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Westlink Industrial Estate, Kemps Creek

Water and Stormwater Management Plan Stage 2

ESR Development (Australia) Pty Ltd

AUGUST 2024

20-748

Document Registration

Document Title	Westlink Industrial Estate – Civil Infrastructure & Water Management Strategy Stage 2
Document File Name	R009-05-20-748-Stage 2 Water and Stormwater Management Plan
Section	Civil
Document Author	Andrew Tweedie

Issue	Description	Date	Author	Checked	Approved
01	Issued for Review	12/09/23	Andrew Tweedie	☒	☒
02	Final Issue	28/09/23	Andrew Tweedie	☒	☒
03	Final Issue	05/10/23	Andrew Tweedie	☒	☒
04	Final Issue	13/10/23	Andrew Tweedie	☒	☒
05	Final Issue	16/08/24	Andrew Tweedie	☒	☒

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1. Introduction

This Water and Stormwater Management Plan (WSMP) has been prepared by AT&L on behalf of ESR Australia in support of a State Significant Development Application (SSD-46983729) for the proposed development of the site located at 1030-1064 Mamre Road Aldington Road and 59-63 Abbotts Road, Kemps Creek (the Site. This SSD builds on the Stage 1 approval SSD-9138102. Combined both these SSD's form the entire Westlink Industry Park.

1.1. Site Description

The extent of the site is presented in Figure 1.

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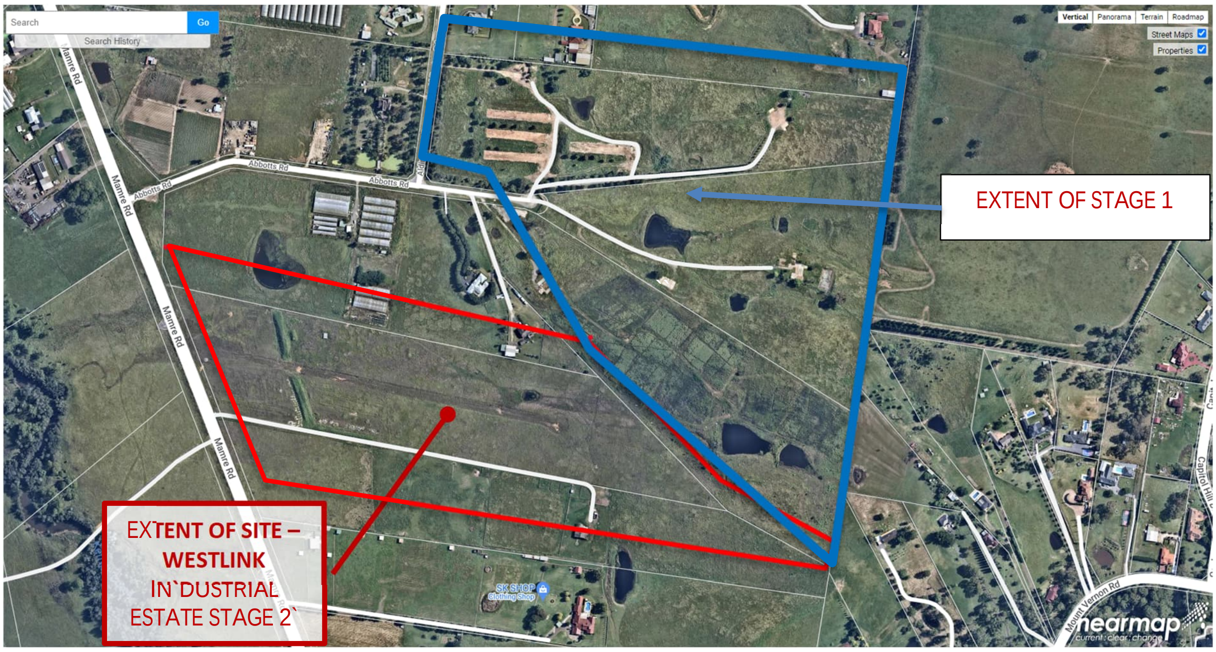


Figure 1: Site Extent (imagery from nearmap, dated 17 February 2022)

The site is located in the suburb of Kemps Creek, within the Penrith Local Government Area (LGA), and approximately 15 km south-east of the Penrith CBD and 5 km north-east of the under-construction Western Sydney Airport. The site is made up of the following allotments:

- Lots 3 and 4 DP250002 (1030-1064 Mamre Road, Kemps Creek)
- Lots 11 and 13 DP253503 (59-63 Abbotts Road, Kemps Creek)

The total area of the site is approximately 53.6 hectares.

Stage 1 SSD approval contains bulk earthworks, servicing and construction of Warehouse 1 and 4. Total work area is approximately 11.72Ha.

The proposed works associated for this Stage 2 SSD application is as follows and referenced in Figure 2:

- Construction of extension of Abbotts Road from Stage 1 extents to southern boundary
- Construction of Aldington Road extension to southern boundary
- Construction of private road north of Lot 6 linking Aldington Road with Abbotts Road extension
- Development of Lot 2 (Bulk earthworks of Lot approved under a different application CDC AT&L Drawings 20-748 C30000 series)
- Bulk earthworks and associated retaining walls within Lots 3, 5 and Lot 6

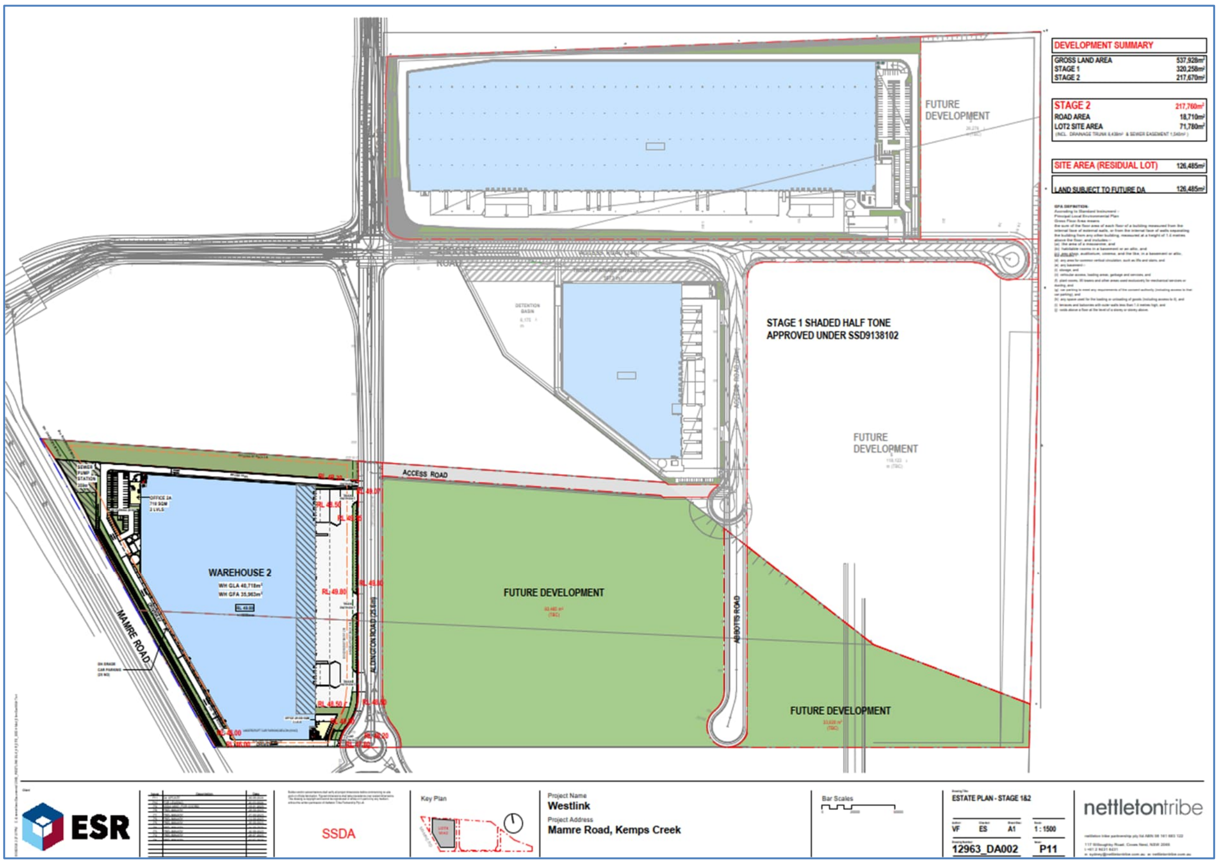


Figure 2 - Estate Plan Stage 2

The site is currently characterised as rural land and comprises residential dwellings, agricultural areas, sheds, greenhouses and some farm dams.

In June 2020, the site was rezoned *IN1 – General Industrial* under the *State Environmental Planning Policy (Western Sydney Employment Area) 2009*. The site is also located in the Mamre Road Precinct and is therefore subject to controls outlined in the *Mamre Road Precinct Development Control Plan 2021*.

1.2. Supporting Documentation

The following documentation is referred to throughout and should be read in conjunction with this report:

- Civil Drawings (AT&L), 20-748-C5000 (Infrastructure) and C6000 (on-lot) series – refer to Appendix 1.
- Stormwater Management Layout Plan 20-748-C11075 in Appendix 1
- Pre-Development hydrology parameters and assumptions letter (LTR007-02)- refer to Appendix 2
- Life Cycle Costings, and O&M Manuals from Landcom & SPEL - refer to Appendix 3
- Trunk Drainage Drawings and associated report by J.Wyndham Prince

2. Site Characteristics

2.1. Existing Topography and Catchments

The Site in its existing condition is characterised by undulating topography. The ground slope across most of the site has a general fall from the east to west towards Mamre Road with existing levels ranging from RL98 in the south-east, RL 93 in the north-east, RL 42.5 in the south and west adjacent Mamre Road.

The eastern portion of the site consists of four ridgelines that are generally aligned in an east-west direction. Ground slopes off these ridgelines towards local gullies within the site are typically between 10% and 15%. The western portion of the site adjacent to Aldington Road and Abbotts Road is generally flatter than the eastern portion, with ground slopes typically in the range of between 2% and 8%.

Most of the site in its existing condition is pervious, other than some residential dwellings, sheds and access driveways.

Delineation of the existing internal drainage catchments and external catchment that drain through the site is presented as Figure 3. Note that this includes the existing conditions before the commencement of Stage 1 works.

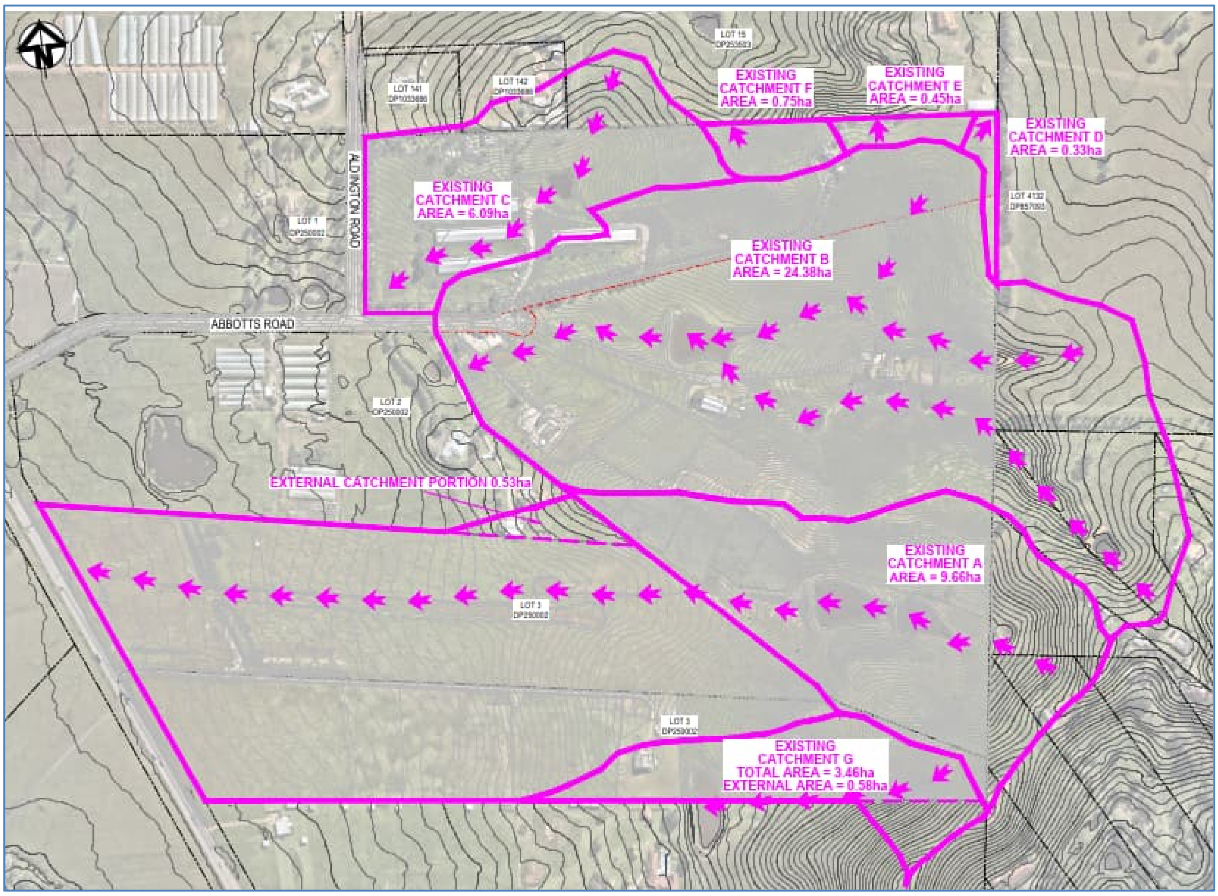


Figure 3: Catchment extents under existing conditions

A summary of the internal catchments under existing conditions is presented in Table 1.

Table 1: Description of internal and external catchments under existing conditions

Catchment ID	Area (ha)	Description
A	28.82	Discharges towards Mamre Road via residual land 1030-1064 Mamre Rd.
B	24.38	Discharges towards the eastern boundary of 1016-1028 Mamre Road (Lot 2 DP250002) and ultimately into a catch drain that runs along the southern edge of Abbotts Road.
C	6.09	Discharges towards the intersection of Abbotts Road and Aldington Road.
D	0.33	Discharges in a north-easterly direction towards 19-105 Capitol Hill Drive Mount Vernon (Lot 4132 DP857093)
E	0.45	Discharges in a northerly direction towards 272 Aldington Road (Lot 15 DP253053)
F	0.75	
G	3.46	Discharges into a shared existing farm dam, which overflows into the 1066-1074 Mamre Rd property to the south.

There is currently no formal trunk stormwater infrastructure within the site.

2.2. Existing Drainage Lines

Based on large-scale topographic mapping (1:25,000 from NSW Six Maps), there is one mapped overland drainage lines within the site, refer to Figure 4.

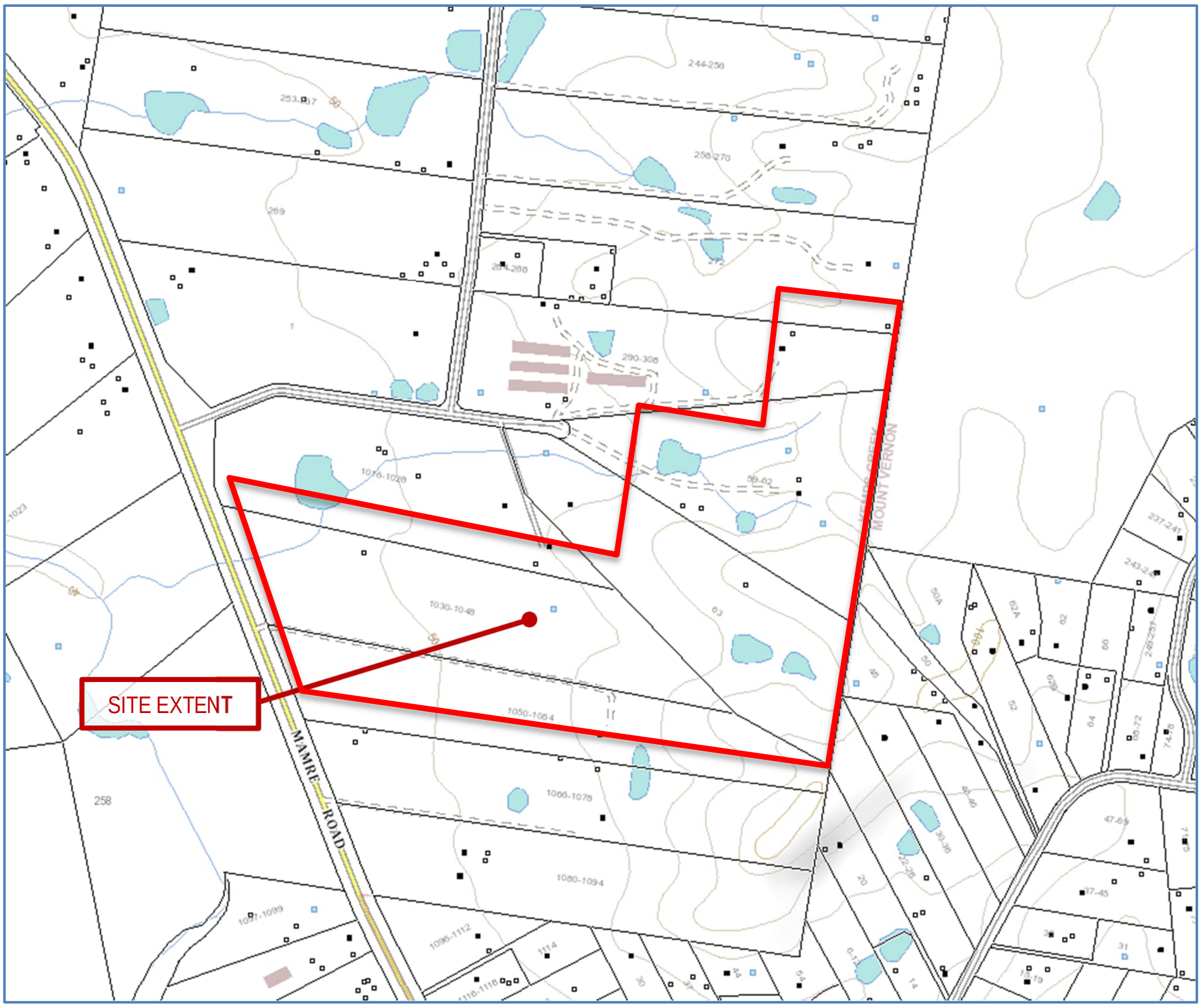


Figure 4: Topographic mapping showing drainage lines in the vicinity of the site (Source: NSW SIX Maps)

The *Mamre Road Precinct Waterway Assessment* (CT Environmental, April 2020), contained in the *Mamre Road Flood, Riparian Corridor, and Integrated Water Cycle Management Strategy* (Sydney Water, October 2020) presents the extents of waterways in the Mamre Road Precinct that have been the subject of a desktop review and field assessment to confirm the presence of mapped and unmapped waterways. An extract of mapping showing the extents of waterways in the Mamre Road Precinct is presented as Figure 5. This shows an unnamed tributary of Kemps Creek passing through the site.

