.48725
4.0%	25848.90008
4.1%	24600.84816
4.2%	22394.16644
4.3%	21719.3666

Percentile	Flow (L/ha/day)
4.4%	20705.92015
4.5%	20218.85563
4.6%	19411.64743
4.7%	18741.61424
4.8%	18030.94407
4.9%	16236.60535
5.0%	15865.74502
5.1%	15284.6783
5.2%	15066.84738
5.3%	14509.78979
5.4%	13762.33164
5.5%	13180.31189
5.6%	12368.5645
5.7%	11748.09025
5.8%	11265.13676
5.9%	10945.86816
6.0%	10677.99202
6.1%	10132.23665
6.2%	9919.298825
6.3%	9712.700882
6.4%	9562.377589
6.5%	9136.208354
6.6%	8739.31885
6.7%	8218.613216
6.8%	7780.389544
6.9%	7574.363056
7.0%	7055.039286
7.1%	6487.748402
7.2%	5977.607235
7.3%	5846.48901
7.4%	5701.760144
7.5%	5391.173606
7.6%	5115.685162
7.7%	4924.168012
7.8%	4792.250912
7.9%	4693.485645
8.0%	4564.160981
8.1%	4311.042273
8.2%	4241.213793
8.3%	4048.542994
8.4%	3907.483616
8.5%	3664.909578
8.6%	3529.430519
8.7%	3344.650954

Percentile	Flow (L/ha/day)
8.8%	3129.391442
8.9%	2959.471732
9.0%	2856.209908
9.1%	2742.521905
9.2%	2671.298551
9.3%	2547.16643
9.4%	2412.774858
9.5%	2326.421175
9.6%	2182.835537
9.7%	2108.326028
9.8%	2074.425546
9.9%	2012.694625
10.0%	1885.070271
10.1%	1832.588316
10.2%	1781.090193
10.3%	1723.072881
10.4%	1645.195154
10.5%	1590.069361
10.6%	1536.371
10.7%	1520.954881
10.8%	1486.440159
10.9%	1471.949864
11.0%	1459.316188
11.1%	1411.450912
11.2%	1365.219939
11.3%	1336.650411
11.4%	1311.288493
11.5%	1278.49814
11.6%	1229.693901
11.7%	1130.886961
11.8%	1063.993651
11.9%	1033.322995
12.0%	1008.243544
12.1%	991.3292696
12.2%	963.9999332
12.3%	921.9521758
12.4%	900.2622538
12.5%	883.5069777
12.6%	855.1781599
12.7%	834.5400635
12.8%	826.4539973
12.9%	813.5475173
13.0%	792.662454
13.1%	774.725002

Percentile	Flow (L/ha/day)
13.2%	759.0817099
13.3%	746.3375836
13.4%	732.6886172
13.5%	707.1540016
13.6%	694.0150237
13.7%	679.9245986
13.8%	675.0590061
13.9%	660.9613708
14.0%	646.2278404
14.1%	626.0241328
14.2%	593.4859248
14.3%	581.2430791
14.4%	568.8727463
14.5%	552.4899712
14.6%	518.7612529
14.7%	502.3435748
14.8%	486.9499725
14.9%	468.6378466
15.0%	457.0241422
15.1%	449.2911422
15.2%	440.0768007
15.3%	421.648977
15.4%	415.6881949
15.5%	403.6446109
15.6%	398.3857854
15.7%	389.2830991
15.8%	381.1133679
15.9%	359.5924034
16.0%	354.3750586
16.1%	345.1017633
16.2%	336.0591523
16.3%	322.3709506
16.4%	313.1520336
16.5%	303.423647
16.6%	294.7958993
16.7%	288.6071198
16.8%	278.8184517
16.9%	264.8917678
17.0%	254.3896997
17.1%	246.3378166
17.2%	242.3446167
17.3%	236.3438476
17.4%	234.478046
17.5%	227.8109299