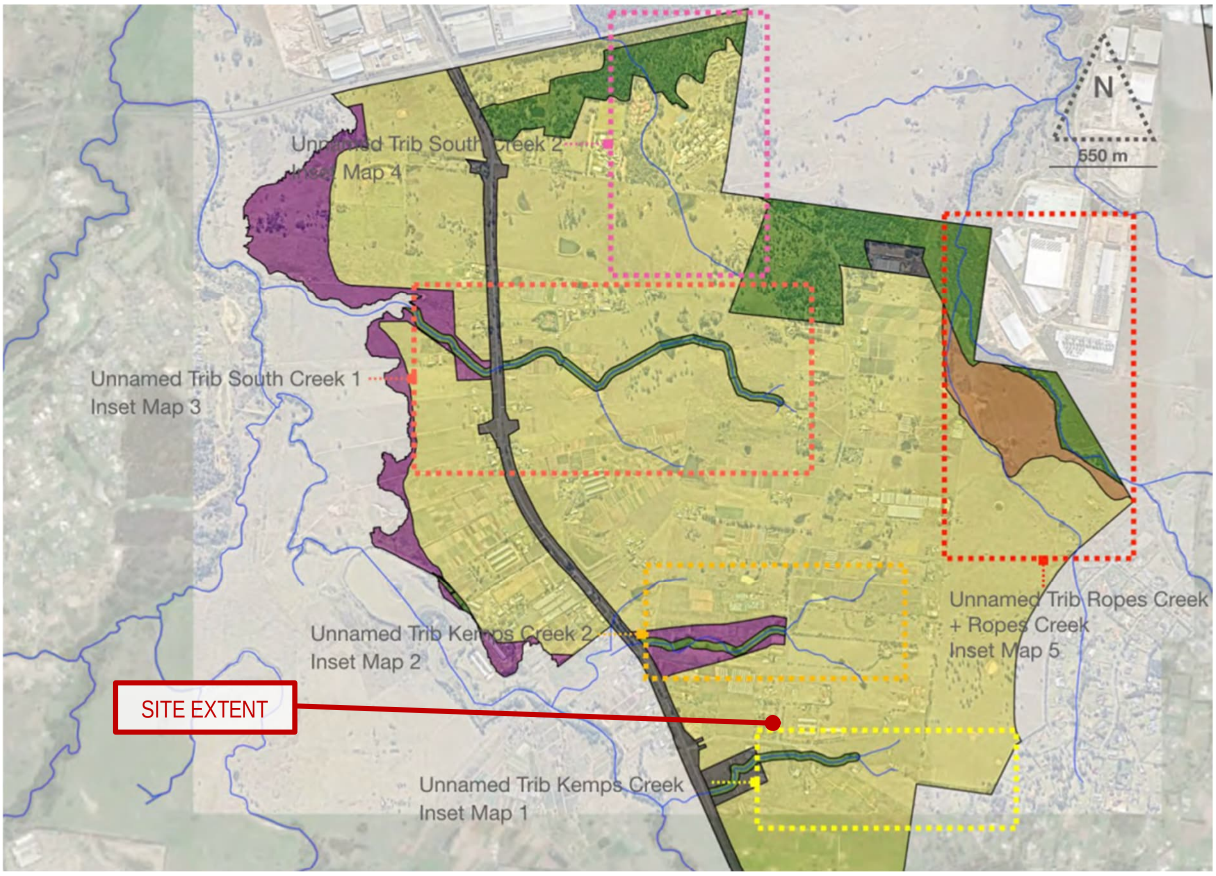


Figure 5: Extract of waterway mapping (CT Environmental, April 2020)

Results of the inspection of the unnamed tributary of Kemps Creek are described in the *Mamre Road Precinct Waterway Assessment* (CT Environmental, April 2020), and are summarised below:

- Two first order watercourses were evident in the headwaters which run to the north and south of the recently demolished house on 59-62 Abbotts Road.
- A clear flow path was evident below the confluence of the two first order watercourses, which validated the presence of a second order watercourse.
- The flow path did not have defined bed and banks, likely due to the presence of three upstream farm dams.
- From a point approximately 200 metres downstream (west) of the confluence of the first order watercourses, the flow path was observed to be heavily modified and formed into a drainage channel that runs parallel to and on the southern side of Abbotts Road. The flow path continues to Mamre Road.
- The section of mapped watercourse downstream of the Westlink Industrial Estate Stage 1, and passing through Stage 2, was not present, refer to Figure 6.
- Due to the lack of vegetation along the upper section of the headwater and significant modification to the drainage channel in the lower section, the watercourse had minimal ecological value.

Figure 6: Field validated flow paths and watercourses within and downstream of the site

2.3. Existing Geology

Based on the Preliminary Geotechnical Investigation undertaken by Douglas Partners (reference: 92352.00, dated August 2019) for 59-63 Abbotts Road and the Geotechnical Investigation Report prepared by Alliance Geotechnical (reference: 9687-GR-1-1, dated October 2019) for 290-308 Aldington Road, the following inferred sub surface soils were encountered across the site:

- TOPSOIL / topsoil filling to depths of 0.1 - 0.6m
- FILL to depths of 2.3m over parts of the site
- Residual Soil – variably stiff to hard silty clay, to depths in the range 2.5-3.5m
- BEDROCK - initially extremely low to very low strength shale or sandstone at first contact at depths of 0.7

2.4. Post-Development Catchment Extents

A post-development catchment plan based on the proposed site grading is presented as Figure 7.

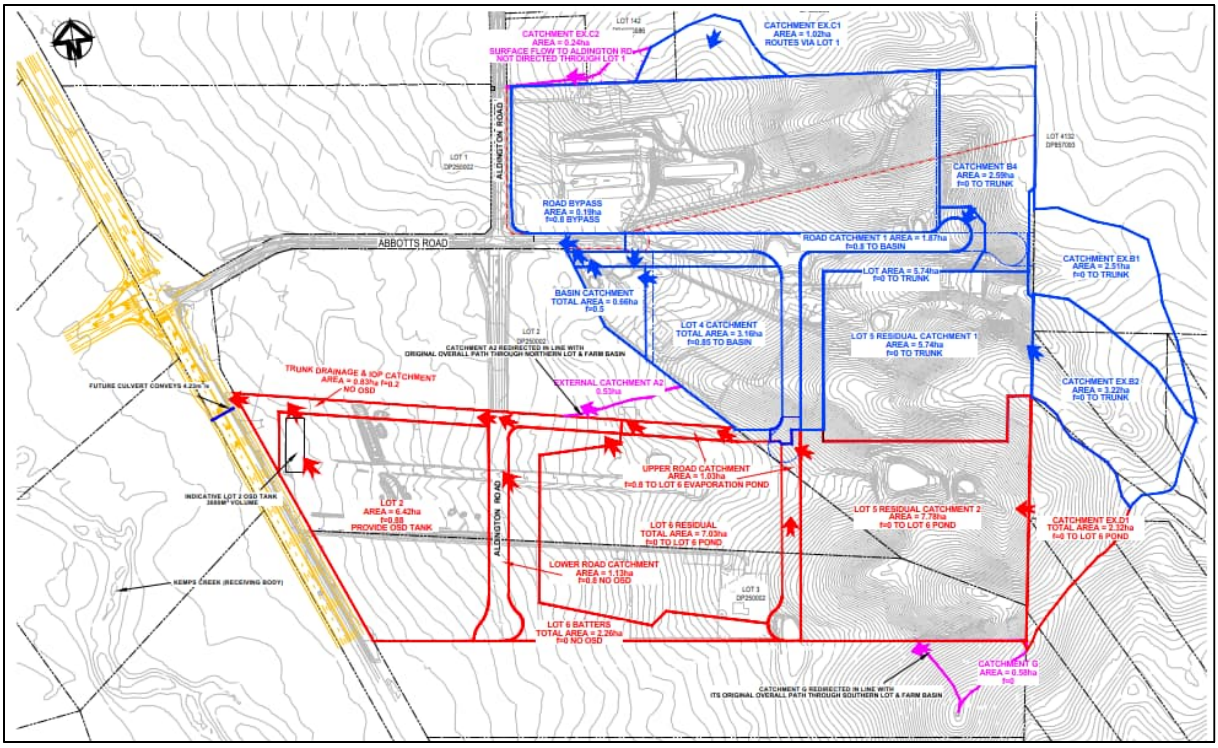


Figure 7: Catchment extents under proposed conditions

The post developed catchment extents are proposed to drain to the existing culvert beneath Mamre Road in the northwest corner of Stage 2 site as per Figure 7. It is noted the existing culverts beneath Mamre Road are scheduled to be upgraded in approximately the same timeline as the Westlink development.

Prior to draining through the culvert beneath Mamre Road, the Stage 2 catchment is proposed as such:

- The Trunk Drainage & Sewer IOP easements bypass all OSD and treatment, draining directly into the downstream culvert
- Developed Lot 2 (western Lot) – drains via a proposed underground OSD tank with orifice outlet and proprietary treatment within the western portion of the lot to drain into the 20m open trunk drainage channel along the north of Lot 2
- Lots 6 and southern half of Lot 5 (both bulk surface only), and the southern portion of Abbotts Road to drain into an evaporation pond on Lot 6, then discharging into the open trunk drainage channel via proprietary treatment and GPT.
- The lower road catchment including Aldington Rd and a number of batters from lot 6 drain into the trunk drainage channel via proprietary treatment and GPT
- Lot 3 and northern portion of Lot 5 (both bulk surface only) to drain into the stage 1 trunk drainage channel (as per the Stage 1 stormwater management plan)
- Undeveloped External catchment to east to drain via lot 5 as surface flows.

Once Lot 5 and Lot 6 and eastern external catchments are developed, detention and treatment measures within each site will be required to be implemented to ensure peak post flows into the open channel do not exceed the pre-developed flows and quality requirements. This will need to be determined as part of the Development Applications on each of these lots. As such the open trunk drainage channel is designed for pre-developed flow rates.

3. Stormwater Drainage

3.1. Stormwater Drainage Design Criteria

Design criteria and requirements for the proposed site stormwater management and stormwater drainage are outlined in the following documents:

- AS 3500.3 – Plumbing and drainage – Stormwater drainage
- Commonwealth of Australia (Geoscience Australia), *Australian Rainfall and Runoff: A guide to flood estimation*, 2019.
- NSW Department of Planning, Industry and Environment (DPIE), *Mamre Road Precinct Development Control Plan 2021*.
- NSW Department of Planning, Industry and Environment (DPIE), *MUSIC Modelling Toolkit – Wianamatta*, 2 August 2021.
- Penrith City Council, *Design Guidelines for Engineering Works for Subdivisions and Developments*, as amended 20 November 2013.
- Penrith City Council, *Water Sensitive Urban Design (WSUD) Policy*, December 2013.
- Penrith City Council, *WSUD Technical Guidelines*, Version 4 – October 2020.

3.2. Proposed Site Stormwater Drainage

The proposed drainage network within the estate has been designed to safely convey major and minor flows prior to discharging to neighbouring properties to the south and west. The following criteria have been adopted for the proposed drainage system:

- Major system (pit and pipe network, overland flow paths and channels): 1% AEP
- Minor system (pit and pipe network): minimum 5% AEP and increased where required to address major system design requirements.
- Flood Impacts from external catchments are to be minimised to an acceptable level for all floods up to the PMF.

The minor system stormwater drainage has been designed to drain towards the culvert crossing beneath Mamre Road in the northwest corner of the site. Limited road overland flow paths discharge into the southern property when exceeding the minor drainage system capacity.

3.3. Trunk Drainage Infrastructure

The *Mamre Road Precinct DCP* includes indicative locations of trunk drainage infrastructure across the precinct, refer to Figure 8. A 25m trunk drainage line is situated within the ESR Westlink Stage 2 site, which would drain in a westerly direction to Mamre Road. J. Wyndham Prince (JWP) has investigated the hydraulics and spatial design of the open trunk drainage channel in stage 2.

Confirmation has been received in discussions with Sydney Water in August 2023 that the naturalized trunk drainage channel within the development can be reduced in width from 25m (as per the Precinct DCP) to 20m and length to solely be located along the northern boundary between the Aldington Road extension at the east and Mamre Road to the west.

As such all documentation refers to the naturalized trunk drainage channel being 20m wide. This open channel is to form the naturalized trunk drainage network as per the DCP and the Mamre Road Precinct Stormwater Scheme Plan (Figure 8). Refer to JWP Channel Drawings for location and extents of open trunk drainage channel.

At the time of writing this report there is no detailed design of this stormwater naturalized trunk drainage channel provided by SWC to the west of Mamre Road and into the proposed Regional Wetland 17 as indicated in Figure 9 – Mamre Road Precinct Stormwater Scheme Plan.

It is assumed construction of the open trunk drainage channel within the Westlink Estate will occur prior to construction of the Regional Wetland and associated channel west of Mamre Road. As such outlet flows into the culvert beneath Mamre Road will be modelled to ensure pre-developed peak flows are not exceeded and existing flow paths west of Mamre Road are maintained.

The future downstream culvert as part of the Mamre Road upgrade is understood to be capable of conveying the entire Westlink Estate stage 2 catchment at pre-developed flows (but excludes the external catchment EX.D1). The culvert requires re-alignment to the updated trunk drainage alignment. This is formally accepted by Sydney Water. We are currently in discussions with TfNSW as the Mamre Road owners, and Transgrid, who have an easement over part of the culvert proposed alignment, for their formal approval. Design of the culvert is not yet fully confirmed, so while the Westlink Stage 2 is based on indicative design from Sydney Water and the Mamre Road upgrade team, it may need to be adjusted as the design process continues.

Latest correspondence with TfNSW indicates the program for the upgrade construction of Mamre Road, including the culvert crossing , is schedule to commence Q3 2024 and be completed by Q1/Q2 2025. Integration of the detail design of the road upgrade will occur during detailed design.

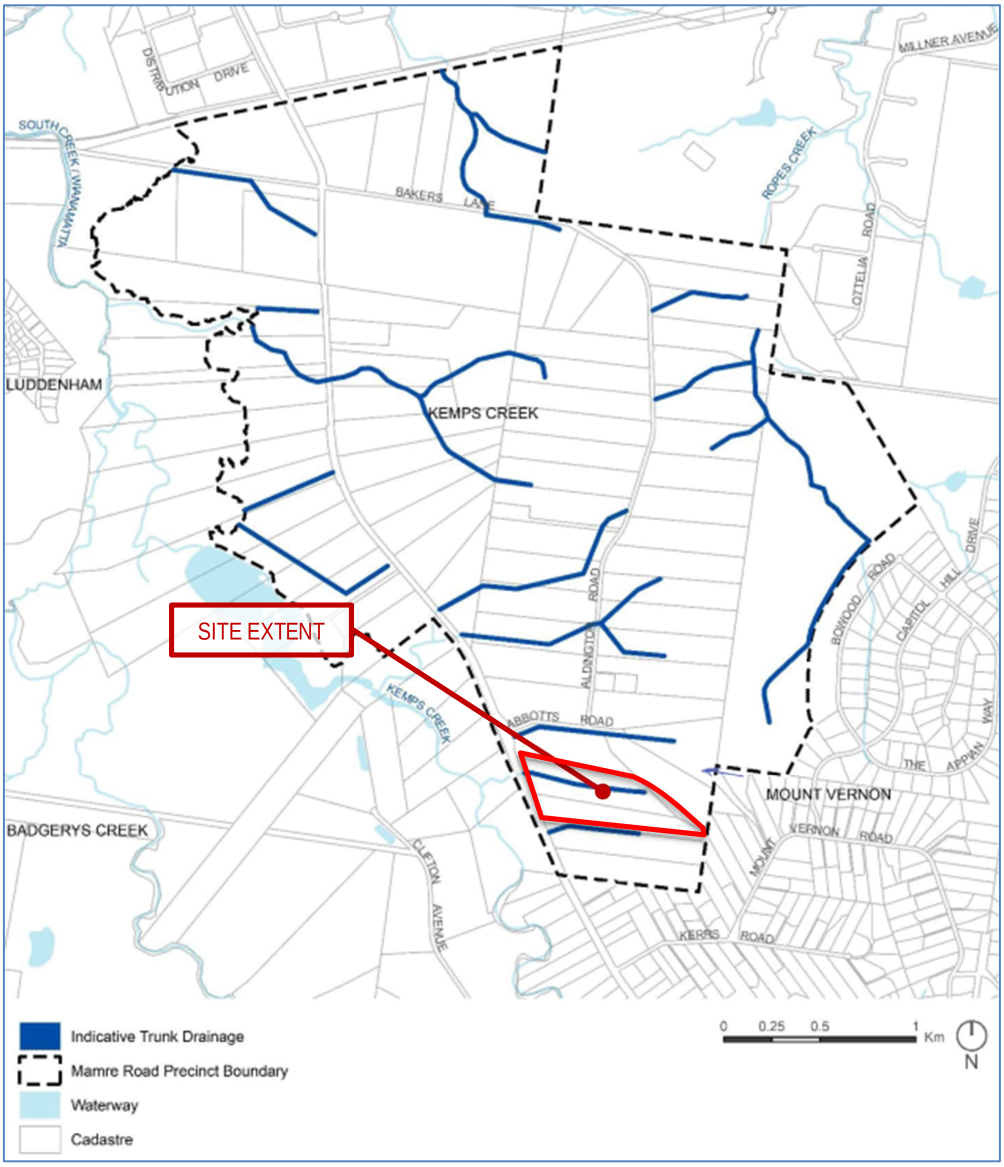


Figure 8: Trunk drainage infrastructure identified in the Mamre Road Precinct DCP

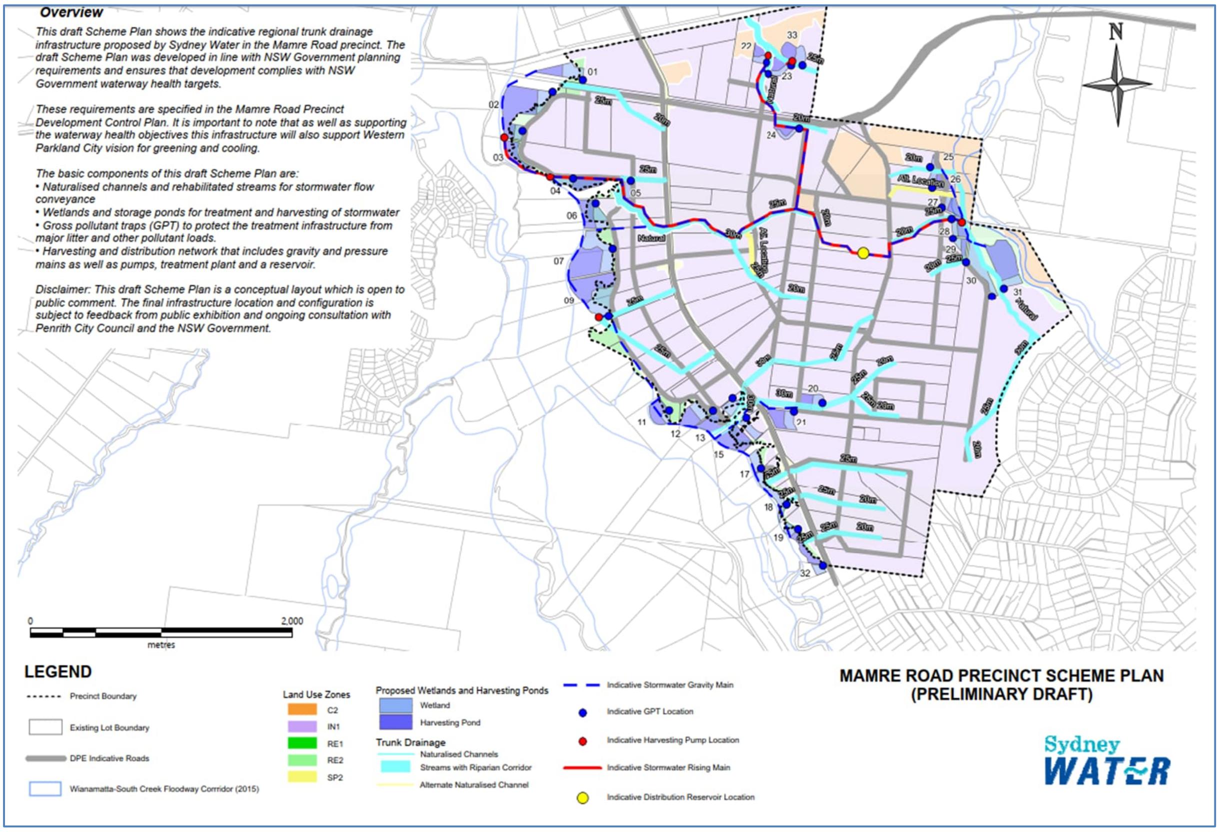


Figure 9 - Mamre Road Precinct Stormwater Scheme Plan

3.4. Downstream Culvert Hydraulics

As of October 2023, the downstream culvert from the stage 2 open channel (at Mamre Road) is still in the strategic design process with TfNSW. It is understood that there are two culvert sizes being considered. For the purposes of the design of stage 2 SSDA, the more conservative of the two options as the downstream culvert, a 0.6m x 3.3m culvert at IL41.911 has been assumed. This provides a higher tailwater level for design of RL 43.024.

It is understood that by the time Stage 2 SSD is approved, the culvert design will be finalised and as such the hydraulic parameters confirmed which will be used at the Detailed Design of the open channel. Assuming the more conservative (higher tailwater level) for the western end of the open channel provides flexibility once detailed design commences.

4. Water Management Strategy

This section summarises the proposed water management strategy for the site, including details of the proposed stormwater management measures and characterisation of water quality, quantity and flow volume at the points of discharge at the site boundary against the controls outlined in the Mamre Road Precinct DCP.

4.1. Water Management Strategy Objectives and Controls

The main objectives pertaining to the management of stormwater within the proposed development site are outlined in Section 2.4 of the Mamre Road Precinct DCP. Controls relating to stormwater quantity management and the requirement to attenuate peak flow rates are outlined in Section 2.5 of the DCP.

Specific controls relating to water management, as well as a response to these controls, is summarised below in Table 2.

Table 2: Response to DCP controls relating to water management

DCP Controls	Response
Waterway health and Water Sensitive Urban Design	
1) Development applications must demonstrate compliance with the stormwater quality targets in Table 4 (DCP) and the stormwater flow targets during construction and operation phases in Table 5 (DCP) and Table 6 (DCP) at the lot or estate scale to ensure the NSW Government's waterway objectives (flow and water quality) for the Wianamatta-South Creek catchment are achieved (see Appendix D). Where the strategy for waterway management is assessed at an estate level, the approval should include for individual buildings within the estate, which may be the subject of future applications.	Performance of the proposed water management strategy against the stormwater quality targets is presented in Section 4.2. Performance against the construction phase stormwater flow & quality targets is shown indicatively in plan 20-748-C5201 noting that contractors are to create their own plan detail for construction. A CPESC has revised the plan and confirms the detail in the documentation is sufficient for the SSD. Performance of the proposed water management strategy against the operational stormwater flow targets is presented in Table 13, which includes measures for Lot 2 Warehouse under the interim arrangement. The strategy is also demonstrated on plan 20-748-C5220.
2) The stormwater flow targets during operation phase (Table 5) include criteria for a mean annual runoff volume (MARV) flow-related option and a flow duration-related option. Applicants must demonstrate compliance with either option.	Performance of the proposed water management strategy against the operational stormwater flow targets is presented in Table 13. Option 1 has been satisfied.
3) Development applications must include a Water Management Strategy (WMS) detailing the proposed Water Sensitive Urban Design (WSUD) approach, how the WMS complies with stormwater targets (i.e., MUSIC modelling), and how these measures will be implemented, including ongoing management and maintenance responsibilities. Conceptual designs of the stormwater drainage and WSUD system must be provided to illustrate the functional layout and levels of the WSUD systems to ensure the operation has been considered in site levels and layout.	The Water Management Strategy for the site is outlined in Section 4, and includes the approach to WSUD for the site, performance of the proposed stormwater management measures against the DCP targets, and description of delivery, ongoing management and maintenance of each proposed measure. Design drawings showing the layout and levels of the proposed stormwater management elements are included in the AT&L civil package.
4) The design and mix of WSUD infrastructure shall consider ongoing operation and maintenance. Development applications must include a detailed	Ongoing management and maintenance considerations are addressed in Section 4.10.

DCP Controls	Response
lifecycle cost assessment (including capital, operation/maintenance, and renewal costs over 30 years) and Maintenance Plan for WSUD measures.	All costs associated with the delivery, operation and maintenance of the estate-based water management measures will be borne by the proponent.
5) WSUD infrastructure may be adopted at a range of scales (i.e., allotment, street, estate, or sub-precinct scale) to treat stormwater, integrate with the landscape and maximise evaporative losses to reduce development flow runoff. Vegetated WSUD measures, naturalised trunk drainage and rainwater/stormwater reuse are preferred. Acceptable WSUD measures to retain stormwater within the development footprint and subdivision are shown in Table 7 (DCP).	A summary of the proposed WSUD infrastructure adopted in the water management strategy is presented in Table 3.
6) Development must not adversely impact soil salinity or sodic soils and shall balance the needs of groundwater dependent ecosystems.	Refer to Geotechnical Investigation Reports prepared by Douglas Partners (for 59-63 Abbotts Road) and Alliance Geotechnical (for 290-308 Aldington Road) for details of soil salinity, sodicity and groundwater.
7) Infiltration of collected stormwater is generally not supported due to anticipated soil conditions in the catchment. All WSUD systems must incorporate an impervious liner unless a detailed Salinity and Sodicity Assessment demonstrates infiltration of stormwater will not adversely impact the water table and soil salinity (or other soil conditions).	The proposed water management strategy does not incorporate infiltration of collected stormwater.
8) Where development is not serviced by a recycled water scheme, at least 80% of its non-potable demand is to be supplied through allotment rainwater tanks.	Refer to Section 4.5.5 for details of proposed rainwater tanks and demand statistics.
9) Where a recycled water scheme (supplied by stormwater harvesting and/or recycled wastewater) is in place, development shall: ▪ *Be designed in a manner that does not compromise waterway objectives, with stormwater harvesting prioritised over reticulated recycled water;* ▪ *Bring a purple pipe for recycled water to the boundary of the site, as required under Clause 33G of the WSEA SEPP. Not top up rainwater tanks with recycled water unless approved by Sydney Water; and* ▪ *Design recycled water reticulation to standards required by the operator of the recycled water scheme.*	Stormwater harvesting in the form of rainwater tanks on proposed Lot 2 will form one of the components of the Interim Arrangement. The supply of harvested rainwater for non-potable uses within the development will be prioritised over reticulated recycled water. Rainwater tanks would not be required under the Ultimate Arrangement. Any tanks constructed on Lot 2 would be required to be decommissioned upon completion of recycled water mains within the Precinct which this Estate will utilise. Refer to Section 4.5.4 and Table 3.
Trunk Drainage Infrastructure	

<table>
<tr><th>DCP Controls</th><th>Response</th></tr>
<tr><td>10) Indicative naturalised trunk drainage paths are shown in Figure 4 (DCP)</td><td>Reproduced in this report for context as Figure 8.</td></tr>
<tr><td>11) Naturalised trunk drainage paths are to be provided when the:
▪ Contributing catchment exceeds 15ha; or
▪ 1% AEP overland flows cannot be safely conveyed overland as described in Australian Rainfall and Runoff – 2019;
unless otherwise agreed by the consent authority.</td><td>Details of the proposed trunk drainage infrastructure are included in Section 3.3.</td></tr>
<tr><td>12) The design and rehabilitation of naturalised trunk drainage paths is to be generally in accordance with NRAR requirements (refer to Section 2.3) that replicates natural Western Sydney streams. An example of a naturalised trunk drainage path is shown in Figure 3.</td><td>Based on discussions with Sydney Water there is no detailed design on the naturalised trunk channel downstream of the Estate. It is proposed at detailed design to coordinate with Sydney Water on the design and rehabilitation of the naturalised trunk drainage channel to match into any downstream open channels. This must also be co-ordinated with TfNSW for the culvert connection across Mamre Road.</td></tr>
<tr><td>13) Naturalised trunk drainage paths shall be designed to:
▪ Contain the 50% AEP flows from the critical duration event in a low flow natural invert;
▪ Convey 1% AEP flows from the critical duration event with a minimum 0.5m freeboard to applicable finished floor levels and road/driveway crossings; and
▪ Provide safe conveyance of flows up to the 1% AEP flood event.</td><td>The alignment of the naturalised trunk drainage has been altered with the approval of Sydney Water. The naturalised trunk drainage path is now along the northern boundary of Lot 2 which was deemed to not compromise the objectives of the trunk drainage, while assisting in preferred layouts of the industrial development.

As described above, trunk drainage infrastructure in the form of a 20m wide open channel along the northern boundary between Aldington Road extension and Mamre Road is proposed as the naturalised trunk drainage path.
This system will have sufficient capacity to capture and convey flows up to or exceeding the 1% AEP design event. Refer to JWP drawings for further detail.</td></tr>
<tr><td>14) Where naturalised trunk drainage paths traverse development sites, they may be realigned to suit the development footprint, provided that they:
▪ Comply with the performance requirements for flow conveyance and freeboard;
▪ Are designed to integrate with the formed landscape and permit safe and effective access for maintenance;
▪ Do not have adverse flood impacts on neighbouring properties; and
▪ Enter and leave the development site at the existing points of flow entry and exit.</td><td>The proposed trunk drainage lines within the site will (as per the J. Wyndham Prince Design):
▪ Comply with requirements for flow conveyance and freeboard.
▪ Incorporate sufficient access points for maintenance – maximum spacing of pits will not exceed 75 metres, which is consistent with Penrith City Council's Design Guidelines for Engineering Works for Subdivisions and Developments (considered an appropriate reference in the absence of any specific Sydney Water guideline or standard).
▪ Have sufficient capacity to capture and convey flow from the external catchments to the east of the Westlink Industrial Estate, and</td></tr>
</table>

DCP Controls	Response
	will therefore not result in adverse flood impacts on neighbouring properties
15) Trunk drainage paths shall remain in private ownership with maintenance covenants placed over them to the satisfaction of Council (standard wording for positive covenants is available from Council). Easements will also be required to benefit upstream land.	The proposed trunk drainage channel will be located in private lands considered part of Lot 2 gross land area. Maintenance covenants over the trunk drainage channel and easements over public stormwater infrastructure located within private lands will be incorporated in the deposited plans prepared by a Registered Surveyor.
16) Where pipes/ culverts are implemented in lieu of naturalised trunk drainage paths, they must remain on private land and not burden public roads, unless otherwise accepted by Council.	Not applicable as pipe/culverts are not proposed as part of the trunk drainage. Open channel drainage is proposed which will be situated within private lands and not within public road reserve. The downstream culvert design is as part of Mamre Rd works.
17) High vertical walls and steep batters shall be avoided. Batters shall be vegetated with a maximum batter slope 1V:4H. Where unavoidable, retaining walls shall not exceed 2.0m in cumulative height.	Batters at maximum 1:4 slope are incorporated across the Estate however given the existing sloping topography of the site along with proposed "flat" pads for industrial warehouses (as the estate is zoned for) retaining walls are unavoidable. Tiered walls as per the Mamre Rd DCP are proposed. Refer Civil Drawings.
18) Raingardens and other temporary water storage facilities may be installed online in naturalised trunk drainage paths to promote runoff volume reductions.	Not applicable to the Westlink Industrial Estate as proposed.
19) Subdivision and development are to consider the coordinated staging and delivery of naturalised trunk drainage infrastructure. Development consent will only be granted to land serviced by trunk drainage infrastructure where suitable arrangements are in place for the delivery of trunk infrastructure (to the satisfaction of the relevant Water Management Authority).	The proposed trunk drainage infrastructure will be staged and delivered commensurate with the staging of earthworks and infrastructure across the estate. The trunk drainage infrastructure will form a critical component of the site water management strategy throughout construction and will be incorporated into the Erosion and Sediment Control Plan and Construction Environmental Management Plan. The final form of the trunk drainage lines, including connections to infrastructure downstream of the Westlink Industrial Estate, will be undertaken at a suitable stage of development and will be subject to further consultation with the Sydney Water (the nominated Waterway Manager).

DCP Controls	Response
20) Stormwater drainage infrastructure, upstream of the trunk drainage, is to be constructed by the developer of the land considered for approval.	All stormwater drainage upstream of the proposed trunk drainage lines will be designed and delivered by the proponent.
21) All land identified by the Water Management Authority as performing a significant drainage function and where not specifically identified in the Contributions Plan, is to be covered by an appropriate "restriction to user" and created free of cost to the Water Management Authority.	Noted – subject to further consultation with Sydney Water (the nominated Waterway Manager).
22) All proposed development submissions must clearly demonstrate via 2-dimensional flood modelling that: *1) Overland flow paths are preserved and accommodated through the site;* *2) Runoff from upstream properties (post development flows) are accommodated in the trunk drainage system design;* *3) Any proposed change in site levels or drainage works are not to adversely impact and upstream or downstream, or cause a restriction to flows from upstream properties;* *4) There is no concentration of flows onto an adjoining property; and* *5) No flows have been diverted from their natural catchment to another.*	Refer to Flood Risk Impact Assessment prepared by Stantec.
Overland Flow Flooding	
10) Development should not obstruct overland flow paths. Development is required to demonstrate that any overland flow is maintained for the 1% AEP overland flow with consideration for failsafe of flows up to the PMF.	The proposed major and minor system drainage has been designed such that development within the estate will not obstruct any overland flow paths. Suitable allowance for overland flow has been made within the design of the major and minor system. Any future development in the external catchments must be attenuated to this flow regime. The flood impact assessment will address storms above the 1% AEP.
11) Where existing natural streams do not exist, naturalised drainage channels are encouraged to ensure overland flows are safely conveyed via vegetated trunk drainage channels with 1% AEP capacity plus 0.5m freeboard. Any increase in peak flow must be offset using on-site stormwater detention (OSD) basins.	Refer to Section 3.3 for details of the proposed trunk drainage infrastructure. While the existing conditions show overland flows primarily as sheet flows, the developed case concentrates into the naturalised trunk drainage system. For stage 2 development, the OSD on Lot 2

DCP Controls	Response
	is overcompensating for bypassing roads such that peak flows are below pre-development levels.
12) OSD is to be accommodated on-lot, within the development site, or at the subdivision or estate level, unless otherwise provided at the catchment level to the satisfaction of the relevant consent authority.	The location of the proposed detention tank within Lot 2 is presented on drawing 20-748-C5071. On site detention is provided on an estate level, not an allotment level, however future lot 5 and lot 6 will require OSD to be provided on-lot.
13) Stormwater basins are to be located above the 1% AEP.	No stormwater basins are proposed as part of this SSD.
14) Post-development flow rates from development sites are to be the same or less than pre-development flow rates for the 50% to 1% AEP events.	The performance of the proposed site post developed flows against the stormwater quantity targets in the Mamre Road Precinct DCP is summarised in Table 12
15) OSD must be sized to ensure no increase in 50% and 1% AEP peak storm flows at the Precinct boundary or at Mamre Road culverts. OSD design shall compensate for any local roads and/or areas within the development site that does not drain to OSD.	As demonstrated in Table 12, the proposed detention tank and outlet from the open channel has been sized to ensure no increase in peak flows at the discharge point from the estate. Stantec flood modelling. The Lot 2 OSD tank overcompensates for bypassing road catchments.