Percentile	Flow (L/ha/day)
17.6%	223.3952075
17.7%	218.9977455
17.8%	214.9781276
17.9%	205.7265336
18.0%	200.3778374
18.1%	198.8799429
18.2%	194.6925254
18.3%	190.4796824
18.4%	180.4307999
18.5%	173.0379738
18.6%	170.5934183
18.7%	167.8911272
18.8%	163.107674
18.9%	159.7503033
19.0%	155.7696602
19.1%	152.7352223
19.2%	151.1022877
19.3%	149.4684381
19.4%	146.5640953
19.5%	144.0720692
19.6%	143.2193005
19.7%	138.9822237
19.8%	137.5929265
19.9%	135.5511493
20.0%	134.8984408
20.1%	132.3199483
20.2%	130.8547949
20.3%	129.0838837
20.4%	127.9811224
20.5%	126.6995296
20.6%	126.3055608
20.7%	124.504357
20.8%	124.1506573
20.9%	123.4001924
21.0%	122.5607424
21.1%	122.1401957
21.2%	121.3690869
21.3%	120.8242492
21.4%	118.8811569
21.5%	118.3198375
21.6%	117.2682956
21.7%	116.8486606
21.8%	116.6416526
21.9%	115.7201464

Percentile	Flow (L/ha/day)
22.0%	115.1444651
22.1%	114.3233992
22.2%	113.8045838
22.3%	113.5264002
22.4%	113.0709475
22.5%	112.7501288
22.6%	112.277524
22.7%	112.0351155
22.8%	111.0480764
22.9%	110.8502849
23.0%	110.6608435
23.1%	110.510068
23.2%	109.7563719
23.3%	109.2631357
23.4%	108.936592
23.5%	108.6370957
23.6%	108.1159755
23.7%	107.5947191
23.8%	107.3273814
23.9%	107.2617148
24.0%	107.1616928
24.1%	107.1108559
24.2%	106.3453373
24.3%	106.1996608
24.4%	105.8878291
24.5%	105.2132125
24.6%	104.9804469
24.7%	104.7766968
24.8%	104.3716741
24.9%	104.2262468
25.0%	103.9841434
25.1%	103.6714671
25.2%	103.5058997
25.3%	103.2013614
25.4%	102.9144364
25.5%	102.7612292
25.6%	102.4767501
25.7%	102.0478663
25.8%	101.8421072
25.9%	101.4625888
26.0%	101.0524107
26.1%	100.7925892
26.2%	100.5927471
26.3%	100.4165638

Percentile	Flow (L/ha/day)
26.4%	100.2873587
26.5%	99.94405581
26.6%	99.6095919
26.7%	99.25749136
26.8%	99.00062854
26.9%	98.82882486
27.0%	98.60901205
27.1%	98.37492459
27.2%	98.01955104
27.3%	97.83103794
27.4%	97.48669084
27.5%	97.31454636
27.6%	97.21893331
27.7%	97.1053366
27.8%	96.95768275
27.9%	96.80926579
28.0%	96.66866367
28.1%	96.49816367
28.2%	96.29799256
28.3%	96.18834562
28.4%	96.02036467
28.5%	95.88722292
28.6%	95.78496852
28.7%	95.62042725
28.8%	95.43114024
28.9%	95.35812758
29.0%	95.23726102
29.1%	94.76412904
29.2%	94.49733855
29.3%	94.44335917
29.4%	94.22211461
29.5%	93.97785806
29.6%	93.82035988
29.7%	93.70819425
29.8%	93.596092
29.9%	93.42035142
30.0%	93.28220313
30.1%	93.1275741
30.2%	93.06425995
30.3%	92.87756335
30.4%	92.72310493
30.5%	92.55681627
30.6%	92.42733965
30.7%	92.36528764

Percentile	Flow (L/ha/day)
30.8%	92.24452695
30.9%	92.02295578
31.0%	91.88343045
31.1%	91.7810926
31.2%	91.7044459
31.3%	91.5711279
31.4%	91.49263613
31.5%	91.26911368
31.6%	91.188527
31.7%	91.09006171
31.8%	91.0197149
31.9%	90.92155124
32.0%	90.7317034
32.1%	90.66081216
32.2%	90.58541769
32.3%	90.41316182
32.4%	90.27328405
32.5%	90.13587287
32.6%	90.04054926
32.7%	89.94982521
32.8%	89.90429886
32.9%	89.86202578
33.0%	89.72341842
33.1%	89.61681495
33.2%	89.48647148
33.3%	89.37432281
33.4%	89.29766908
33.5%	89.13525466
33.6%	89.00651433
33.7%	88.94244292
33.8%	88.92777326
33.9%	88.85890921
34.0%	88.70963153
34.1%	88.60250924
34.2%	88.53599272
34.3%	88.428497
34.4%	88.25941342
34.5%	88.23017608
34.6%	88.1410055
34.7%	88.03549541
34.8%	87.93724165
34.9%	87.86157429
35.0%	87.68561446
35.1%	87.58571616