4.2. Water Management Strategy Overview

Since the release of the Draft Mamre Road Precinct DCP in November 2020, AT&L has been working with several landowners in the Mamre Road Precinct, Government, other Industry Bodies, and experts in water management to resolve practical solutions that will address the stormwater flow targets that have been adopted in the final DCP.

The *Mamre Road Flood, Riparian Corridor and Integrated Water Cycle Management Report* (FRCIWCM) (Sydney Water, 2023) addresses links between waterway health, hydrology and water quality targets. The stormwater management objectives outlined in the FRCIWCM Report, which have ultimately been adopted in the Mamre Road Precinct DCP, were developed by applying the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (NSW OEH, 2017). The effects-based assessment outlined in the FRCIWCM Report addressed three metrics relating to waterway health and stormwater management:

1. Flow volume – mean annual runoff volume (MARV), measured in ML/ha/year. The target adopted in the Mamre Road Precinct DCP is 2 ML/ha/year (revised from 1.9 ML/ha/year in the Draft DCP). The outcomes for the Westlink Industrial Estate are summarised in Section 4.9.

2. Seasonal pulses – as shown by flow duration curves. The targets and outcomes demonstrated by a flow duration curve under post-development conditions is presented in Section 4.9.

3. Water quality – as indicated by stormwater pollution reduction. The targets and outcomes demonstrated as reduction in average annual pollutant load are summarised in Section 4.7. Note that as this design contains significant natural catchment, we have adopted the concentration targets as provided in the 21/09/2022 “Technical guidance for achieving Wianamatta South Creek stormwater management targets” produced by DPE.

In the FRCIWCM, Sydney Water also discussed the potential for regional facilities to be implemented to satisfy the stormwater flow objectives for the Mamre Road Precinct. The FRCIWCM report states:

> *“It is noted that the most cost-effective way to achieve stormwater volume load reductions is via open water bodies and these have a maintenance implication for developers and a wildlife risk.*
>
> *Through master planning of the Wianamatta South Creek precinct, it will be possible to integrate regional wetlands and water bodies and offset the need for wetlands and open water to be distributed through the Precinct on private lands.*
>
> *This centralised management of water is preferable as it provides a more appropriate scale of WSUD assets for more cost-effective maintenance and management outcomes.”*

The Water Management Strategy for Stage 2 has been developed to satisfy the flow targets fully without the regional solution being in place, by taking advantage of residual undeveloped land as part of the catchment area. It is important to note that for the full site (i.e. further lots becoming developed) to satisfy the flow duration and MARV requirements, the stage 2 measures may need to be altered. By the time that the future development is under assessment, it may also be the case that the regional scheme is further progressed, and these measures may be reduced or decommissioned instead. This report focuses on the “Estate” level flow duration and MARV strategies.

A summary of the proposed stormwater management measures that would be required to satisfy stormwater quality, quantity and flow controls under both the “Estate” and “Regional” Arrangem*ents is presented in Table 3.*

Table 3: Proposed water management measures under the Estate and Regional Arrangements

		Estate Arrangement (Stage 2) (prior to implementation of regional stormwater management scheme)		Regional Arrangement (with regional stormwater scheme to be operated by Sydney Water)
Rainwater tanks for non-potable reuse (refer to Section 4.5.5 for further details)	✓	Required for proposed Lot 2 to comply with the following DCP control: *Where development is not serviced by a recycled water scheme, at least 80% of its non-potable demand is to be supplied through allotment rainwater tanks.*	×	Rainwater tanks would not be required under the Ultimate Arrangement. Any tanks constructed on Lot 2 would be required to be decommissioned upon completion of recycled water mains within the Precinct which this Estate will utlitise.
Gross pollutant traps (GPTs) (refer to Section 4.5.1 for further details)	✓	GPTs with capacity for hydrocarbon and sediment removal to be installed upstream of the proposed OSD tank and open drainage channel as a pre-treatment measure for the regional stormwater management scheme. Note that currently no GPT is rated under SQIDEP to treat sediment and hydrocarbons.	✓	GPTs with capacity for hydrocarbon and sediment removal to be installed upstream of the proposed detention basin and open drainage channel as a pre-treatment measure for the regional stormwater management scheme. Note that currently no GPT is rated under SQIDEP to treat sediment and hydrocarbons.
Detention Tank (refer to Section 4.5.2 for further details)	✓	Required to satisfy stormwater quantity controls.	✓	Required to satisfy stormwater quantity controls.
Evaporation / Storage ponds and residual irrigation (refer to Section Error! Reference source not found. for further details)	✓	Required to satisfy interim stormwater flow controls and stormwater quality treatment.	×	Will not be required on the basis that stormwater flow controls and stormwater quality treatment will be incorporated into the regional stormwater management scheme.

4.2.1. Technical Guidance for achieving Wianamatta-South Creek stormwater management targets

In September 2022 The Department of Planning and Environment released a *Technical guidance for achieving Wianamatta-South Creek stormwater management targets.* This guideline was prepared to give advice on modelling to undertake, assumptions to make and which data is to be used to demonstrate that the water targets are being achieved. It also provided a range of example WSUD strategies that could be utilised to meet the water quantity targets.

Refer to Figure 10 below for extract from the Technical Guidelines (page 14) which indicates typical WSUD measures which could be implemented to meet the required water quantity targets.

Technical guidance for achieving stormwater management targets

On lot or allotment measures

Typical on lot or allotment WSUD measures include, but are not limited to:

- rainwater tanks
- on-site stormwater detention
- gross pollutant traps (GPTs)
- bioretention basins
- swales
- wetlands, subject to relevant wildlife risk mitigation measures to manage bird strikes (note that wetlands are likely to be interim or temporary under a regional-scale WSUD strategy, see Chapter 4 of this guide)
- stormwater harvesting systems (likely to be interim or temporary under a regional-scale WSUD strategy, see Chapter 4 of this guide).

The design of on lot or allotment measures should consider the existing documents relevant to the Wianamatta–South Creek catchment (see section 'Relationship to other documents'). Important considerations include:

- accessibility for inspections and maintenance
- protection from damage during construction and building phase and then finalised once the site is finished and landscaped
- careful integration with the landscape but avoiding large level drops and walls, and vegetated with trees.

Figure 10 - Extract from Technical Guidance

For this SSD all the dot points as noted within Figure 10 aside from wetlands and bioretention basins are being incorporated into the civil design to ensure the water quantity targets are met. Refer to Section 4.5 for additional details.

4.3. Hydrological and Hydraulic Modelling

DRAINS modelling software has been used to calculate the Hydraulic Grade Line (HGL) of the proposed estate-wide stormwater network, including pits, pipes, overland flow paths and detention basins. DRAINS is a software package used for designing and analysing urban stormwater drainage systems and catchments. It is widely accepted by Council's across NSW as the basis for stormwater design and has been confirmed by Penrith City Council as the preferred stormwater software analysis package.

A summary of the key hydrological and hydraulic design parameters adopted in DRAINS to develop a major and minor system drainage design for the proposed development are as follows:

- Minor system (pit and pipe) drainage has been designed to accommodate the 5% AEP storm event.
- The combined pit and pipe drainage and overland flow paths have been designed to accommodate the 1% AEP storm event.
- Where trapped low points are unavoidable and potential for flooding private property is a concern, an overland flow path capable of carrying the total 1% AEP storm event has been provided. Alternatively, the pipe and inlet system has been upgraded to accommodate the 1% AEP storm event.
- Rainfall intensities have been adopted using the Bureau of Meteorology Design Rainfall Data System (2016).
- Times of concentration for each sub catchment have been determined using the kinematic wave equation.
- The width of flow in the gutter does not exceed 2.5 metres and pits are spaced no further than 75 metres apart.
- Velocity x depth product shall not exceed 0.4 m^2/s for all storms up to and including the 1% AEP event.
- Bypass from any pit on grade shall not exceed 15% of the total flow at the pit.
- Blockage factors of 20% and 50% shall be adopted for on-grade and sag pits respectively.
- A hydraulic grade line HGL design method shall be adopted for all road pipe drainage design.
- Pipelines in roadways shall have a minimum diameter of 375mm.
- A desirable minimum grade of 1% for all pipelines is preferred for self-cleansing under low flow velocities. An absolute minimum grade of 0.5% has been adopted.
- The minimum cover over pipes shall be 450mm in grassed areas and 600mm within carriageways.
- Where minimum cover cannot be achieved due to physical constraints the pipe class shall be suitably increased.
- All pipes in trafficable areas will be Reinforced Concrete Pipes (RCP) or Fibre Reinforced Cement (FRC) equivalent.
- Pipes discharging to an overland flow path shall adopt a minimum tailwater level equivalent to respective overland flow level.
- Pit Loss coefficients have been calculated in accordance with the Hare Charts as documented in the Queensland Urban Drainage Manual.
- A minimum 150mm freeboard has been maintained between pit HGL and pit surface levels for the minor design storm event (5% AEP).
- Overland flow paths maintain a minimum of 300mm freeboard to all habitable floor levels.

4.4. Stormwater Quality Modelling

The proposed stormwater treatment train has been modelled using the MUSICX software package (Version 1.1.0). Modelling has been undertaken in accordance with the *MUSIC Modelling Toolkit – Wianamatta* (NSW DPIE, 2021).

Rainfall and evaporation data

Penrith City Council's MUSIC-link climate data (rainfall and evapotranspiration) was adopted in the MUSIC model, as well as some evapotranspiration data from the MUSIC Modelling toolkit. The meteorological data includes:

- Pluviometer data (six-minute rainfall intensity and evapotranspiration) for Penrith Lakes AWS (Station 67113) for the period between 1999 and 2008 inclusive (average annual rainfall over this period = 691mm).
- Monthly potential evapotranspiration (PET) as per the *MUSIC Modelling Toolkit - Wianamatta*.

Rainfall-runoff parameters

The rainfall-runoff parameters adopted in the MUSIC model are consistent with the parameters adopted in *MUSIC Modelling Toolkit – Wianamatta*, refer to Table 4.

Table 4: Rainfall-runoff parameters adopted in MUSIC

Parameter	Unit	Value
Impervious area parameters		
Rainfall Threshold	mm/day	1.0
Pervious area parameter		
Soil Storage Capacity	mm	150
Initial Storage	% of Capacity	30
Field Capacity	mm	130
Infiltration Capacity Coefficient α	-	175
Infiltration Capacity Coefficient β	-	2.5
Groundwater properties		
Initial Depth (groundwater)	mm	10
Daily Recharge Rate	%	25
Daily Baseflow Rate	%	1.4
Daily Seepage Rate	%	0.0

Source nodes and pollutant generation

Pollutant events mean concentrations (EMCs) for base flow and storm flow scenarios have been adopted from Table 6 of Blacktown City Council's WSUD developer handbook (consistent with the *MUSIC Modelling Toolkit - Wianamatta*). The EMC values are applied to source nodes in the MUSIC model to estimate annual pollutant loads exported from the site under the proposed ultimate development scenario. The adopted pollutant EMCs for various catchment types are summarised in Table 5.

Table 5: Stormwater quality parameters for MUSIC source nodes

Landuse category		log10 TSS (mg/l)		log10 TP (mg/l)		log10 TN (mg/l)	
		Base flow	Storm flow	Base flow	Storm flow	Base flow	Storm flow
Roof areas	Mean	1.20	1.30	-0.85	-0.89	0.11	0.30
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19
Road areas	Mean	1.20	2.43	-0.85	-0.30	0.11	0.34
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19
Pervious areas	Mean	1.20	2.15	-0.85	-0.60	0.11	0.30
	Std dev	0.17	0.32	0.19	0.25	0.12	0.19

4.5. Proposed Stormwater Management Measures

A series of stormwater quantity and quality control measures are proposed to be adopted within the site to satisfy the stormwater management strategy objectives listed in Section 4.1. A general description of the proposed stormwater treatment train components is presented in the following sections.

4.5.1. Gross Pollutant Traps

The proposed stormwater treatment train under the Interim Arrangement would consist of gross pollutant traps (GPT) upstream of the proposed OSD tank on Lot 2 and connection into open trunk drainage channel as a means of primary stormwater treatment. GPTs are designed to capture litter, debris, coarse sediment, as well as some oils and greases. All GPT's are proposed to be located within private lands with two located within Lot 2 and the other upstream (east) of the open trunk drainage channel.

A high-flow bypass for the GPTs would nominally be equivalent to the 4 EY (3-month ARI) peak flow rate discharging to the GPT. Design flows for the GPTs and their final configuration would be confirmed at the detailed design phase. SQIDEP approved proprietary tertiary treatments have been proposed downstream

4.5.2. Detention Tanks

Stormwater runoff from the developed Lot 2 is proposed to be collected via pits and pipes and discharge into the proposed detention tank within the north west corner of the lot. This underground tank will provide storage and with a controlled outlet structure detain all storm events up to and including the 1% AEP event. Proprietary treatment devices will be installed within the tank to ensure the stormwater nutrient targets as met to comply with the Mamre Road DCP. Part of the tank volume (excluded from OSD volume) is to be used as stormwater storage for reuse purposes. This is discussed further in section 4.5.4.

A summary of the key detention tank parameters and DRAINS model results for the major and minor system flow is presented in Table 6.

Table 6 : Key Lot 2 Detention Tank & Reuse tank parameters and Drains model results

Parameter	Unit	Lot 2 Basin
Base level	mAHD	42.50
Reuse Tank max Still Water Level	mAHD	43.00
Low Flow orifice level	mAHD	43.00
Low Flow orifice diameter	mm	375
Mid Flow orifice level	mAHD	44.25
Mid flow orifice diameter	mm	525
High flow weir crest level	mAHD	44.65
High flow weir length	mm	5000
Outlet pipe diameter	mm	4x375dia
Outlet pipe upstream IL	mAHD	43.00
Outlet pipe downstream IL (at channel)	mAHD	42.30
Outlet pipe length	m	17m
Tank Roof Level	mAHD	45.00
Total Tank Volume	m^3	2150
Total Tank Reuse Volume	m^3	150
Total Tank OSD Volume	m^3	2000
5% AEP		
Peak Inflow	m^3/s	2.09
Peak Outflow total	m^3/s	1.041
Peak basin water level	mAHD	44.75
Peak basin storage	m^3	1750
1% AEP		
Peak Inflow	m^3/s	2.83
Peak Outflow total	m^3/s	1.842
Peak OSD water level	mAHD	44.89
Peak basin storage (excluding long term storage)	m^3	1900

4.5.3. Erosion and Sediment Basins (acting as evaporation ponds)

Ponds provide an effective means of reducing runoff volume from the site as water would be lost via evaporation over a large area. A pond can capture large quantities of stormwater runoff, while also being relatively easy to maintain.

Large-scale MUSIC modelling undertaken by AT&L indicates that, in combination with other measures, ponds can achieve a relatively high reduction of stormwater runoff volume and are generally more efficient than irrigation.

This Water Management Strategy under the Estate Arrangement (in the absence of the regional stormwater management scheme), which addresses the stormwater flow targets adopted in the Mamre Road Precinct DCP, incorporates an erosion and sediment pond within the residual pads of Lot 6, Lot 3 and the northern part of lot 5.

Table 7: Adopted estate-wide pond parameters

Parameter	Lot 6 Pad	Lot 5 Northern Pad	Lot 3 Pad
Contributing Catchment (ha)	15.86	5.75	2.72
Surface Area (m^2)	3093	1250	1258
Permanent pool volume (m^3)	5082	1881	1090
Exfiltration rate (mm/hr)	0	0	0
Evaporative loss (% of PET)	100	100	100

4.5.4. Stormwater Harvesting for Irrigation

As per the Technical guidance for achieving Wianamatta-South Creek stormwater management targets stormwater harvesting and reuse is another effective way to reduce stormwater flow volumes from frequent flows events to achieve the water quantity targets.

Water runoff from the developed Lot 2 is proposed to be stored in tank volume underneath the OSD tank volume (refer Section 4.5.2) within Lot 2 carpark. Refer to Drawing 20-748 C6121 for early layout. Water from this reuse tank will be stored and used as irrigation in the residual lot 6 pads. Refer to Drawing 20-748 C5220 for extent of residual lands to be irrigated via this basin. It is noted this basin arrangement is interim only, to be used only before the regional basins are constructed (and decommissioned when instructed by DPIE).

4.5.5. Rainwater Tanks

Rainwater tanks retain a significant proportion of stormwater that falls on roof areas. Given the large-scale industrial development proposed on the site, rainwater tanks can provide a significant contribution to the objective of minimising the total volume of runoff discharging from the site.

A rainwater tank reuse system on individual lots can be installed in many different configurations, including placing the tank above or below ground and using gravity or pressure systems (pumps) to supply rainwater for non-potable domestic uses. These uses typically include toilet flushing, laundry, hot water installations, car washing and irrigation.