Percentile	Flow (L/ha/day)
35.2%	87.41470303
35.3%	87.31291923
35.4%	87.26290859
35.5%	87.21319755
35.6%	87.16945599
35.7%	87.10494527
35.8%	87.05440301
35.9%	86.96572637
36.0%	86.90908901
36.1%	86.75928364
36.2%	86.60372099
36.3%	86.51361904
36.4%	86.34553648
36.5%	86.30312328
36.6%	86.22177439
36.7%	86.12280041
36.8%	86.05518855
36.9%	85.99102252
37.0%	85.91277274
37.1%	85.89483389
37.2%	85.74526252
37.3%	85.67735901
37.4%	85.56825439
37.5%	85.51315557
37.6%	85.43620609
37.7%	85.33523806
37.8%	85.28328087
37.9%	85.25899829
38.0%	85.21207726
38.1%	85.15178527
38.2%	85.02168502
38.3%	84.9045666
38.4%	84.8017467
38.5%	84.65766124
38.6%	84.57523188
38.7%	84.54788256
38.8%	84.4927858
38.9%	84.42331488
39.0%	84.37962262
39.1%	84.29564761
39.2%	84.15359252
39.3%	84.03757963
39.4%	83.91866994
39.5%	83.80978163

Percentile	Flow (L/ha/day)
39.6%	83.66344281
39.7%	83.52027704
39.8%	83.42203995
39.9%	83.36890903
40.0%	83.29861584
40.1%	83.15827499
40.2%	83.05966063
40.3%	83.00359316
40.4%	82.89305512
40.5%	82.83584301
40.6%	82.62978097
40.7%	82.58210253
40.8%	82.49410698
40.9%	82.27620751
41.0%	82.17327984
41.1%	82.09055366
41.2%	81.95102679
41.3%	81.90061755
41.4%	81.75289819
41.5%	81.61883537
41.6%	81.54902558
41.7%	81.46890588
41.8%	81.41645976
41.9%	81.33476181
42.0%	81.30483816
42.1%	81.22977697
42.2%	81.14671388
42.3%	81.11943381
42.4%	80.97475002
42.5%	80.88782537
42.6%	80.75187435
42.7%	80.7192826
42.8%	80.66375312
42.9%	80.53571111
43.0%	80.49850622
43.1%	80.43565685
43.2%	80.35875967
43.3%	80.26946232
43.4%	80.19567686
43.5%	80.01016534
43.6%	79.85129451
43.7%	79.70145603
43.8%	79.52070379
43.9%	79.42824682

Percentile	Flow (L/ha/day)
44.0%	79.37150602
44.1%	79.10119963
44.2%	79.00559459
44.3%	78.88593679
44.4%	78.8329475
44.5%	78.77845969
44.6%	78.61415398
44.7%	78.55644281
44.8%	78.48486709
44.9%	78.36800236
45.0%	78.25518351
45.1%	78.19784554
45.2%	78.14163342
45.3%	78.00340391
45.4%	77.82991254
45.5%	77.72647137
45.6%	77.6490609
45.7%	77.61163229
45.8%	77.44410887
45.9%	77.26545352
46.0%	77.1418123
46.1%	77.04884651
46.2%	76.94828978
46.3%	76.74567352
46.4%	76.6382828
46.5%	76.50318336
46.6%	76.41867698
46.7%	76.3395049
46.8%	76.16127665
46.9%	76.11273453
47.0%	76.08375311
47.1%	75.98133764
47.2%	75.81328107
47.3%	75.65680965
47.4%	75.53580364
47.5%	75.42042389
47.6%	75.34220067
47.7%	75.2630304
47.8%	75.14803489
47.9%	75.02195515
48.0%	74.94551107
48.1%	74.8190548
48.2%	74.72729103
48.3%	74.6424627

Percentile	Flow (L/ha/day)
48.4%	74.46723388
48.5%	74.40879311
48.6%	74.20814568
48.7%	74.13569171
48.8%	73.99115338
48.9%	73.76312368
49.0%	73.6580406
49.1%	73.57688796
49.2%	73.46928939
49.3%	73.4271954
49.4%	73.2818018
49.5%	73.21818939
49.6%	73.07662475
49.7%	72.96661394
49.8%	72.79538466
49.9%	72.68259175
50.0%	72.47022382
50.1%	72.31798479
50.2%	72.1590534
50.3%	72.08453328
50.4%	71.92870477
50.5%	71.85993908
50.6%	71.73791976
50.7%	71.61865832
50.8%	71.53807494
50.9%	71.47438366
51.0%	71.3782235
51.1%	71.23927238
51.2%	71.14246301
51.3%	71.04515233
51.4%	70.97596392
51.5%	70.90991657
51.6%	70.75292843
51.7%	70.67634015
51.8%	70.38214584
51.9%	70.30091451
52.0%	70.22577434
52.1%	70.15709629
52.2%	69.98554722
52.3%	69.91619076
52.4%	69.74909497
52.5%	69.69938136
52.6%	69.55696431
52.7%	69.45360803

Percentile	Flow (L/ha/day)
52.8%	69.39821368
52.9%	69.30670087
53.0%	69.05949777
53.1%	68.99980366
53.2%	68.90362003
53.3%	68.77163282
53.4%	68.55636177
53.5%	68.48202617
53.6%	68.35268863
53.7%	68.25917659
53.8%	68.15832932
53.9%	68.08680994
54.0%	67.99176186
54.1%	67.94135491
54.2%	67.85198436
54.3%	67.7162329
54.4%	67.62704156
54.5%	67.57202129
54.6%	67.41061526
54.7%	67.36632438
54.8%	67.23892712
54.9%	67.14117522
55.0%	66.90080733
55.1%	66.81286301
55.2%	66.70813051
55.3%	66.53566712
55.4%	66.49684107
55.5%	66.31804687
55.6%	66.25050057
55.7%	66.13464986
55.8%	66.09172368
55.9%	66.01559981
56.0%	65.8969582
56.1%	65.86247795
56.2%	65.72524208
56.3%	65.65763323
56.4%	65.49150383
56.5%	65.41175035
56.6%	65.2522345
56.7%	65.17155171
56.8%	65.04635543
56.9%	64.90256375
57.0%	64.8067093
57.1%	64.74814423

Percentile	Flow (L/ha/day)
57.2%	64.65454356
57.3%	64.61888181
57.4%	64.48904867
57.5%	64.43428914
57.6%	64.34893299
57.7%	64.17025577
57.8%	64.06818652
57.9%	64.0020772
58.0%	63.87397051
58.1%	63.71730957
58.2%	63.64650652
58.3%	63.52049543
58.4%	63.43017557
58.5%	63.32023403
58.6%	63.28347796
58.7%	63.21710939
58.8%	63.15623075
58.9%	63.02825408
59.0%	62.91870295
59.1%	62.87405832
59.2%	62.83726008
59.3%	62.75574082
59.4%	62.65791311
59.5%	62.57910705
59.6%	62.46002298
59.7%	62.37679867
59.8%	62.20404474
59.9%	62.06490813
60.0%	62.02833702
60.1%	61.99055508
60.2%	61.91434685
60.3%	61.7899188
60.4%	61.70430365
60.5%	61.58639323
60.6%	61.50149182
60.7%	61.24252586
60.8%	61.15338988
60.9%	61.1110449
61.0%	61.03719348
61.1%	60.8417195
61.2%	60.79232601
61.3%	60.73620327
61.4%	60.66820087
61.5%	60.55274784

Percentile	Flow (L/ha/day)
61.6%	60.37100336
61.7%	60.27064416
61.8%	60.1457444
61.9%	60.02728092
62.0%	59.95700509
62.1%	59.93201883
62.2%	59.82572908
62.3%	59.67556549
62.4%	59.64907868
62.5%	59.54674554
62.6%	59.34901209
62.7%	59.26858846
62.8%	59.18222106
62.9%	59.08725503
63.0%	58.94923488
63.1%	58.88110464
63.2%	58.75067906
63.3%	58.64021016
63.4%	58.51225427
63.5%	58.40851685
63.6%	58.27328471
63.7%	58.18575115
63.8%	58.06959946
63.9%	58.02331083
64.0%	57.89163596
64.1%	57.82328316
64.2%	57.73928832
64.3%	57.6093508
64.4%	57.51167736
64.5%	57.43123948
64.6%	57.12205438
64.7%	57.05083578
64.8%	56.86618741
64.9%	56.78907104
65.0%	56.59110911
65.1%	56.50952805
65.2%	56.4135301
65.3%	56.35156278
65.4%	56.2807147
65.5%	56.15951827
65.6%	55.99234795
65.7%	55.92688258
65.8%	55.81806828
65.9%	55.65412212