The MUSIC model was developed to estimate the rainwater tank volume required to satisfy the Mamre Road Precinct DCP requirement. To determine the tank volume required to meet at least 80% of non-potable demand on individual lots, the following assumptions have been made:

- Non-potable demand of 15L/person/day at 25 persons/ha has been adopted as per the Wianamatta Creek MUSIC modelling guidelines. This has been calculated on a gross hectare basis
- 50% of the total warehouse roof area would drain to the rainwater tanks.

A summary of the rainwater tanks total sizing for all reuse purposes adopted in MUSIC is presented below in Table 8.

Note that this will vary with roof catchment available in more detailed design. As per Table 3 these rainwater tanks are incorporated in the Stage 2 design to meet the waterway health guidelines. Once the regional Sydney Water basins are constructed and recycled water is available for the Estate it is proposed the on lot tanks will be decommissioned. Rainwater tanks would not be required under the Ultimate Arrangement. Any tanks constructed on Lot 2 would be required to be decommissioned upon completion of recycled water mains within the Precinct which this Estate will utlitise.

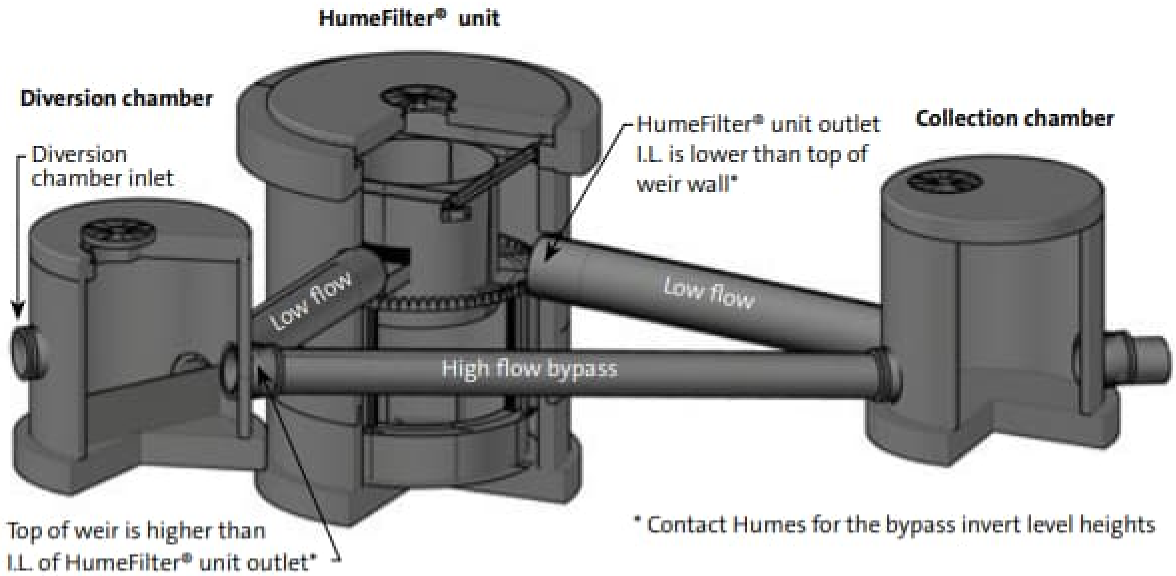
Table 8: Summary of rainwater and reuse tank parameters under the Stage 2 Arrangement

Lot	Total Lot Area (ha)	Catchment Area of Tank (ha)	Estimated annual irrigation demand (kL/yr)	Estimated Toilet reuse demand (kL/d)	Rainwater storage required (kL)
2 (RWT)	7.16	1.349 (Roof Only)	192	2.4	100
2 (Storage tank)	7.16	6.42	10000 (On Lot 6)	0	900

4.5.6. HumeFilter - Proprietary Product by Humes

To satisfy the concentration-based stormwater treatment requirements, a HumeFilter UPT3600 units is proposed to treat stormwater runoff from the road catchments prior to discharging to the open trunk channel. The unit is proposed to be placed upstream (east) of the open trunk drainage channel headwall and will be maintained by the developer. The HumeFilter unit is SQIDEP approved and all values for MUSIC are in line with the SQIDEP review document. Both units will be located within private lands and not public road reserves. Refer to Civil Plan for location of each unit.

Each UPT3600 unit has a treatable flow of 160L/s. Flows exceeding the treatable flow will bypass over a weir due to the off-line nature of the unit. We have specified an upstream GPT with treatable flow in excess of 160L/s, so that the HumeFilter does not quickly fill up with gross pollutants.



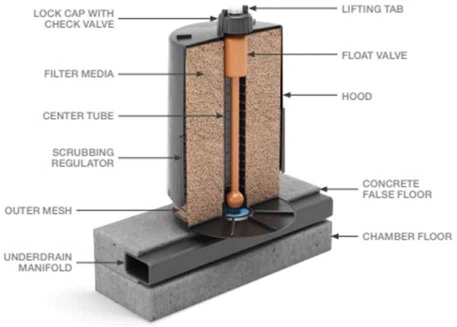
4.5.7. Passively Irrigated Street Trees

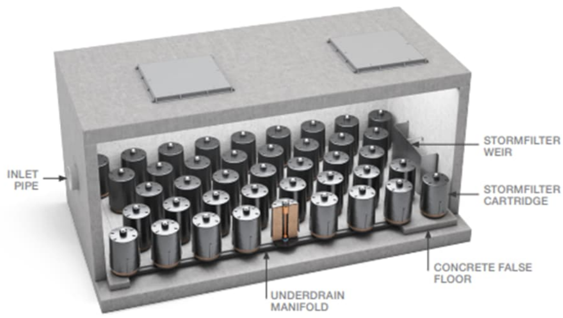
Advice received from Sydney Water are that passively irrigated street trees are an important component of their Regional stormwater drainage scheme. These street trees need to be designed to the Sydney Water Stormwater Scheme Infrastructure and Council's approval.

As the time of writing this report (August 2024) it is our understanding SWC and Penrith City Council have prepared a draft design for the passively irrigated street tree (PIST) which is on exhibition for comments. Whilst no design of the PIST are including within street infrastructure of Westlink Estate as yet these trees will be incorporated into the street infrastructure design once finalised. These trees will be included within all public road reserves as per Sydney Water's requirements. The street trees are excluded from the MUSIC modelling.

4.5.8. StormFilter Cartridges – Proprietary product by Ocean Protect

StormFilter cartridges have been proposed on Lot 2 within the OSD tanks, to meet the stormwater treatment demands in the allotment until the Regional Scheme by Sydney Water is operational. The system comprises of a number of filter cartridges that work in parallel to meet the treatment targets. Each cartridge siphonically treats 1.26L/s from a buildup of water to 750mm within the chamber. Excess storage/flows will spill over and bypass into the OSD system.

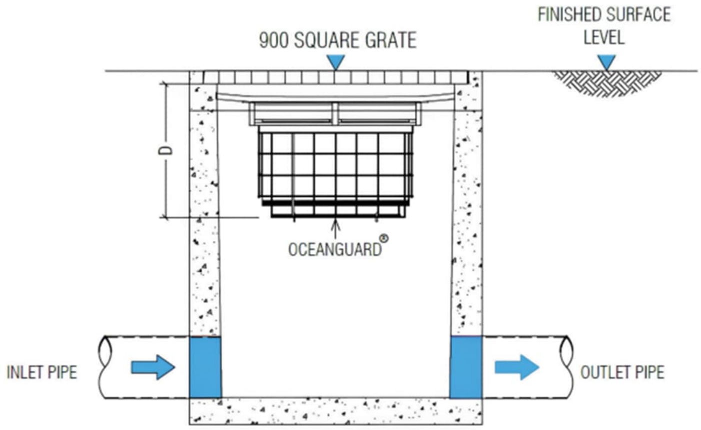




A maintenance plan with Ocean Protect is required to ensure that the filters are kept operational and functioning during the time that they are required. When the regional scheme is operational, the filters can simply be removed from the tank, and the OSD system will still be fully operational. The StormFilter Cartridges are SQIDEP approved products and as such can be used for the MUSIC modelling to reduce pollutant loads.

4.5.9. OceanGuard Pit Baskets – Proprietary product by Ocean Protect

OceanGuard pit baskets are specified within Lot 2, for every stormwater pit directly draining surface water from pavements and landscape. Roof catchments are excluded from this requirement. The OceanGuard pit basket is a SQIDEP approved GPT, so in contrast to the centralised system upstream of the HumeGuard, it is permitted to provide treatment in the MUSIC modelling for TN, TP, and TSS, as well as for GPTs. This greatly assists the pollutant treatment modelling in conjunction with the StormFilter cartridges.



Each pit basket directly filters pollutants into a basket/net, preventing gross pollutants and organic matter such as leaves from entering the drainage system. Additionally, the pollutants are suspended above the base of the pit, reducing pollutant leaching from wet materials. A maintenance plan is required for regularly emptying the baskets and replacing the baskets at regular intervals. The OceanGuard pit baskets will not be decommissioned when the regional scheme is connected – as the gross pollutant reduction is still required.

4.6. Scenario Modelling

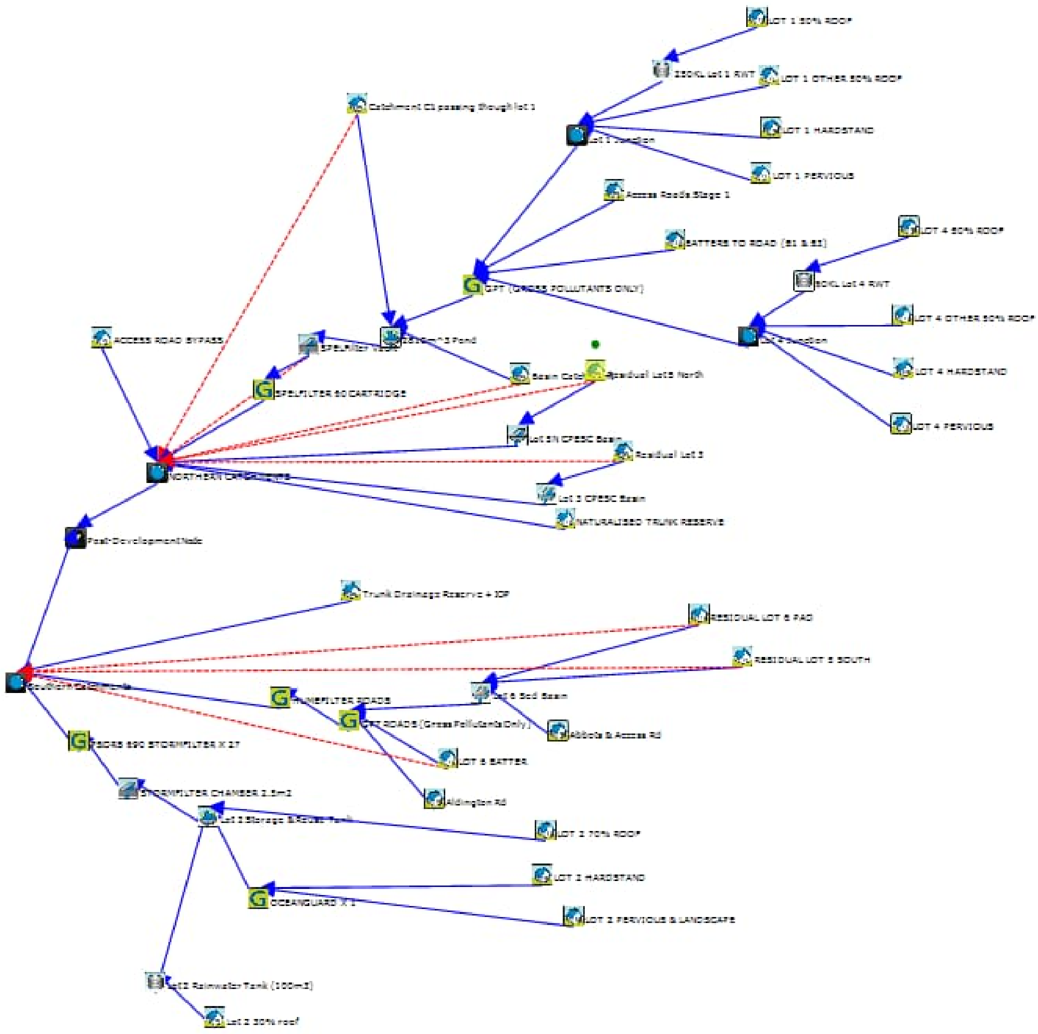


Figure 11: Post-development MUSIC model layout (Stage 2 Arrangement)

A MUSIC model was created to simulate post-development mean annual loads under the Stage 2 scenario. The post-development model has been created based upon the proposed post-development catchment extents presented in Figure 7 and includes the approved Stage 1 scenario. Source nodes for each of the proposed lots have been adopted based on typical large-scale industrial land uses, including those depicted in the Estate Plan prepared by Nettleton Tribe. The layout of the post-development scenario is presented in Figure 11. Note that the natural catchments draining externally are not included in the MUSIC modelling, or in per hectare targets.

The post-development model has been created based upon the proposed post-development catchment extents presented in Table 9. This table only presents catchments associated with Stage 2.

Table 9: Music Modelling Catchments

Catchment	Total Area (ha)	Impervious Area (ha)	Pervious Area (ha)
LOT 2 70% ROOF	3.14	3.14	-
LOT 2 HARDSTAND	1.13	1.13	-
LOT 2 PERVIOUS & LANDSCAPE	0.75	-	0.75
LOT 2 30% ROOF	1.35	1.35	-
ALDINGTON RD	1.13	0.90	0.23
LOT 6 BATTER	2.28	-	2.28
RESIDUAL LOT 6 PAD	7.03	-	7.03
RESIDUAL LOT 5 SOUTH	7.83	-	7.83
ABBOTS & ACCESS RD	1.03	0.82	0.21
TRUNK DRAINAGE RESERVE + IOP	0.79	0.16	0.64
STAGE 1 AREA (APPROVED UNDER PREVIOUS SSD)	27.2		
TOTAL INTERNAL	53.66	22.11	31.55

Table 10: Post-development scenario land use breakdown under the Interim Arrangement

Catchment	Total Area (ha)	Roof area to rainwater tanks (ha)	Other impervious area (ha)	Pervious area (ha)	% Pervious area
Lot 2 (including drainage reserve)	7.16	1.35	4.43	1.39	19.4
Access Roads to Southern Trunk	2.16	-	1.73	0.43	20
Stage 2 Developed Areas	9.32	1.35	6.16	1.82	19.5
Residual catchments draining through stage 2	19.39	-	-	19.39	100

Pond area is considered impervious area.

Note: Residual and External catchments are assumed to represent existing greenfield flows and not included within the Music modelling for flow duration or stormwater quality management, as agreed with EH&G in the consultation period.

The post-development scenario model under the Interim Arrangement incorporates the following stormwater management measures:

- Pervious landscape target of 15% as per Clause 4.2.3 (4) of the Mamre Road DCP s achieved as the total % pervious area for the developed portion of Stage 2 equates to 19.5% (refer Table 10).
- Rainwater tanks, as per the parameters presented in Section 4.5.5.
- GPTs, as per the parameters described in Section 4.5.1.
- Detention tank, as per the parameters described in Section 4.5.2.
- Stormwater reuse tank for irrigation, as per the parameters presented in Section 4.5.4

- Erosion and Sediment Basin for CPESC compliance, but improving flow reduction targets, described in Section Error! Reference source not found.
- Landscape irrigation, at 3.0ML/ha of pervious space (600mm/year with 50% of area irrigated).
- Residual land irrigation at 6.0ML/ha (600mm/year with 100% of area irrigated)
- Baseflow from pervious residual land surfaces is assumed to drain directly to the receiving node over time (red dashed arrows in Figure 11).
- HumeFilters to provide interim water quality treatment before discharge into trunk drainage system, as presented in Section 4.5.6.

The attributes for each of the proposed stormwater management measures have been determined such that they will satisfy the stormwater quality, quantity and flow targets outlined in Section 4.1.

4.7. Performance against stormwater quality targets

The "MUSIC MODELLING TOOKIT – WIANAMATTA" Published on 20/04/2022 by DPE, supplied to "support assessments and development of proposals for State Significant Development", provides two options for operational phase stormwater quality targets. The first option is the traditional "reduction in mean annual load from unmitigated development", while the new Option 2 provides an allowable mean annual load. For this development, due to the high amount of residual land, the allowable mean annual load target has been selected.

MUSIC model results presented as mean annual loads per hectare per year at the receiving node indicate that the adopted stormwater quality target reductions are achieved, as shown in Table 11.

Table 11: Summary of MUSIC modelling results against stormwater quality targets (kg/ha/year)

Parameter	Proposed Layout Source Load (kg/ha/yr)	Proposed Layout Residual Load for Stage 2 (kg/ha/yr)	Target allowable Mean Annual Load (kg/ha/yr)
TSS (kg/ha/yr)	422.5	78.9	80.00
TP (kg/ha/yr)	0.88	0.23	0.30
TN (kg/ha/yr)	6.13	2.54	3.50
Gross Pollutants (kg/ha/yr)	74.10	2.30	16

The MUSIC model results presenting treatment train effectiveness shows that while the adequately satisfies the allowable mean annual loads (Option 2). Due to the large proportion of un-developed land contributing to the treatment train, the reduction targets are less feasible than in a fully developed estate assessment.

Under the Sydney Water Regional strategy, stormwater quality management measures would be incorporated into the regional stormwater management scheme to be designed, delivered and operated by Sydney Water. In this case, the Stage 1 and 2 filter cartridges, Stage 2 HumeFilter, residual irrigation, rainwater tanks, and storage ponds or tank volumes are expected to become redundant, with treatment targets met by Sydney Water centralised assets.

4.8. Performance against stormwater quantity targets

Table 12 presents the pre-development and post development flow rates, generated by hydrologic and hydraulic modelling in DRAINS, for a range of events between and including the 50% AEP and 1% AEP design storm events at the discharge points from the site.

Table 12: Pre-development and post-development peak flow rates (Interim and Ultimate Arrangements)

Design Storm Event	Pre-Development Peak Flow Rate (m^3/s)	Post-Development Peak Flow Rate (m^3/s)
50% AEP	1.37	0.958
20% AEP	2.09	2.09
10% AEP	3.00	3.00
5% AEP	4.01	3.95
2% AEP	6.13	5.51
1% AEP	7.42	6.65

The DRAINS model results demonstrate that the post-development peak flow rates would be less than or equal to pre-development peak flow rates for a range of storm events between (and including) the 50% AEP and 1% AEP design events. Therefore, the stormwater drainage system and detention basins as proposed would satisfy the development controls relating to stormwater quantity management.

The Westlink Estate design flows have been derived using IL-CL methods and post development flows use ILSAX modelling to these limits. It is understood that the higher level modelling undertaken by Sydney Water uses RAFTS modelling, resulting in significantly lower pre-development peak flow rates (5.1m^3/s for the 1% AEP). RAFTS is not practical or accurate for finely modelling urban catchments to the level of detail the civil design must reach. Our understanding is that while using ILSAX and IL-CL results in higher flow rates, as long as we are consistent with our internal modelling of pre-development and post-development this will be acceptable to Sydney Water. The flood modelling by Stantec will provide a like for like analysis against Sydney Water modelling showing that the development does not negatively impact the downstream catchments, regardless of the modelling method used for the urban catchments.

4.9. Performance against stormwater runoff volume targets

MUSIC model results demonstrating performance of the proposed stormwater management measures in the Interim Arrangement against the stormwater flow targets are presented below in Table 13. The resultant flow duration curve is presented as Figure 12.

Table 13: Summary of MUSIC model results against stormwater flow targets (Interim Arrangement)

Parameter	Result	DCP Target	Complies with DCP target	
			DCP Option 1 (MARV approach)	DCP Option 2 (Flow Duration Curve approach)
Mean annual runoff volume (ML/ha/yr)	1.99	2.0	Yes	n/a
95%ile flow (L/ha/day)	24,898	3000 to 15000	n/a	No
90%ile flow (L/ha/day)	4,682	1000 to 5000	Yes	Yes
75%ile flow (L/ha/day)	352	100 to 1000	n/a	Yes
50%ile flow (L/ha/day)	51	5 to 100	Yes	Yes
10%ile flow (L/ha/day)	0	0	Yes	n/a
Cease to flow	12%	10% to 30%	n/a	Yes

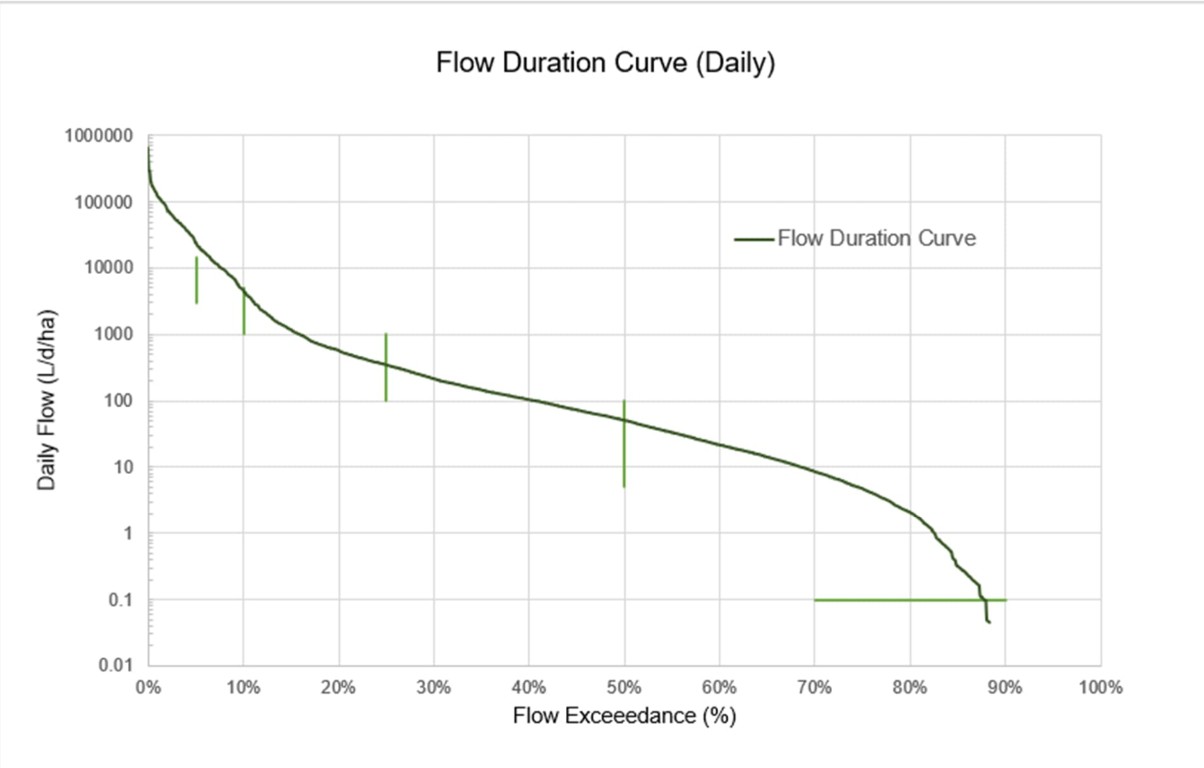


Figure 12: Flow duration curve for the proposed stormwater management measures

The results presented in Table 13 demonstrate the proposed stormwater management measures that will be implemented under the Interim Arrangement satisfy the Option 1 DCP stormwater flow targets for the site.

4.10. Ongoing Management and Maintenance

All proposed water management measures that make up the Interim Arrangement of the water management strategy would be managed and maintained by the proponent. An Inspection and Maintenance Plan will be prepared and lodged with the construction certificate for the subdivision works once final design details and the extent and layout of all proposed water management measures is confirmed. It is anticipated that the Inspection and Maintenance Plan would be prepared using current best practice guidance such as *Water sensitive urban design inspection and maintenance guidelines* (Blacktown City Council, 2019) and would describe:

- Each of the functional components of each water management measure.
- Expertise required to inspect, maintain and (where necessary) repair or replace components.
- Minimum required frequency of inspection, repair or replacement activities.
- Inspection and maintenance forms that list all necessary activities and contain a record of activities completed.

The Estate Arrangement would incorporate some estate-based measures such as on-lot rainwater tanks, GPTs and an estate-wide detention basin. These measures would be managed and maintained by the proponent, with inspection and maintenance requirements consistent with those described above. The planned regional stormwater management scheme, which would incorporate measures to manage stormwater quality and volume across the Mamre Road Precinct, would be managed and maintained by Sydney Water.

5. Site Water Balance

5.1. Water Balance Overview

Potable water supplies in the Sydney area are in recognised short supply with projected population increases, potential climate change and periods of extended drought. It is acknowledged that any development in the Sydney region places greater demand on an already limited water supply. As a result, government bodies, together with Sydney Water have encouraged sustainable development by the implementation of an integrated approach to water cycle management (potable water, sewerage, stormwater and rainwater) to minimise potable water demand and maximise the potential for non-potable water sources to replace potable water demand where possible.

With the appointment of Sydney Water as the regional Waterway Manager and the announcement of a regional stormwater management scheme, opportunities for water reuse within the Mamre Road Precinct will include regional stormwater harvesting and reticulated recycled water.

5.2. Water Requirements

Water requirements within the Westlink Industrial Estate will be typical of large format warehouses and distribution centres. Sources of demand for water within the proposed allotments and public domain will include:

- Office amenities (kitchen, bathrooms)
- Landscape irrigation
- Dust suppression (depending on end user requirements)

5.3. Water Sources

The primary source of water to the Westlink Industrial Estate will be Sydney Water's potable water reticulation network.

A "third-pipe" reticulated recycled water network will supply non-potable water throughout the Mamre Road Precinct. Non-potable water will be supplied from two sources:

- Stormwater harvested within precinct-wide wetlands / ponds, to be delivered and operated by Sydney Water as part of a regional stormwater management scheme.
- Recycled water from the planned Upper South Creek Advanced Recycled Water Centre.
- Recycled roof runoff water treated and pumped on site.

5.4. Water Use Minimisation

Sydney Water provides a wide range of advice and guidance relating to water use minimisation and water efficiency. Whilst warehouses and distribution centres are relatively low water users in comparison to other industrial users, the following water use minimisation principles will apply to development within the Westlink Industrial Estate:

- Avoid using water where possible, such as sweeping hard surfaces instead of washing them.
- Reduce water use by installing water-efficient appliances and equipment (e.g., toilets, urinals, shower heads).
- Reuse water from manufacturing or cooling processes to toilet flushing, landscape irrigation and dust suppression.

6. Overland Flow Flooding

The site is located outside the extent of the Flood Planning Area identified in the *Penrith Local Environment Plan 2010*, refer to Figure 13.

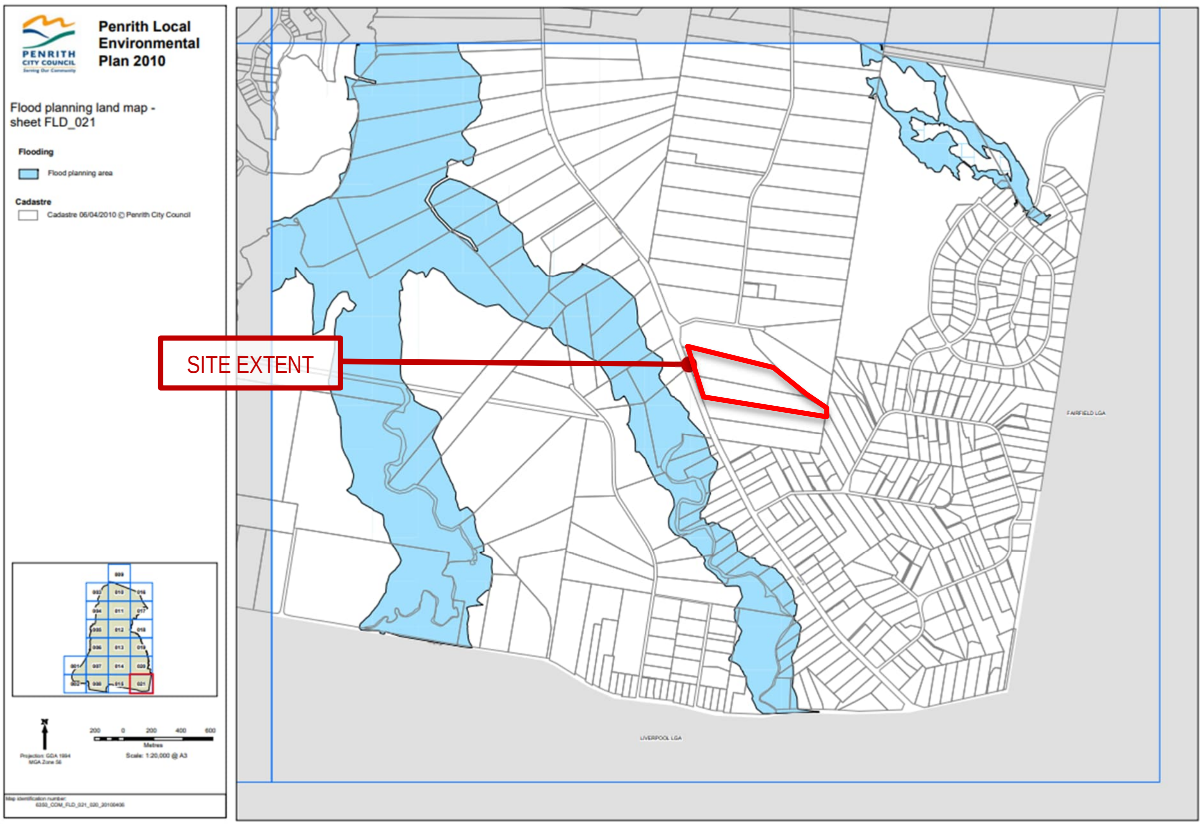


Figure 13 : Extract of flood planning land map (Penrith LEP 2010)

Mapping of the 1% AEP flood extent from local catchments within the Mamre Road Precinct is presented in the *Mamre Road Flood, Riparian Corridor and Integrated Water Cycle Management Strategy* (Sydney Water, October 2020), and is reproduced as Error! Reference source not found. This mapping shows the extent and depth of overland flow from local catchments within the site.

The proposed development of the site, including bulk earthworks, construction of a major and minor drainage system and construction of the proposed detention basin, will satisfy the development controls related to flood prone land outlined in Section 2.5 of the Mamre Road Precinct DCP.

The design of major system drainage elements is consistent with the principles of the NSW Government *Floodplain Development Manual* and Penrith City Council's *Stormwater Drainage Specification for Building Developments*. Under the post-development scenario, overland flow will be safely contained within the proposed road reserve and within trunk drainage infrastructure that has been incorporated into the design of the subdivision works.

As presented in Table 12, the post-development peak flow rates will be less than the pre-development peak flow rates at each of the discharge points for all design storm events between (and including) the 50% AEP and the 1% AEP event. Therefore, there will be no flood impact on adjacent properties associated with the proposed development of the site.

Refer to "Response to Sydney Water Comments on the Stage 2 Flood Impact Assessment , Westlink Industrial Estate at 290-308 Aldington Road, 59-62 Abbotts Road & 63 Abbotts Road, Kemps Creek" August 2024 by Stantec for further details including 2D flood modelling of downstream impacts.

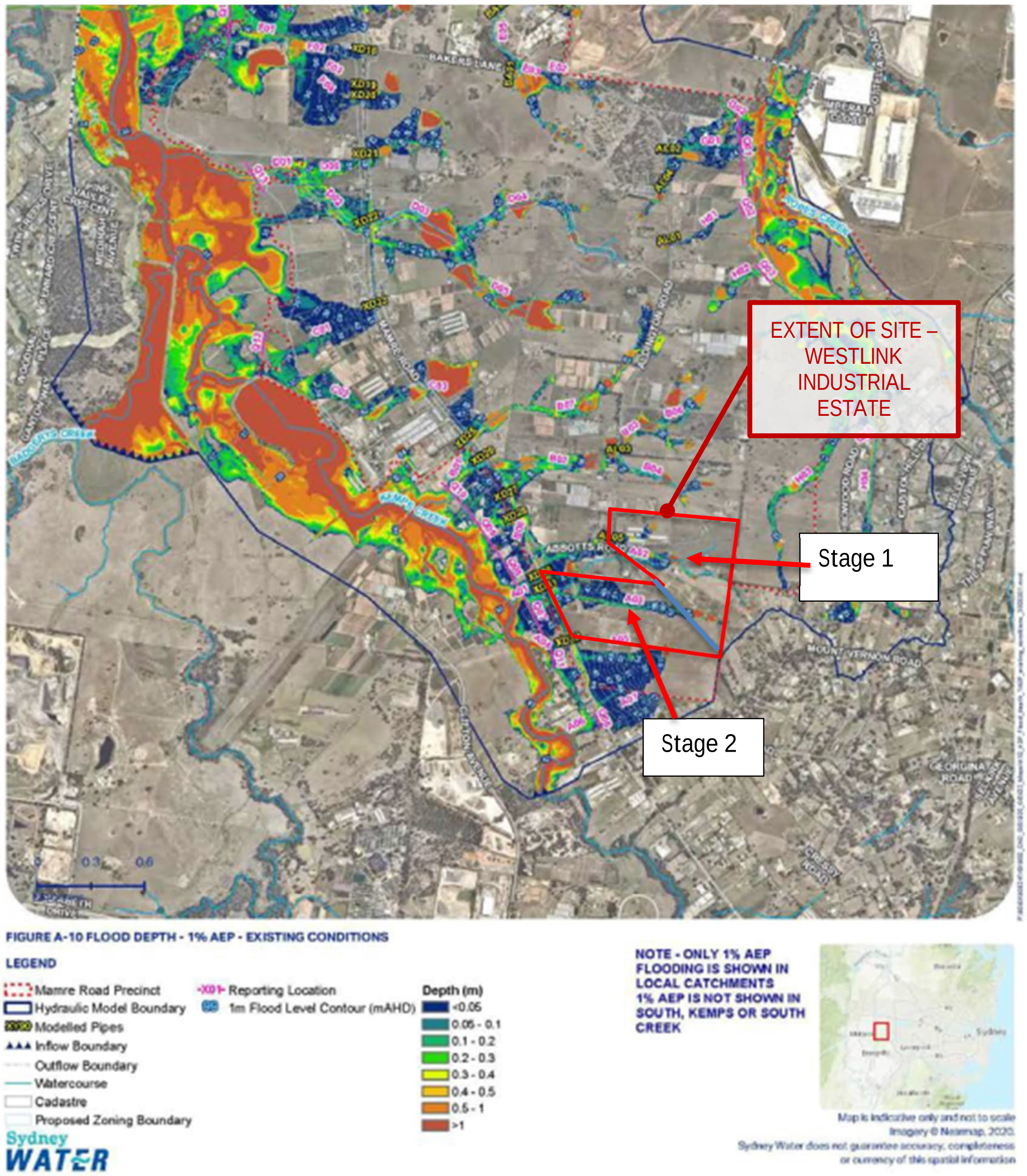


Figure 14: 1% AEP flood depth from local catchments under existing conditions (Sydney Water, 2020)

Figure 14 above shows that there are some flood impacts under the existing conditions within the stage 2 site.

The Stantec modelling for stage 2 indicates that while storms below the 200 year ARI overall reduce downstream flooding impacts compared to the pre-developed flooding, there are moderate downstream impacts during the 500yr and PMF events spilling towards Mamre Road and also north of the Mamre Road-Abbotts Road intersection. These slight increases have been taken into account for these intersection design works. For both the 500 yr and PMF events there are reductions in flooding west of Mamre Road at the Stage 2 boundary.

7. Inspection and Maintenance Plan

7.1. Maintenance and Operations

Inspection and maintenance of the stormwater management measures that will be implemented under Stage 2 Phase 1 conditions shall be undertaken at the minimum frequency as outlined in Error! Reference source not found.. The majority of these requirements have been derived from the Penrith City Council guideline titled *Water sensitive urban design (WSUD) inspection and maintenance guidelines* (Version 1.0, 2022).