Percentile	Flow (L/ha/day)
66.0%	55.58387362
66.1%	55.55134639
66.2%	55.44622233
66.3%	55.29361567
66.4%	55.1557062
66.5%	55.05328088
66.6%	54.93904157
66.7%	54.76607757
66.8%	54.52932917
66.9%	54.50837338
67.0%	54.3608087
67.1%	54.15818049
67.2%	54.00142131
67.3%	53.8913858
67.4%	53.79061795
67.5%	53.66443221
67.6%	53.60274762
67.7%	53.42145883
67.8%	53.36461329
67.9%	53.19251925
68.0%	53.06167524
68.1%	52.93904837
68.2%	52.88896701
68.3%	52.7694432
68.4%	52.57861933
68.5%	52.47519625
68.6%	52.35738692
68.7%	52.25732968
68.8%	52.17765236
68.9%	52.06306473
69.0%	51.98282481
69.1%	51.88461732
69.2%	51.72062448
69.3%	51.52480942
69.4%	51.3024285
69.5%	51.23528867
69.6%	51.15356676
69.7%	51.01263784
69.8%	50.86076654
69.9%	50.81179389
70.0%	50.66809484
70.1%	50.45938808
70.2%	50.3666807
70.3%	50.3147498

Percentile	Flow (L/ha/day)
70.4%	50.07851025
70.5%	50.02316955
70.6%	49.91603396
70.7%	49.87245249
70.8%	49.76665476
70.9%	49.68229547
71.0%	49.47620402
71.1%	49.31986493
71.2%	49.18683287
71.3%	48.98379256
71.4%	48.8947531
71.5%	48.79904165
71.6%	48.72474321
71.7%	48.68429667
71.8%	48.62631812
71.9%	48.42866729
72.0%	48.23040932
72.1%	48.12248736
72.2%	48.08268243
72.3%	47.92197923
72.4%	47.78185528
72.5%	47.67277097
72.6%	47.575629
72.7%	47.52249911
72.8%	47.36849042
72.9%	47.18712891
73.0%	47.1453757
73.1%	46.87405892
73.2%	46.80957278
73.3%	46.65240715
73.4%	46.47780773
73.5%	46.41289548
73.6%	46.3165223
73.7%	46.11795857
73.8%	45.99826765
73.9%	45.89339926
74.0%	45.7788434
74.1%	45.68425183
74.2%	45.5258043
74.3%	45.32035785
74.4%	45.22915358
74.5%	45.07384463
74.6%	44.8590324
74.7%	44.80341746

Percentile	Flow (L/ha/day)
74.8%	44.68087446
74.9%	44.57015079
75.0%	44.47603996
75.1%	44.35496473
75.2%	44.17763022
75.3%	44.04297141
75.4%	43.97103791
75.5%	43.82886311
75.6%	43.58588685
75.7%	43.41328015
75.8%	43.28537285
75.9%	43.10038129
76.0%	42.88766668
76.1%	42.78013814
76.2%	42.65116231
76.3%	42.51322163
76.4%	42.26070687
76.5%	42.09288228
76.6%	42.03020343
76.7%	41.92704614
76.8%	41.84076572
76.9%	41.60180763
77.0%	41.51602968
77.1%	41.33395855
77.2%	41.06427055
77.3%	40.83173769
77.4%	40.67738434
77.5%	40.51683605
77.6%	40.30565882
77.7%	40.15141561
77.8%	40.02310632
77.9%	39.84810219
78.0%	39.503131
78.1%	39.37670712
78.2%	39.27399129
78.3%	39.21910597
78.4%	39.03410366
78.5%	38.74655692
78.6%	38.35556999
78.7%	38.09219883
78.8%	37.95252665
78.9%	37.65354087
79.0%	37.46701464
79.1%	37.40434192

Percentile	Flow (L/ha/day)
79.2%	37.34939503
79.3%	36.79141277
79.4%	36.67410177
79.5%	36.57699924
79.6%	36.38161807
79.7%	36.01410057
79.8%	35.8613485
79.9%	35.69230052
80.0%	35.36023001
80.1%	35.05355995
80.2%	34.83459504
80.3%	34.60261803
80.4%	34.44783977
80.5%	34.26942002
80.6%	33.99932605
80.7%	33.74034809
80.8%	33.3073167
80.9%	32.98991286
81.0%	32.8596658
81.1%	32.67799984
81.2%	32.38788285
81.3%	32.14875095
81.4%	31.81374951
81.5%	31.44696513
81.6%	31.29856562
81.7%	31.13283865
81.8%	31.04401289
81.9%	30.62945149
82.0%	30.22851966
82.1%	30.17018621
82.2%	30.05770811
82.3%	29.41575229
82.4%	29.34436386
82.5%	29.29331228
82.6%	28.82615684
82.7%	28.60514626
82.8%	28.16025713
82.9%	27.74175318
83.0%	27.50252763
83.1%	27.30241893
83.2%	27.1465825
83.3%	26.61770241
83.4%	26.20088279
83.5%	25.95461269

Percentile	Flow (L/ha/day)
83.6%	25.70086518
83.7%	25.16635538
83.8%	24.77997538
83.9%	24.55391442
84.0%	24.24823765
84.1%	23.80827956
84.2%	23.50502561
84.3%	23.35832669
84.4%	22.88970823
84.5%	22.42724294
84.6%	22.18020579
84.7%	21.94816826
84.8%	21.44817041
84.9%	21.04477785
85.0%	20.70790893
85.1%	19.80362509
85.2%	19.35131724
85.3%	18.85560977
85.4%	18.40550657
85.5%	18.18076578
85.6%	17.83173998
85.7%	17.51020319
85.8%	16.42663714
85.9%	15.95589612
86.0%	15.58984641
86.1%	14.6101984
86.2%	13.24177233
86.3%	12.61534091
86.4%	12.02477116
86.5%	11.52419295
86.6%	11.30321711
86.7%	10.95652999
86.8%	9.172695629
86.9%	7.86929683
87.0%	6.340761119
87.1%	5.719781783
87.2%	3.937156801
87.3%	3.480043286
87.4%	3.216310905
87.5%	2.870246234
87.6%	2.508531779
87.7%	1.690068449
87.8%	1.358928208
87.9%	1.214025846

Percentile	Flow (L/ha/day)
88.0%	1.043828556
88.1%	0.979448681
88.2%	0.808436234
88.3%	0.623908811
88.4%	0.482277709
88.5%	0.394163089
88.6%	0.32413118
88.7%	0.274585915
88.8%	0.251983025
88.9%	0.187886306
89.0%	0.158678947
89.1%	0.108335146
89.2%	0.097931873
89.3%	0.06689601
89.4%	0.054501349
89.5%	0.038719687
89.6%	0.032293843
89.7%	0.023070325
89.8%	0.008836431
89.9%	0.002602752
90.0%	0
90.1%	0
90.2%	0
90.3%	0
90.4%	0
90.5%	0
90.6%	0
90.7%	0
90.8%	0
90.9%	0
91.0%	0
91.1%	0
91.2%	0
91.3%	0
91.4%	0
91.5%	0
91.6%	0
91.7%	0
91.8%	0
91.9%	0
92.0%	0
92.1%	0
92.2%	0
92.3%	0

Percentile	Flow (L/ha/day)
92.4%	0
92.5%	0
92.6%	0
92.7%	0
92.8%	0
92.9%	0
93.0%	0
93.1%	0
93.2%	0
93.3%	0
93.4%	0
93.5%	0
93.6%	0
93.7%	0
93.8%	0
93.9%	0
94.0%	0
94.1%	0
94.2%	0
94.3%	0
94.4%	0
94.5%	0
94.6%	0
94.7%	0
94.8%	0
94.9%	0
95.0%	0
95.1%	0
95.2%	0
95.3%	0
95.4%	0
95.5%	0
95.6%	0
95.7%	0
95.8%	0
95.9%	0
96.0%	0
96.1%	0
96.2%	0
96.3%	0
96.4%	0
96.5%	0
96.6%	0
96.7%	0

Percentile	Flow (L/ha/day)
96.8%	0
96.9%	0
97.0%	0
97.1%	0
97.2%	0
97.3%	0
97.4%	0
97.5%	0
97.6%	0
97.7%	0
97.8%	0
97.9%	0
98.0%	0
98.1%	0
98.2%	0
98.3%	0
98.4%	0
98.5%	0
98.6%	0
98.7%	0
98.8%	0
98.9%	0
99.0%	0
99.1%	0
99.2%	0
99.3%	0
99.4%	0
99.5%	0
99.6%	0
99.7%	0
99.8%	0
99.9%	0
100.0%	0