Refer to Appendix 3 for Inspection and Maintenance Sheets for each of the stormwater management elements that will be owned, operated and maintained by the Property Owner (or representatives), including:

- Rainwater tanks
- On-lot stormwater drainage
- Gross pollutant traps
- OSD Tank

Table 14 - Inspection and monitoring requirements

Inspection / Monitoring Requirement	Responsibility	Timing / Frequency	References / Notes
1. On-lot stormwater drainage (including rainwater tanks)			
Eaves / box guttering system and downpipes	ESR as current property manager	At least once every six months	Refer to Inspection and Maintenance Sheets for rainwater tanks in Appendix 3.
On-lot stormwater drainage – grates and pits	ESR as current property manager	At least once every year	Refer to Inspection and Maintenance Sheets for on-lot stormwater drainage in Appendix 3.
On-lot stormwater pits and pipes (by CCTV)	ESR as current property manager	At least once every three years	
Rainwater tank (first flush device, external inspection of tank and fittings)	ESR as current property manager	At least once every six months	Refer to Inspection and Maintenance Sheets for rainwater tanks and Maintenance Manual (Appendix 3).
Rainwater tank – internal inspection and cleaning of tank, pumps, pipework and fittings	ESR as current property manager	At least once every year	
2. Gross pollutant traps			
GPT components (lids and surrounds, inlet, outlet, sump, screens, oil baffles)	ESR as current property manager	At least once every six months	Refer to Humeceptor Operation and Maintenance Manual
3. Estate-wide stormwater drainage (within road reserve)			
Stormwater drainage elements visible at ground level (grates, lintels, headwalls)	Penrith City Council	To be determined by Penrith City Council	Assets to be incorporated into Council's asset management system
Stormwater pits and pipes (by CCTV)	Penrith City Council	To be determined by Penrith City Council	

Inspection / Monitoring Requirement	Responsibility	Timing / Frequency	References / Notes
4. OSD Tank			
Tank inlet and outlet	ESR as current property manager	At least once every six months	Refer to Inspection and Maintenance Sheets for OSD Tank in Appendix 3.
Tank discharge control pit (grates, orifices, screens)	ESR as current property manager	At least once every six months	
5. Stormwater Pump Station and Irrigation Rising Main			
Pre-packaged pump station	ESR as current property manager	At least once every six months	To be confirmed with Pump Manufacturers
Rising Main	ESR as current property manager	At least once every six months	
Irrigation sprinkler system	ESR as current property manager	At least once every six months	
6. Open Trunk Drainage Channel			
Irrigation of landscaped elements	Sydney Water and ESR as current property manager	Monthly during establishment. TBC with Sydney Water	Assumed SWC will maintain open trunk drainage channel. To be confirmed with ESR as current property manager how hand over process works
Visual inspections after more than 5mm of rainfall	Sydney Water and ESR as current property manager	Monthly and/or after 5mm of rainfall during establishment	
Debris/Blockage removal	Sydney Water and ESR as current property manager	Monthly during establishment. TBC with Sydney Water	
Weed Management and Plant replacement	Sydney Water and ESR as current property manager	Monthly during establishment. TBC with Sydney Water	
Soil / Rock Protection inspections	Sydney Water and ESR as current property manager	Monthly during establishment. TBC with Sydney Water	

7.2. Monitoring

Elements of the stormwater management measures that will be monitored will be limited to general condition of each of the measures, which will be recorded on the Inspection and Maintenance Sheets for each measure (refer to Appendix 3).

7.3. Reporting and Auditing

Reporting and auditing of the stormwater management measures that will be incorporated under Stage 1 Phase 1 conditions will require completion of Inspection Sheets and Maintenance Sheets at the minimum interval recommended in Error! Reference source not found.. Inspection and Maintenance Sheets for each of the measures are included in Appendix 3 and have been either:

- Reproduced from the Penrith City Council WSUD inspection and maintenance guideline; or
- Produced using a similar format to the sheets incorporated in Council's guideline.

Completed Inspection Sheets and Maintenance Sheets for all stormwater management measures that will be owned, monitored and implemented by the Property Owner will be incorporated in an asset register and retained for the purpose of monitoring and environmental audit reporting that is required under Division 9.4 of Part 9 of the *Environmental Planning and Assessment Act 1979*.

8. Contingency Management

In the event that this SMP is not effective in managing potential environmental impacts, specific contingency actions will be implemented. Table 15 lists actions to be implemented if inspections, monitoring or auditing indicate that the stormwater management measures listed in Section 5 and any specialist management plans are not effective in managing environmental impacts.

The Contingency Plan categorises conditions as follows:

- Condition Green – considered to be normal operating condition.
- Condition Amber – minor non-compliance that should be rectified as soon as practical.
- Condition Red – non-compliance that should be rectified as a matter of urgency.

Table 15 - Contingency measures relating to operational stormwater management

Element	Trigger / Response	Condition Green	Condition Amber	Condition Red
Water quality monitoring	Trigger	No visible indicators within the Westlink Estate (oil / grease, turbidity). No complaints from property owners downstream of the Westlink Estate	Visible indicators within the Westlink Estate. Complaints from property owners downstream of the Westlink Estate	Prolonged poor water quality within ponds and downstream of the Westlink Estate.
	Response by ESR as current property manager	Continue SMP / OEMP implementation	Water quality sampling and testing to be undertaken to ensure results are just an anomaly and not a trend.	Appropriate rectification measures are implemented (e.g., aeration, additional filtration). Follow up water quality monitoring is undertaken to ensure parameters meet the ambient water quality objectives for the Wianamatta-South Creek catchment.
Flooding (inundation of lots, surcharge of stormwater drainage)	Trigger	Stormwater drainage system and riparian corridor functioning as per design intent (no exceedance of capacity, no surcharge in road network or inundation of lots)	N/A	Inundation of lots. Surcharge of stormwater drainage within road reserve.
	Response by ESR as current	Continue SMP / OEMP implementation	N/A	Check for blockages within stormwater drainage network

Element	Trigger / Response	Condition Green	Condition Amber	Condition Red
	property manager			(sediment, debris, OSD Basin inlet and outlet structures). Rectify when required.
OSD Tank-Safety	Trigger	OSD tank functioning as intended – no visible damage to tank structure	Minor defects within OSD tank (e.g., blockage at discharge control pit).	Major defects within OSD Tank (e.g., failure of the discharge control pit)
	Response by ESR as current property manager	Continue SMP / OEMP implementation	Undertake short-term rectification works to address defects.	Undertake urgent works to address defects.
Pumped Irrigation System	Trigger	Pumped Irrigation system functions as intended- no visible damage to pumps or pressure mains.	Minor defects to Pump and pressure main but pump still operating	Major defects with pump and pressure main. Pump broken and not operating
	Response by ESR as current property manager	Continue SMP/OEMP implementation	Undertake minor repairs	Undertake urgent works to address defects

9. Lifecycle Costs

9.1. OSD Basin

Lifecycle costs associated with the OSD basin will be in accordance with Landcom Water Sensitive Urban Design Book 4 – Maintenance as indicated in Figure 15.

The costs within Figure 15Figure 15 are based off 2003-2004 rates so would need to be indexed off 2023 prices (According to Rawlinsons 2022, 2003 to 2021 indexation is + 93% is a conservative estimate) and based off current rates provided by Civil and Landscape contractors for all associated WSUD works. These prices would be confirmed during Detailed Design and civil/landscaping tendering periods.

LIFE CYCLE COST ELEMENT	BIORETENTION	WETLANDS	PONDS & SEDIMENTATION BASINS
Life cycle	25 to 50 years	15 to 80 years (with 50 years used as the default in MUSIC) Wetlands are designed to have an infinite life span. However, to determine a life cycle cost, a finite number needs to be set	5 year (sedimentation basins) 50 years (ponds)
Total acquisition cost (TAC) (per m^2)	$387.4 \times (A)^{0.7673}$ \$1000/m^2 for first 20 m^2 (\$200/m^2 for remaining area)	$1911 \times (A)^{0.6435}$ The treatment area used in defining the total acquisition cost is the combined inlet and macrophyte zone area	$685.1 \times (A)^{0.7893}$
Total annual maintenance (TAM) (%TAC)	$48.87 \times (TAC)^{0.4410}$	$6.831 \times (A)^{0.8634}$	$185.4 \times (A)^{0.4780}$ The annual maintenance cost considers the volume of material likely to be removed from the basin per year (referred in MUSIC as the size attribute, V). The size attribute is the sum of gross pollutants, coarse sediment and total suspended solids (TSS) that are trapped in the basin / pond per year
Renewal period (years)	25	20 Renewal considerations include replanting and recontouring of the macrophyte zone	1 year (default in MUSIC due to lack of evidence). 10 years based on available data
Renewal costs (%TAC p.a.)	2.0%	0.52%	1.4% Costs associated with access ramps and contouring Limited data available
Decommisioning costs (% TAC)			38% - only applicable to sedimentation basins

Figure 15 - Lifecycle Costs from Landcom

9.2. Proprietary Stormwater Treatment Devices

Proprietary stormwater treatment device specifications and life cycle costs will be confirmed by the Manufacturer. Ocean Protect as manufacture will provide these specifications at the detailed design stage.

9.3. Pumping and Landscape Irrigation System

Pumping spec and life cycle cost will be confirmed by the Hydraulic Engineer.

APPENDIX 1 – CIVIL DRAWINGS

- 20-748-C5000 SERIES (INFRASTRUCTURE)
- 20-748-C6000 SERIES (ON-LOT)

APPENDIX 2 – STORMWATER HYDROLOGY SUMMARY

Level 7
153 Walker Street
North Sydney
NSW 2060
P 02 9439 1777
F 02 9923 1055
E info@atl.net.au
ABN 96 130 882 405
www.atl.net.au

04 July 2023

Sydney Water
PO Box 399
Parramatta NSW 2124

Your Ref: TBC
Our Ref: LTR007-02 -20-748 Westlink Industrial Estate Hydrology

Attention: John Molteno

Email: TBC

Dear John,

Westlink Industrial Estate Hydrology

1. General

This letter summarises the hydrological assumptions being utilised by AT&L across the Mamre Road Precinct to establish predevelopment and post development flow rates.

2. Existing Available Information

The following list of documents provide historical hydrological estimation methods within the Wianamatta South Creek Catchment:

- Flood Study Report, South Creek' (Department of Water Resources, 1990).
- South Creek Floodplain Management Study' (Willing and Partners Pty Ltd, 1991).
- ADI St Mary's Watercycle & Soil Management Study - Final Study Report' (Sinclair Knight Merz, 1998).
- Austral Floodplain Risk Management Study and Plan' (Perrens Consultants, 2003).
- South Creek Floodplain Risk Management Study and Plan' (Bewsher Consulting, 2004).
- Upper South Creek Flood Study' (WMA Water, 2012).
- Upper South Creek Floodplain Risk Management Study and Plan' (Cardno, 2014).
- Updated South Creek Flood Study' (WorleyParsons, 2015).
- South Creek Floodplain Risk Management Study and Plan' (Advisian, 2020).
- Wianamatta-South Creek Catchment Flood Study Existing Conditions (Advisian, 2022).
- Stormwater Scheme Infrastructure Design Guidelines Draft (Sydney Water, 2022).

We note that the hydrological methods for establishing existing conditions across the Wianamatta South Catchment in the reports above vary greatly and range from RAFTS, RORB, WBNM and ILSAX.

3. Predevelopment Hydrology Assumptions

AT&L have been consistent with the Stormwater Scheme Infrastructure Design Guidelines Draft (Sydney Water,

2022) and utilised the ARR2019 IL-CL methodology to establish existing conditions across the development. We note that the *Wianamatta-South Creek Catchment Flood Study Existing Conditions* by Advisian utilised ARR1987 rainfall values in combination with RAFTS to calibrate flows to an existing Flood Frequency Analysis (FFA) for the area.

3.1. Rainfall Data

Rainfall Data was derived from ARR Datahub for the area.

- Coordinates: Longitude: 150.792 Latitude: -33.845
- Rainfall IFD (2019) data
- NSW median pre-burst rainfalls were derived from ARR Datahub.

3.2. IL - CL values

The IL-CL values were derived from the Stormwater Scheme Infrastructure Design Guidelines Draft (2022)

- Pervious Areas – IL: 37.1mm CL: 0.94mm
- Impervious Areas – IL: 1.00mm CL: 0.00mm

No Bx value was nominated as the RAFTS (Laurenson) method for calculating flows was not used.

3.3. Catchment Perviousness

The following Assumptions have been made for catchment perviousness.

- Effective Impervious Area: 5% of total catchment area to account for waterbodies and directly connected roads.
- Remaining Impervious Area: Not utilised
- Pervious Area: 95% remainder of site. We note a sensitivity test was run on perviousness of 100% and 90% and found changes in the order of +- 5%.

3.4. Time of Concentration

Time of concentration estimation was determined through a combination of the following methods:

- Friend's equation: at the most upstream ends of the catchment to estimate sheet flow (*dependent on Horton's roughness and slope*). A comparative assessment of kinematic wave vs friends equation was undertaken with JWP and AT&L, results indicated time of concentration is similar in both instances for catchment lengths less than 30m . For catchment lengths greater than 30m the a typical manning's open channel equation was utilised with an assumed velocity ranging between 1.5m/s-3m/s dependant on flow rate.
- Manning's Open Channel Flow: where sheet flow ends and becomes concentrated.
- Manning's Pipe Flow: Where open channel flow ends and enters a culvert.

Time of concentration typically ranged between 15 minutes – 28 minutes.

4. Post Development Hydrology

AT&L have been consistent with the industry standards for estimating flows in urban catchments and utilised the ILSAX methodology to establish post development conditions across the local site.

4.1. Rainfall Data

Rainfall Data was derived from ARR Datahub for the area.

- Coordinates: Longitude: 150.792 Latitude: -33.845
- Rainfall IFD (2019) data
- NSW median pre-burst rainfalls were derived from ARR Datahub.

4.2. Soil Depression Storage

The ILSAX values were derived from the Stormwater Scheme Infrastructure Design Guidelines Draft (2022)

- Paved (impervious) area depression storage: 1 mm
- Grassed (pervious) area depression storage: 5 mm
- Soil type: 3

4.3. Catchment Perviousness

Catchment perviousness was established based on land use as follows:

- IN2 Land – 85% imperviousness and 15% perviousness (to be measured at detailed design).
- Roads – 85% imperviousness and 15% perviousness (to be measured at detailed design)
- Water Courses 5% imperviousness and 95% perviousness.

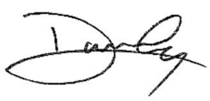
4.4. Time of Concentration

Time of concentration estimation was determined through a combination of the following methods:

- Friend's equation: at the most upstream ends of the catchment to estimate sheet flow (*dependent on Horton's roughness and slope*).
- Manning's Pipe Flow: Where open channel flow ends and enters a culvert.

Time of concentration typically ranged between 6 minutes – 15 minutes. Generally, lots scales along with pit and pipe data results in a fast-reacting catchment.

Yours sincerely,



Darren Galia
Senior Civil Engineer
0433 759 556

APPENDIX 3 – INSPECTION, MAINTANCE AND OPERATIONS GUIDELINES

REFERENCE SHEET – Rainwater tank

Functional component		Part C number	Required frequency (months)	Good (condition score - 1)	Moderate (condition score - 2)	Poor (condition score - 3)
1	**Roof, gutters and downpipes**					
1a	Roof and gutters	25	6	Stable roof and guttering with minimal rust. Minimal leaf litter present on roof and in gutter. No impact on inflow into tank.	Roof or guttering has minor damage and/or areas of rust. Damage is not posing a safety risk. Leaf litter present on roof and/or in gutters and may impede flows into tank. No or minimal impact on inflow into tank.	Roof or guttering has major damage and/or extensive areas of rust. Damage is posing a risk to safety. Build-up of leaf litter on roof and/or in gutters. Major impact on inflow into tank.
1b	Downpipes and screens (rainhead)	8	6	Secure downpipe. No holes or leaks. Downpipe and screen (rainhead) are clear of leaf litter and debris.	Downpipe showing signs of wear and/or has holes or leaks. Downpipe and screen (rainhead) has some leaf litter and debris present but water can still enter tank.	Downpipe is unstable and/or is not transferring inflow to tank. Showing extensive signs of wear. Downpipe and screen (rainhead) are blocked by leaf litter and debris.
1c	First flush device	12	6	Minimal blockage. Water can easily enter the first flush device.	Some blockages. Water can still enter the first flush device at a reduced rate.	Major blockage stopping most water from entering the first flush device.
2	**Tank inlets**					
2a	Screen	26	6	Water from roof delivered into tank correctly. No holes or damage to the screen. No blockages.	Water from roof delivered into tank through screen at a reduced rate. Some small holes/light damage. Can still function to remove most gross pollutants. Minor blockages.	Pipe from roof not delivering water to the tank correctly. Large holes/heavy damage to the screen. Gross pollutants can enter the tank. Severe blockages at the inlet.
3	**Tank**					
3a	Overflow	19	6	Overflow is free of blockages and is directly connected to the stormwater system. No erosion or scour at the overflow outlet.	Overflow is partially blocked and/or is indirectly connected to the stormwater system (via overland flow path). Minor erosion or scour at the overflow outlet.	Overflow is entirely blocked and/or completely disconnected from the stormwater system. Major erosion or scour at the overflow outlet.
3b	Body integrity	4	6	No damage to the body of the tank. No surrounding areas that suggest leakage.	Some small holes/cracks present in the tank body. Surrounds suggest that minor leakage could be occurring.	Tank body integrity is undermined by extensive holes and/or cracks.
3c	Base stability	2	6	Tank is stable with no damage to base.	Tank base is not completely stable, but unlikely to move. Some cracks and signs of wear on the footings and/or foundation.	Tank base is unstable, likely to move and posing a safety risk. Major cracking and wear of footings and/or foundation.
3d	Sludge	28	6	No sediment present in outflow. Water flowing from tank is clear.	Water is clear with small amounts of sediment present in outflow.	Water is discoloured and/or carries large amounts of sediment.
4	**Pumps, filters and valves**					
4a	Pump	24	12	Pump working correctly and clear of dust and debris.	Pump working but requires adjustment. Pump has accumulated dust and debris.	Pump not working or requires replacement. Produces an unusual noise or vibration when operating.
4b	Filter	11	12	Filter is clean and in good condition.	Filter requires cleaning or replacement.	Filter damaged or failed.
4c	Valves	32	12	Valves working correctly.	Valves working but require adjustment.	Valve systems are not working or require replacement.

Sheet 1 of 2

PENRITH CITY COUNCIL

Functional component		Part C number	Required frequency (months)	Good (condition score - 1)	Moderate (condition score - 2)	Poor (condition score - 3)
5	**Mains backup, flow meter and backflow**					
5a	Potable mains backup device	23	12	Potable mains backup working correctly.	Potable mains backup working but requires adjustment.	Potable mains backup system is not working or requires replacement.
5b	Backflow prevention device	1	12	Backflow prevention device (dual non-return valve) working and fitted correctly.	Backflow prevention device (dual non-return valve) working but requires adjustment.	Backflow prevention device (dual non-return valve) is not working, requires replacement or not fitted correctly.
5c	Flow meter	14	12	Flow meter working correctly and readings for top-up, pump and mains backup are consistent with last reading.	Flow meter readings are inconsistent with last inspection.	Flow meter system is not working or requires replacement.

Sheet 2 of 2

INSPECTION SHEET – Rainwater tank

PENRITH CITY COUNCIL

Date ______________________

Location ______________________

Asset name ______________________

Asset ID ______________________

Inspected by (name/company) ______________________

Purpose of visit

- ☐ Inspection
- ☐ Response to complaint
- ☐ Other (specify) ______________________

Rainfall conditions

- ☐ Rainfall today (__ mm)
- ☐ Rainfall in last 3 days (__mm)
- ☐ No recent rainfall

Functional component		Condition score and evidence *Circle the score 1, 2, 3 or NA (not applicable) for each functional component based on good (1), moderate (2), or poor (3) conditions as noted in the reference sheet. Write why the score was given in the 'Notes' section.*
1	**Roof, gutters and downpipes**	
1a	Roof and gutters	1 2 3 NA Notes:
1b	Downpipes and screens (rainhead)	1 2 3 NA Notes:
1c	First flush device	1 2 3 NA Notes:
2	**Tank inlets**	
2a	Screen	1 2 3 NA Notes:
3	**Tank**	
3a	Overflow	1 2 3 NA Notes:
3b	Body integrity	1 2 3 NA Notes:
3c	Base stability	1 2 3 NA Notes:
3d	Sludge	1 2 3 NA Notes:
4	**Pumps, filters and valves**	
4a	Pump	1 2 3 NA Notes:
4b	Filter	1 2 3 NA Notes:
4c	Valves	1 2 3 NA Notes:

Sheet 1 of 2

Functional component		Condition score and evidence *Circle the score 1, 2, 3 or NA (not applicable) for each functional component based on good (1), moderate (2), or poor (3) conditions as noted in the reference sheet. Write why the score was given in the 'Notes' section.*
5	**Mains backup, flow meter and backflow**	
5a	Potable mains backup device	1 2 3 NA Notes:
5b	Backflow prevention device	1 2 3 NA Notes:
5c	Flow meter	1 2 3 NA Notes:

Other:

REFERENCE SHEET - On-lot stormwater drainage

Functional component		Required frequency (months)	Good (condition score - 1)	Moderate (condition score - 2)	Poor (condition score - 3)
1	**Downpipes**				
1a	Connection to subsurface drainage	36	Secure downpipes. No holes or leaks.	Downpipes showing signs of wear and/or damage (holes, cracks, leaking joints).	Downpipes are unstable and/or not discharging flow to subsurface drainage.
2	**Stormwater pits**				
2a	Grates / covers	12	Grates / covers are in place not blocked and do not pose a safety hazard.	Grates / covers require adjustment or clearing of blockage.	Grates / covers require repair or replacement due to damage.
2b	Internal	36	No damage or blockage evident.	Minor blockage or evidence of damage (cracking, spalling).	Significant blockage causing loss of conveyance capacity. Damage to pit that poses a risk to structural integrity, safety or function of stormwater system.
3	**Stormwater pipes / culverts**				
3a	Structural condition	36	No defects or blockage evident	Minor defects evident (e.g., hairline cracks)	Major defects requiring repair (e.g., cracks, concrete spalling, displacement at joints, pipe collapse).
3b	Debris / blockage	36	No blockage evident.	Minor blockage (<15% of pipe / culvert cross-sectional area)	Significant blockage affecting pipe conveyance capacity (>15% of cross-sectional area).

INSPECTION SHEET - On-lot stormwater drainage

Date: ______________________

Location: ______________________

Asset Name: ______________________

Asset ID: ______________________

Inspected by: (name / company) ______________________

Purpose of visit

- ☐ Inspection
- ☐ Response to complaint
- ☐ Other (specify) ______________________

Rainfall conditions

- ☐ Rainfall today (___mm)
- ☐ Rainfall in last 3 days (___mm)
- ☐ No recent rainfall

Functional component		Condition score and evidence Circle the score 1, 2, 3 or N/A (not applicable) for each functional component based on good (1), moderate (2) or poor (3) conditions as noted in the reference sheet. Write why the score was given in the Notes section.
1	**Downpipes**	
1a	Connection to subsurface drainage	1 2 3 NA Notes:
2	**Stormwater pits**	
2a	Grates / covers	1 2 3 NA Notes:
2b	Internal	1 2 3 NA Notes:
3	**Stormwater pipes / culverts**	
3a	Structural condition	1 2 3 NA Notes:
3b	Debris / blockage	1 2 3 NA Notes:

MAINTENANCE SHEET - On-lot stormwater drainage

Date: ______________________

Location: ______________________

Asset Name: ______________________

Asset ID: ______________________

Inspected by: (name / company) ______________________

Purpose of visit

- ☐ Inspection
- ☐ Response to complaint
- ☐ Other (specify) ______________________

Rainfall conditions

- ☐ Rainfall today (___mm)
- ☐ Rainfall in last 3 days (___mm)
- ☐ No recent rainfall

Functional component		**Maintenance response and information**	**Maintenance completed**
1	**Downpipes**		
1a	Connection to subsurface drainage	Response: Information:	Y / N / NA Notes:
2	**Stormwater pits**		
2a	Grates / covers	Response: Information:	Y / N / NA Notes:
2b	Internal	Response: Information:	Y / N / NA Notes:
3	**Stormwater pipes / culverts**		
3a	Structural condition	Response: Information:	Y / N / NA Notes:
3b	Debris / blockage	Response: Information:	Y / N / NA Notes:

REFERENCE SHEET – Gross pollutant trap (GPT)

Functional component		Part C number	Required frequency (months)	Good (condition score - 1)	Moderate (condition score - 2)	Poor (condition score - 3)
	Surrounds and other infrastructure					
	Damage or removal of structures	6	6	Stable structures. No damage to structure or surrounding infrastructure. No safety risks.	Minor damage. Does not pose risk to structural integrity or asset function.	Major damage. Poses risk to structural integrity, public safety or asset function.
1	**Inlet**					
1a	Blockage	3	6	No accumulated solids or minimal solids with no obvious impacts.	Partial blockage of inlet causing some obstruction of flows or requiring removal.	Blockage of inlet preventing or significantly obstructing flows.
2	**GPT sump**					
2a	Debris, sediment and oil accumulation	7	6	None, or minimal accumulated solids/oil (<10% capacity).	Some accumulated solids/oil (>50% capacity).	Accumulated sediment/oil is reaching capacity (>75% capacity).
3	**Screens**					
3a	Damage	5	6	No holes or damage to the screen.	Some small holes/light damage. Can still function to filter most gross pollutants.	Large holes/heavy damage to the screen. Gross pollutants can pass through. Screen not securely attached to wall.
3b	Blockage	3	6	No accumulated solids or minimal solids with no obvious impacts.	Partial blockage of screen causing some obstruction of flows or requiring removal.	Blockage of screen preventing or significantly obstructing flows.
4	**Outlet**					
4a	Blockage	3	6	No blockage.	Partial blockage of outlet causing some obstruction of outflows or requiring removal.	Blockage of outlet preventing or significantly obstructing outflows.

Sheet 1 of 1

INSPECTION SHEET – Gross pollutant trap (GPT)

PENRITH CITY COUNCIL

Date ____________________

Location ____________________

Asset name ____________________

Asset ID ____________________

Inspected by (name/company) ____________________

Purpose of visit

- ☐ Inspection
- ☐ Response to complaint
- ☐ Other (specify) ____________________

Rainfall conditions

- ☐ Rainfall today (__ mm)
- ☐ Rainfall in last 3 days (__ mm)
- ☐ No recent rainfall

Functional component		Condition score and evidence *Circle the score 1, 2, 3 or NA (not applicable) for each functional component based on good (1), moderate (2), or poor (3) conditions as noted in the reference sheet. Write why the score was given in the 'Notes' section.*
	Surrounds and other infrastructure	
	Damage or removal of structures	1 2 3 NA Notes:
1	**Inlet**	
1a	Blockage	1 2 3 NA Notes:
2	**GPT sump**	
2a	Debris, sediment and oil accumulation	1 2 3 NA Notes:
3	**Screens**	
3a	Damage	1 2 3 NA Notes:
3b	Blockage	1 2 3 NA Notes:
4	**Outlet**	
4a	Blockage	1 2 3 NA Notes:

Other:

Sheet 1 of 1

REFERENCE SHEET – On-site stormwater detention (OSD)

PENRITH CITY COUNCIL

Functional component		Part C number	Required frequency (months)	Good (condition score - 1)	Moderate (condition score - 2)	Poor (condition score - 3)
	Surrounds and other infrastructure					
	Damage or removal of structures	6	6	Stable structures. No damage to structure or surrounding infrastructure. No safety risks.	Minor damage. Does not pose risk to structural integrity or asset function.	Major damage. Poses risk to structural integrity, public safety or asset function.
1	**Inlet**					
1a	Blockage	3	6	No blockage.	Partial blockage of inlet causing some bypass of flows or restricted inflows.	Blockage of inlet causing significant bypass or restriction of inflows.
1b	Erosion	9	6	No erosion.	Minor erosion. Does not pose risk to structural integrity, public safety or asset function (e.g. limited short circuiting of flows).	Major erosion. Posing risk to structural integrity, public safety or asset function (e.g. short circuiting of the majority of flows).
2	**Storage area**					
2a	Storage volume	30	6	No significant sediment accumulation or other volume reduction.	Some sediment accumulated, but no more than 5% of volume has been lost.	Sediment or debris accumulation resulting in 5% or more of volume being lost.
2b	Sediment accumulation	27	6	No accumulated sediment or minimal sediment with no obvious impacts.	Some accumulated sediment (covering <50% of surface), causing some redirection of flows through the system.	Accumulated sediment (covering >50% of the surface). Significantly impeding flows.
2c	Standing water or boggy conditions	29	6	No standing water.	Standing water visible at time of inspection.	Standing water >5% of depth remains more than 12 hours since last rainfall.
3	**Outlet (discharge control pit)**					
3a	Blockage	3	6	No blockage.	Partial blockage of outlet causing some obstruction of outflows or requiring removal.	Blockage of outlet preventing or significantly obstructing outflows.
3b	Screen	26	6	No holes or damage to the screen. No clogging evident.	Some small holes/light damage. Can still function to remove most gross pollutants. Screen not securely attached to the wall of the pit.	Large holes/heavy damage to the screen. Gross pollutants can enter the tank. Screen completely detached from the wall of the pit.
3c	Sediment accumulation	27	6	No accumulated sediment or minimal sediment with no obvious impacts.	Some accumulated sediment (covering <50% of surface), causing some redirection of flows through the system.	Accumulated sediment (covering >50% of the surface). Significantly impeding flows.
4	**Overflow**					
4a	Blockage	3	6	No blockage.	Partial blockage of overflow causing some obstruction of outflows or requiring removal.	Blockage of overflow preventing or significantly obstructing outflows.
4b	Erosion	9	6	No erosion.	Minor erosion. Does not pose risk to structural integrity, public safety or asset function (e.g. limited short circuiting of flows).	Major erosion. Posing risk to structural integrity, public safety or asset function (e.g. short circuiting of the majority of flows).

Sheet 1 of 1

OSD Tank

INSPECTION SHEET – On-site stormwater detention (OSD)

PENRITH CITY COUNCIL

Date ______________________

Location ______________________

Asset name ______________________

Asset ID ______________________

Inspected by (name/company) ______________________

Purpose of visit

- ☐ Inspection
- ☐ Response to complaint
- ☐ Other (specify) ______________________

Rainfall conditions

- ☐ Rainfall today (__ mm)
- ☐ Rainfall in last 3 days (__mm)
- ☐ No recent rainfall

Functional component		Condition score and evidence *Circle the score 1, 2, 3 or NA (not applicable) for each functional component based on good (1), moderate (2), or poor (3) conditions as noted in the reference sheet. Write why the score was given in the 'Notes' section.*
	Surrounds and other infrastructure	
	Damage or removal of structures	1 2 3 NA Notes:
1	**Inlet**	
1a	Blockage	1 2 3 NA Notes:
1b	Erosion	1 2 3 NA Notes:
2	**Storage area**	
2a	Storage volume	1 2 3 NA Notes:
2b	Sediment accumulation	1 2 3 NA Notes:
2c	Standing water or boggy conditions	1 2 3 NA Notes:
3	**Outlet (discharge control pit)**	
3a	Blockage	1 2 3 NA Notes:
3b	Screen	1 2 3 NA Notes:
3c	Sediment accumulation	1 2 3 NA Notes:
4	**Overflow**	
4a	Blockage	1 2 3 NA Notes:
4b	Erosion	1 2 3 NA Notes:

Other:

Sheet 1 of 1

OSD Tank

MAINTENANCE SHEET – On-site stormwater detention (OSD)

PENRITH CITY COUNCIL

Date ____________________

Location ____________________

Asset name ____________________

Asset ID ____________________

Maintained by (name/company) ____________________

Purpose of visit

- ☐ Maintenance
- ☐ Response to complaint
- ☐ Other (specify) ____________________

Rainfall conditions

- ☐ Rainfall today (__ mm)
- ☐ Rainfall in last 3 days (__mm)
- ☐ No recent rainfall

	Functional component	Maintenance response and information	Maintenance completed *Circle Y (yes), N (no) or NA (not applicable) and write what maintenance was done in the 'Notes' section.*
	Surrounds and other infrastructure		
	Damage or removal of structures	**Response:** Rectification works for structural issues to be undertaken immediately. **Information:** Refer to Works as Executed plans for specifications for structural repairs.	Y N NA Notes:
1	**Inlet**		
1a	Blockage	**Response:** Inspect via manhole, pit or inlet. Remove litter, debris and sediment by hand, shovel or machinery. **Information:** Ensure that water can enter the system freely. Forks and tongs may be used for litter pick ups. Waste must be transported to a waste facility that is appropriately licensed to accept such waste (if there is no opportunity for reuse on-site). A pit is considered a confined space, requiring safety equipment and training.	Y N NA Notes:
1b	Erosion	**Response:** Re-profiling using hand tools or light machinery. Replant if required. **Information:** Typically required after heavy rainfall.	Y N NA Notes:
2	**Storage area**		
2a	Storage volume	**Response:** Remove any litter, debris and sediment by hand, shovel or machinery. **Information:** Ensure that the detention volume is maintained as per design. May require personnel with confined space clearance to carry out maintenance tasks. If detention volume is occupied by something else, reconstruct and replace the volume lost. Notify council of proposal.	Y N NA Notes:
2b	Sediment accumulation	**Response:** If accumulated sediment is present on the surface, remove using a flat shovel and dispose. **Information:** Waste must be transported to a waste facility that is appropriately licensed to accept such waste (if there is no opportunity for reuse on-site). A pit is considered a confined space, requiring safety equipment and training.	Y N NA Notes:
2c	Standing water or boggy conditions	**Response:** System should be desilted and screens cleaned. **Information:** Water should drain away within hours after rain events.	Y N NA Notes:
3	**Outlet (discharge control pit)**		
3a	Blockage	**Response:** Inspect via manhole, pit or inlet. Remove litter, debris and sediment by hand, or shovel. **Information:** Waste must be transported to a waste facility that is appropriately licensed to accept such waste (if there is no opportunity for reuse on-site). A pit is considered a confined space, requiring safety equipment and training.	Y N NA Notes:
3b	Screen	**Response:** Use a broom, hose or high pressure hose to clean screen of debris. Replace screen if required. **Information:** Remove grate and screen and examine for rust or corrosion, especially at corners or welds.	Y N NA Notes:

MAINTENANCE SHEET – On-site stormwater detention (OSD)

PENRITH CITY COUNCIL

Functional component		Maintenance response and information	Maintenance completed *Circle Y (yes), N (no) or NA (not applicable) and write what maintenance was done in the 'Notes' section.*
3c	Sediment accumulation	**Response:** If accumulated sediment is present on the surface, remove using a flat shovel and dispose. **Information:** Waste must be transported to a waste facility that is appropriately licensed to accept such waste (if there is no opportunity for reuse on-site). A pit is considered a confined space, requiring safety equipment and training.	Y N NA Notes:
4	**Overflow**		
4a	Blockage	**Response:** Unblock outlet pipes. Remove sediment from outflow areas. **Information:** Waste must be transported to a waste facility that is appropriately licensed to accept such waste (if there is no opportunity for reuse on-site). A pit is considered a confined space, requiring safety equipment and training.	Y N NA Notes:
4b	Erosion	**Response:** Re-profiling using hand tools or light machinery. Replant if required. **Information:** Typically required after heavy rainfall.	Y N NA Notes:

Other: