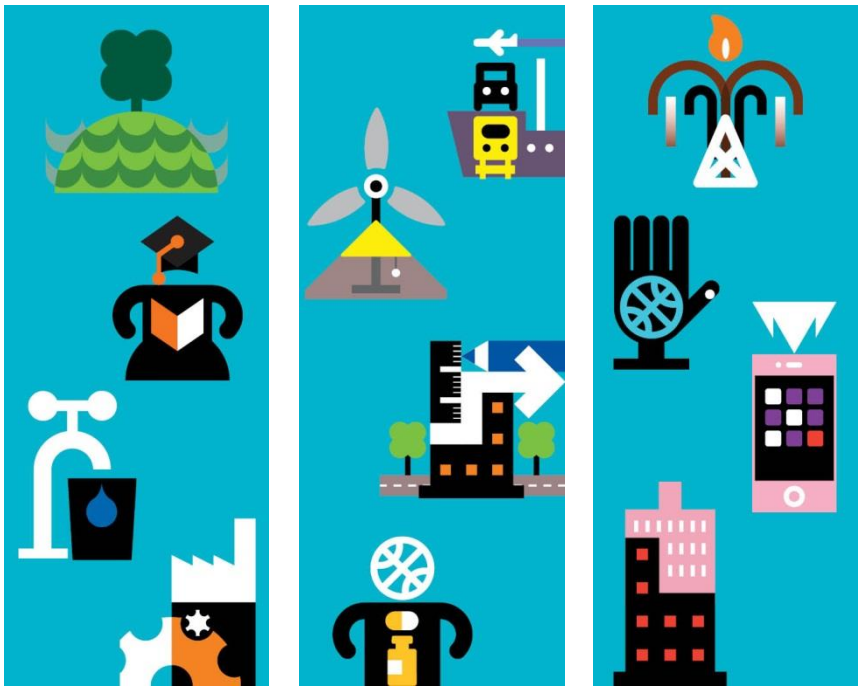

Telopea Master Plan

Flooding & Watercycle Management Report

April 2017

NSW Land & Housing Corporation

Family & Community Services
Land & Housing Corporation

Mott MacDonald

Telopea Master Plan

Flooding & Watercycle Management Report

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A	03/05/2016	A. Zou G. Hosseini	G. Lee	C. Avis	Draft
B	23/05/2016	G. Hosseini	G. Lee	C. Avis	Work In Progress Issue for Discussion
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G	27/04/17	R. Higgisson	G. Lee	C. Avis	Minor amendments

Information class: Standard

Contents

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1 Introduction

The NSW Land and Housing Corporation (LAHC), in partnership with City of Parramatta Council have prepared a master plan to guide the revitalisation of Telopea. Mott MacDonald (MM) has been engaged to identify existing opportunities, constraints and risks associated with civil engineering and services infrastructure to support the delivery of this master plan.

1.1 Scope of Work

The Telopea master plan is proposed to facilitate viable urban renewal outcomes. The objectives of the master plan are to improve built form outcomes, road, and pedestrian linkages within walking distance of the new Parramatta Light Rail Hub.

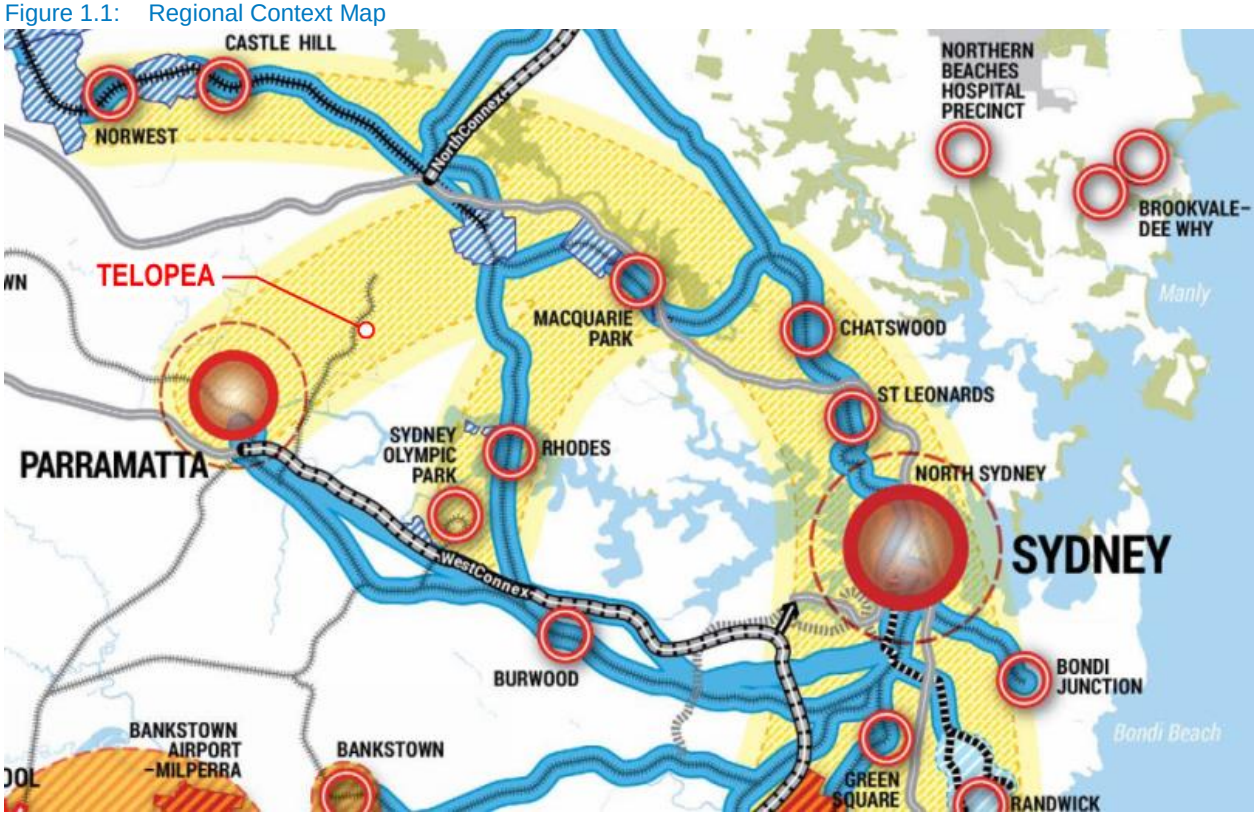
To assist in the preparation of the master plan, MM has undertaken the following tasks relating to Stormwater and Flooding:

- Review of previous reports, investigations;
- Assessment of the existing stormwater pit and pipe network;
- Review and consider On-site Detention requirements for the development works;
- Modelling of water sensitive urban design requirements for runoff quality improvements;
- Assessment of flooding related to Ponds Creek and its impact on redevelopment options; and
- Modelling of drainage upgrades to alleviate localised overland flow and localised ponding issues.

1.2 Regional Context

Telopea is located approximately 20 kilometres west of the Sydney CBD, and situated within the local government area of the City of Parramatta. The suburb is bordered by Kissing Point Road to the south and Pennant Hills Road to the north. Importantly, it is also situated within the Global Economic Corridor in the Plan for Growing Sydney and along the proposed Parramatta Light Rail corridor, as shown in Figure 1.1.

Figure 1.1: Regional Context Map



Source: Plan for Growing Sydney

1.3 Telopea Study Area

The study area is approximately 60 hectares in total, and generally grades from a ridge line along Adderton Road towards Ponds Creek to the south east. Slopes across the area vary from as little as 1% in the flatter areas in the vicinity of Sturt Park up to 7% in the steepest parts near the eastern extents of the study area.

Within the study area there are approximately 1,400 dwellings. This includes a mix of privately owned and social/ affordable housing. Within the core of the study area there is an existing retail centre with parking, a Council library and community centre and a number of public and community facilities. The study area is adjacent to the existing Telopea Railway station, which sits on the Camellia to Carlingford line. This line is

currently planned to be converted to light rail as part of the Parramatta Light Rail project, which includes a stop at Telopea.

The study area is located in the Ponds/Subiaco Creek catchment which forms part of the larger Lower Parramatta River Catchment. The Ponds Creek Reserve and associated riparian corridor are generally along and outside the eastern boundary of the study area with one exception, where Ponds Creek crosses Sturt Street in the southern corner of the area as indicated in Figure 1.2.

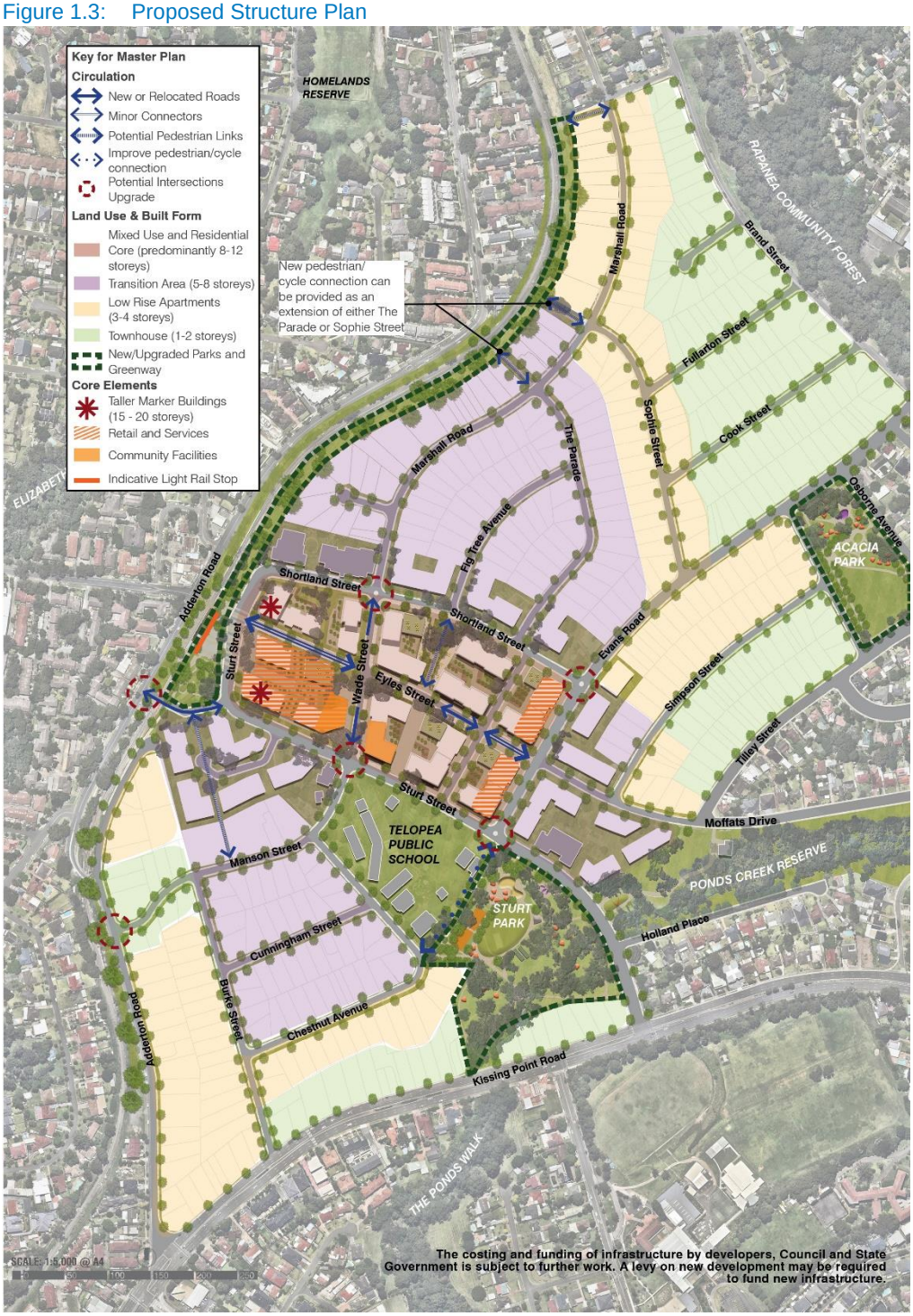
Figure 1.2: Study Area and Existing Environs

1.4 Proposed Study Area and Re-Zoning Works

The Telopea master plan will result in an increase in dwelling density via a rezoning process. Although the majority of the existing road network will be maintained, some additional road connections and upgrade works will be required to support new development sites and to improve connectivity within and through the study area. New pedestrian links are proposed through the core area; it is envisaged these links will provide a connection from the light rail stop to Eyles Street and the surrounding community facilities.

The proposed master plan in Figure 1.3 shows the new road and lot layout, along with the proposed vehicular and pedestrian/cycle connections.

Figure 1.3: Proposed Structure Plan



Source: Urbis

Based on the proposed development potential and likely take up rates, the likely residential yield of the master plan to 2036 would be between 5,000-5,500 total dwellings with an increase of 3,500-4,500 additional dwellings. Broader catchment based infrastructure assessments for flooding, stormwater and roads have been based on full development of the study area.

The following report outlines the required stormwater and flooding measures required in accordance with the applicable authorities as a result of the master plan development. The proposed measures are detailed to a level appropriate for Planning Proposal submission. Further refinement may need to be undertaken during the Development Application Stage; however the underlying principles and objectives of this report are to be maintained.

2 Water Cycle Management

MM has undertaken an assessment of the required water quantity and quality systems to ensure compliance with the relevant design standards and to ensure that development in the proposed study area does not adversely affect neighbouring properties. The following sections analyse and discuss the required treatment devices to achieve compliance detention and treatment targets applicable to the area. Supporting plans are provided in the appendices.

2.1 Existing Drainage Network

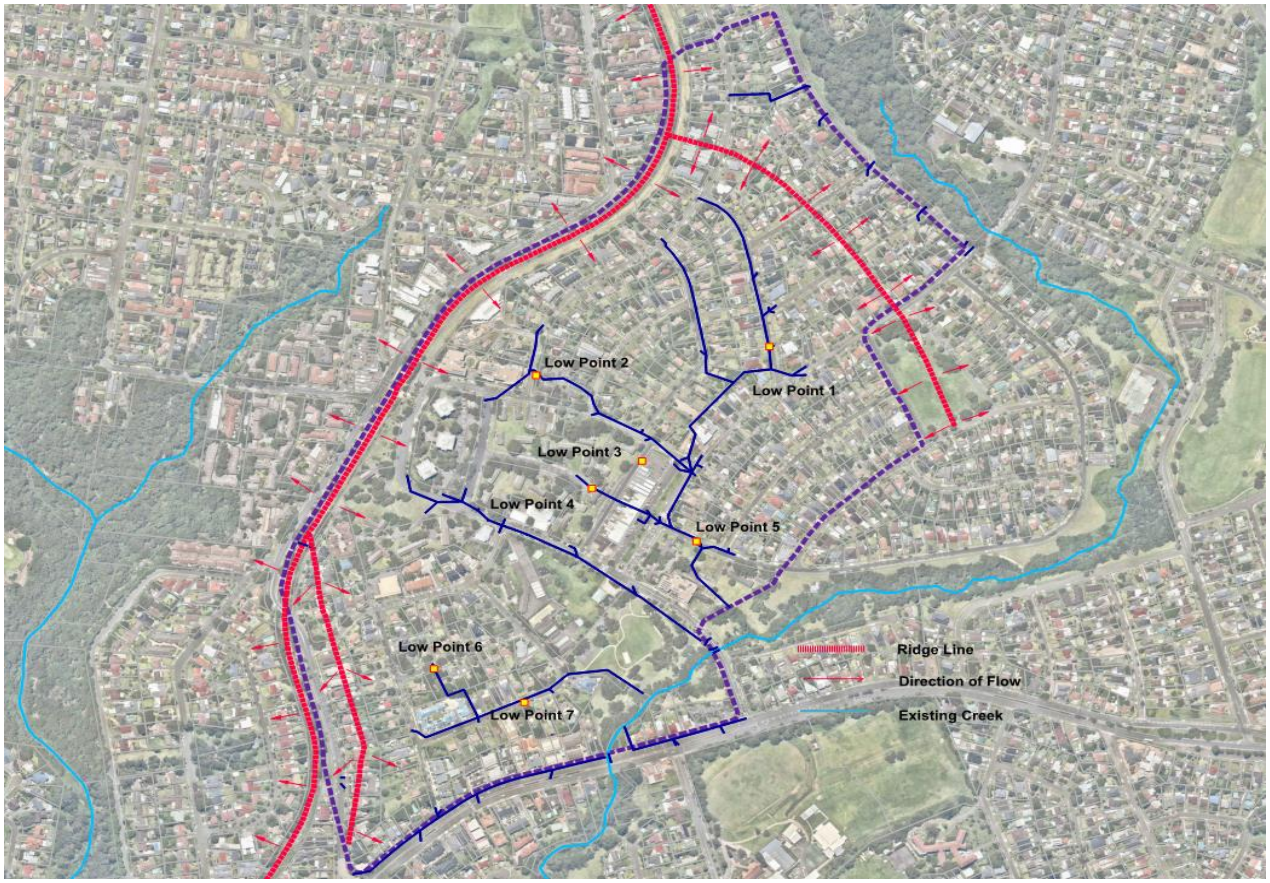
The study area is bound by Ponds Creek at the south and Vineyard Creek at the north and north-west. Based on topographic information, the Telopea rail line located at the north-west side of the study area forms the ridge of the catchment and the vast majority of run-off within the study area will drain via the existing pit and pipe network system into Ponds Creek. The exception to this is a small area in the western portion of the study area adjacent to Adderton Road, where the land falls towards the rail corridor to the west. This is shown in Figure 2.1.

The existing drainage network has been assessed by MM using DRAINS software and results indicate that there is sufficient capacity to convey stormwater runoff in storms up to the 1 in 10 with isolated areas having capacity for the 1 in 20 year average recurrence interval (ARI) event. Council's current policy is to provide new drainage works to the 20yr ARI event. Results also indicate that the existing road corridors have capacity to convey the 1 in 100 year ARI runoff via overland flows.

A number of trapped low points have been identified within the study area (shown in Figure 2.1). During large storm events, stormwater will pond at the road low points. In some locations, this ponding results in flows "spilling" over these ponds and through properties. In these locations future developers of the lots may wish to upgrade the proposed drainage network within the site to provide for overland flow. Where new roads are proposed, opportunities have been explored to remove existing trapped low points through road grading.

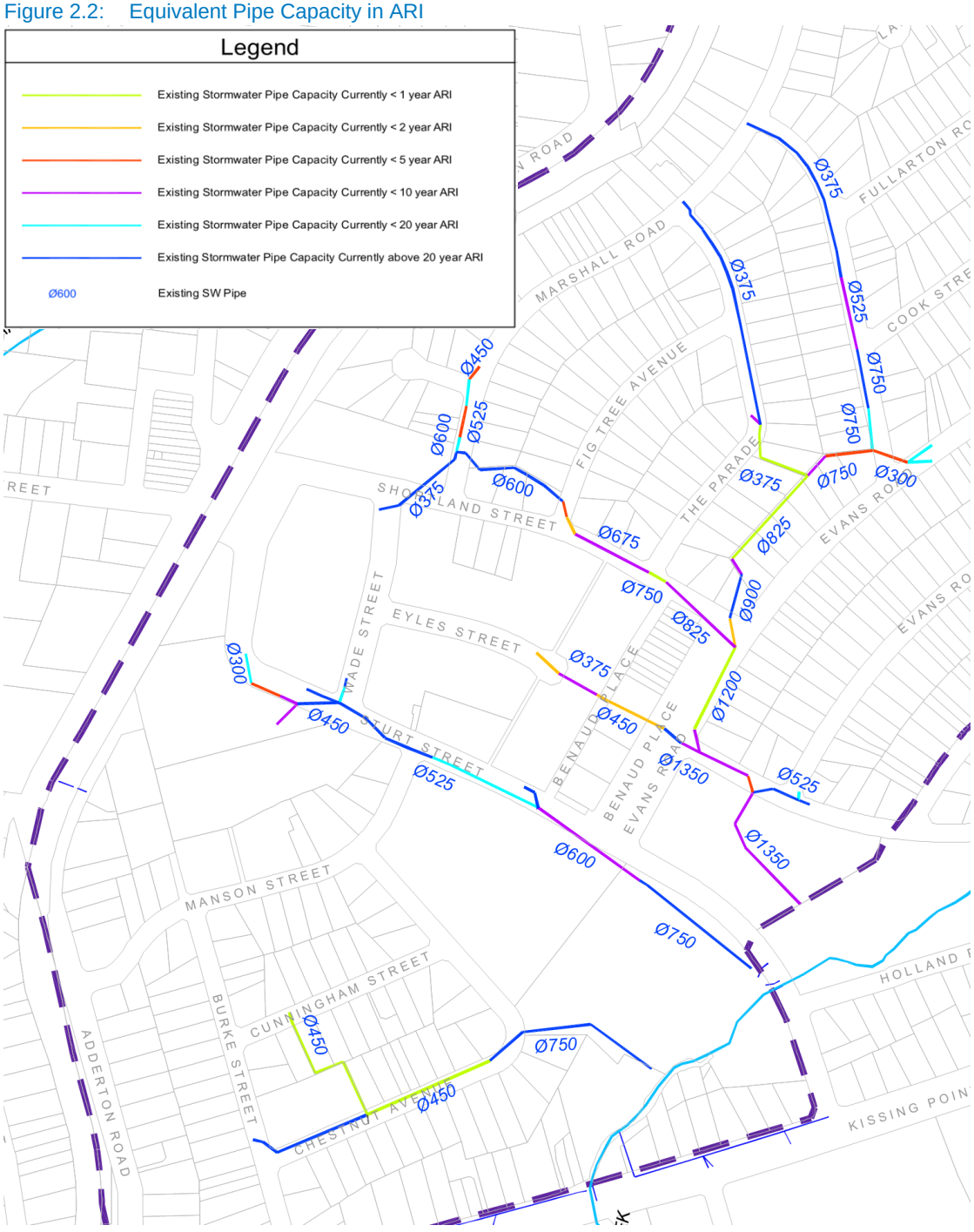
There are no existing detention basins in the vicinity of the Telopea Precinct. It is understood that water quality treatment devices in the form of trash screens and bags are situated at pipe discharge locations into the Ponds Creek. As such the majority of existing stormwater runoff discharges into Ponds Creek relatively untreated.

Figure 2.1: Existing Public Drainage Network



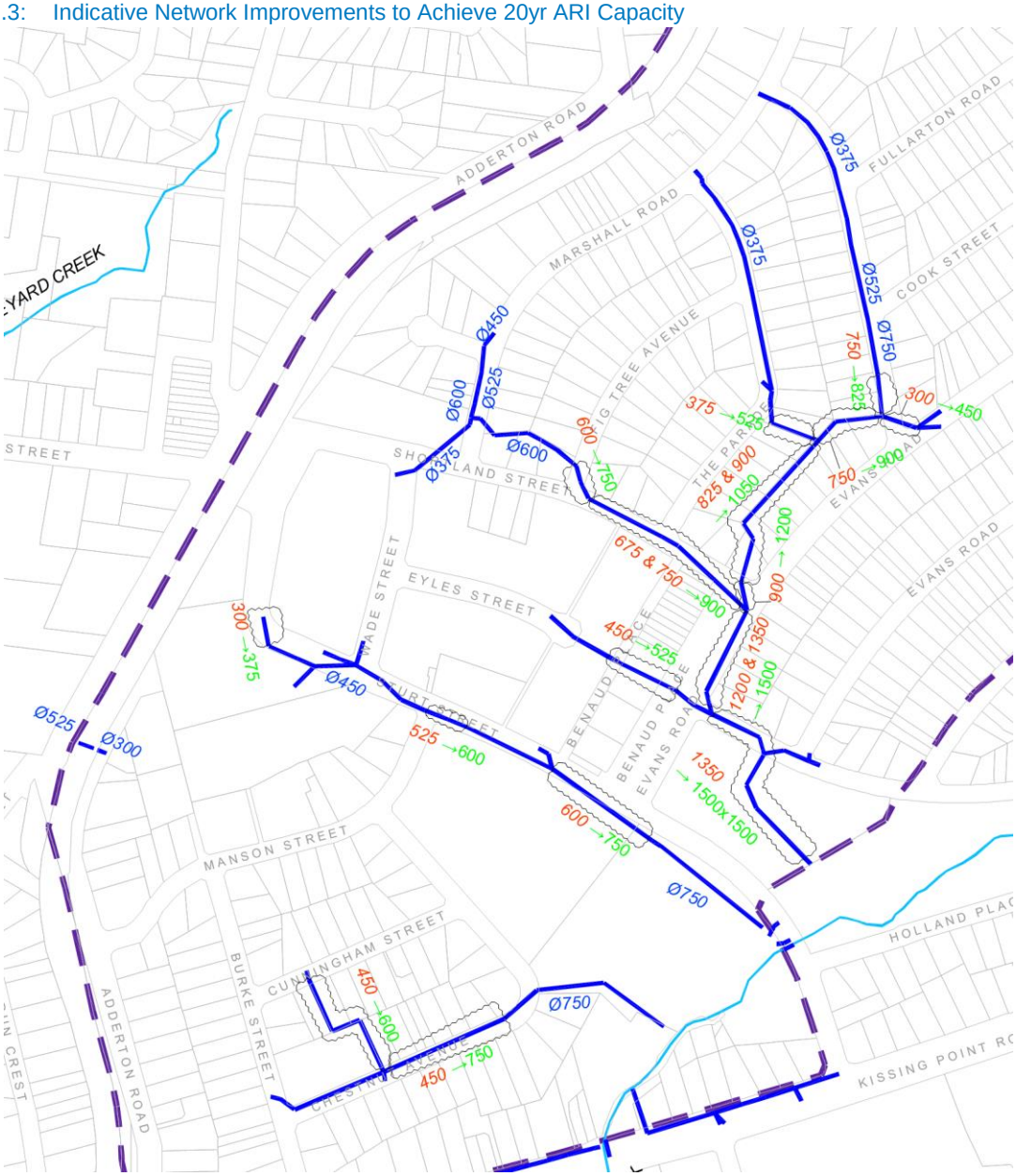
An assessment has been undertaken as part of this report to review the adequacy of the current drainage network to cater for 1:20 year ARI storm event. A pit, pipe and overland flow assessment was undertaken using DRAINS. Flows generated from catchments were compared to the equivalent capacity of a given pipe. As indicated in Figure 2.2 the majority of the pipe network generally has the capacity to accommodate 20 year ARI flows. Additional stormwater pits may be required in order to achieve the capacities indicated particularly on Chestnut Avenue and Evans Road (adjacent the existing shops) where road grades are flat and there is little fall in the pipes.

Figure 2.2: Equivalent Pipe Capacity in ARI



It is understood that Council are currently undertaking an overland flow assessment of the Telopea network and as part of Council's study a more detailed breakdown of potential remediation works will be assessed and costed. An initial assessment by MM of the possible upgrades to the stormwater network are shown in Figure 2.3 below, however results of Council's detailed overland flow assessment will govern. It is expected that in the ultimate development scenario all developments will have provided onsite detention, as such a corresponding reduction in peak flows from the study area is also anticipated, improving the existing pipe network. Existing network improvements are expected to be implemented as part of Council's capital works plans. Opportunities may be explored by individual developments to deviate any drainage that passes through private property as development applications are lodged.

Figure 2.3: Indicative Network Improvements to Achieve 20yr ARI Capacity



2.2 Water Quantity Management

A large portion of Sydney's suburban areas are now undergoing redevelopment as a result of Sydney's growing population, particularly in areas around major centres and transport nodes. Within these areas considerable changes in development typology are being observed with low density housing being intensified to accommodate higher density land uses. These medium and high density developments mean more intensive site usage and less efficient stormwater drainage systems. Without compensatory measures, the cumulative impacts of the increased stormwater runoff and loss of flood storage across development sites would increase the flooding risk to downstream development/properties.

In order to manage the intensification associated with development and as per Council's requirements, Onsite Detention (OSD) must be provided for all new developments and new roads. OSD is the temporary storage of stormwater; traditionally within a development footprint, to ensure that peak runoff from a development site does not exceed existing conditions therefore in general negating any adverse impacts to downstream development/properties.

Without OSD or other compensatory flood storage, the cost of dealing with additional stormwater runoff from a new development is passed onto downstream residents in the form of increased flood damage and distress, or onto the local authorities that must upgrade the drainage system or construct additional flood mitigation works.

2.2.1 Stormwater Detention Strategy

City of Parramatta Council's DCP states OSD is to be provided as outlined in the Upper Parramatta River Catchment Trust (UPRCT) OSD handbook. Telopea is slightly outside of the UPRCT Catchment area however the Handbook provides guidance on the detention requirements for areas directly adjacent the UPRCT boundary. The objectives of the OSD handbook are to limit peak flows throughout a catchment and prevent any increase in downstream flooding and draining problems. As per the OSD handbook, OSD must be provided for all new developments, including all new roads and paths. Where no detention is provided for new road areas, the discharge for developable lots should be adjusted to provide the equivalent storage volume for the roads and paths as well as the lot.

For the purposes of assessing the OSD requirements for the study area, the Telopea master plan has been divided into 3 categories of development.

1. **Redevelopment of sites (including consolidation of land parcels) that <u>do not</u> include creation of a new road.**
   This is the most common style of development expected throughout Telopea. In these areas road frontages currently exist and development will be accommodated within the property boundary. In these cases, developments are to provide OSD within the lot area in accordance with City of Parramatta Council requirements. In these areas it is expected that the developer will provide the OSD.

2. **Redevelopment of sites (including consolidation of land parcels) that include creation of a new road.**
   These areas are generally isolated to the core of the study area. In these locations some road frontages currently exist however new master plan road alignments are also proposed. The OSD requirements apply to the whole development area including the additional area of new roads and paths, not just the individual lots. Where individual storages are provided on each future lot, the discharges should be adjusted to provide the equivalent storage for the area of new roads or paths. In these areas it is expected that the developer will provide the OSD including the offset storage for the creation of the new road (or part road).

3. **New master plan roads that are not attributable to a development parcel.**
   OSD may also be required for new roads that bisect public space with no development parcels adjacent. In these cases, OSD will be provided within the public space adjacent to the road.
   It is understood that the required OSD associated with the new road will be incorporated within a Section 94 Contributions Plan or in detailed design of the road and adjoining park.

The extension of Evans Road to Chestnut Avenue, and the links between Eyles Street and Evans Road and Sturt Street have been modelled in this report as road connections, however, these may be provided as pedestrian/cycle links. Modelling of the connections as a road provides a worst case scenario for development with regard to stormwater management.

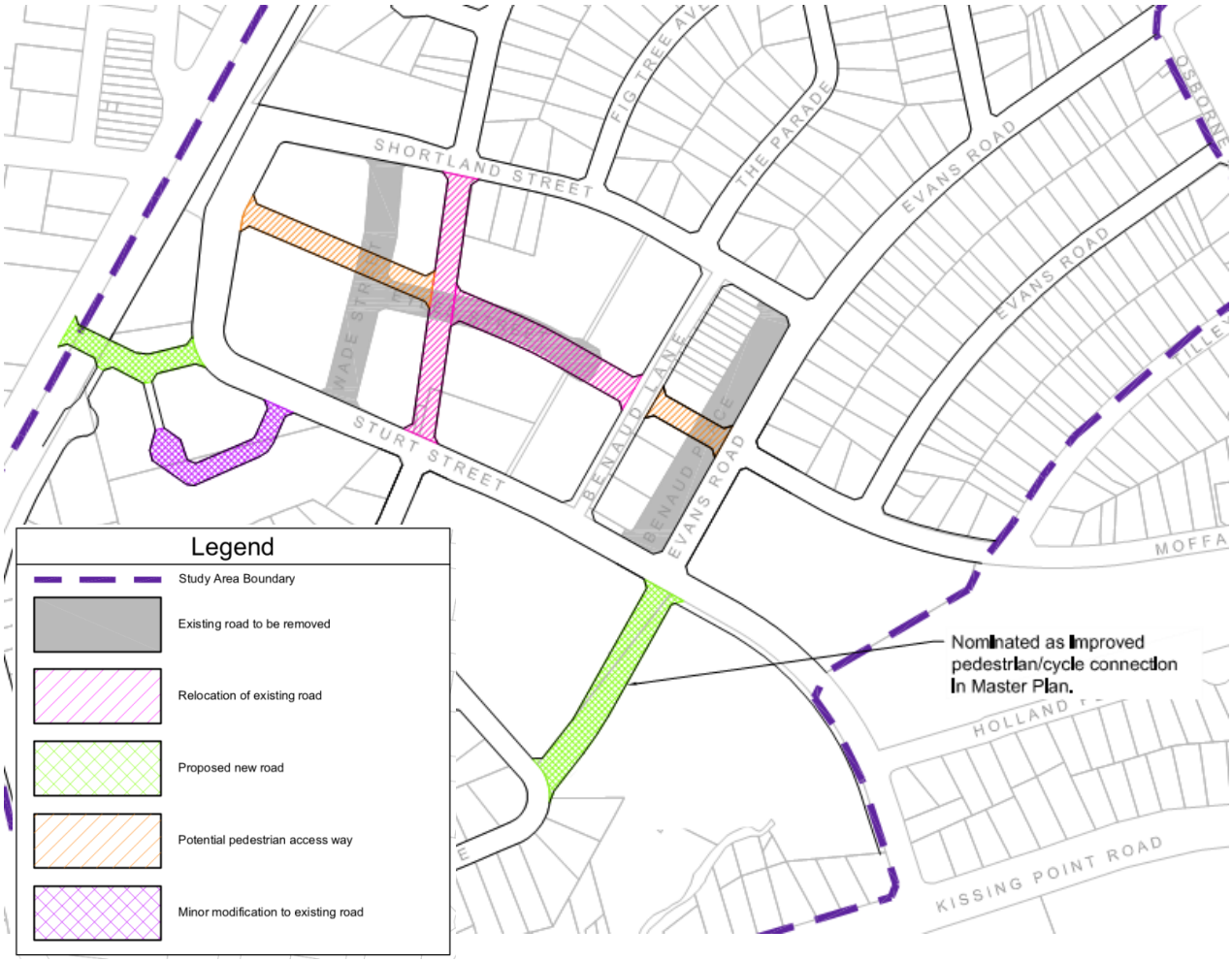
2.2.2 Stormwater Detention Requirement

The detention volumes required for all lots and new roads was calculated in accordance with the UPRCT OSD handbook. The handbook indicates a site storage requirement (SSR) of **330m^3/ha** is required for the Ponds/Subiaco Creek catchment, which includes the Study area. Each site will therefore be required to provide detention storage of **330m^3/ha** based on the lot area, some compensation may be provided if a development site results in the creation of public open space. Council will assess individual applications as DA's are lodged.

This detention can occur on redeveloped sites in landscaped areas and/or tank structures in accordance with the guidelines. The new roads are limited in the scheme. Eyles Street is an existing road and Wade Street has principally been relocated down slope. There will be new connections between Eyles Street and Benaud Lane at the rear of the shops (replacing existing hard stand) and to Sturt Street. A new road is proposed to provide a connection between Adderton Road and Sturt Street.

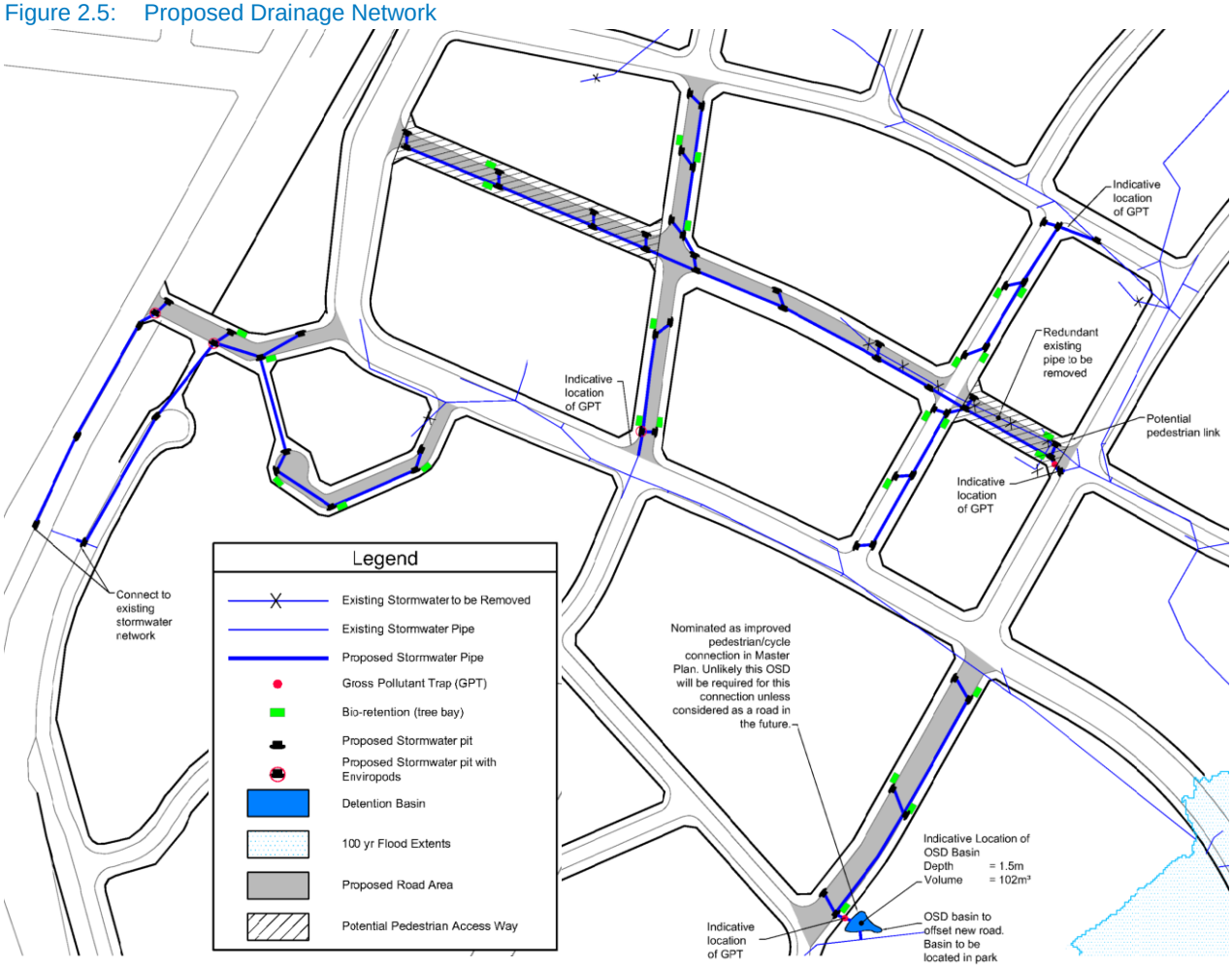
Where new roads are to be constructed, the land parcels fronting the road will be required to provide detention for 50% of the new road reserve area. Detention can be located in the property boundary or in devices within the roads themselves. This is the traditional approach in 'subdivision' areas in accordance with the UPRCT handbook. It will therefore be the responsibility of developers to ensure that adequate OSD is provided for both the developable land and the new public roads. Figure 2.4 shows the proposed new roads layout. Compensation will be provided to these lots where roads are principally relocated.

Figure 2.4: Proposed New Road Layout



The following proposed drainage network is provided for the new road alignments. Redundant stormwater infrastructure will be removed and replaced with a 20yr ARI system within the new roads. As discussed above a drainage network has been shown in the pedestrian access ways to show the compatibility should road connections be constructed. In the final layout if pedestrian access ways are incorporated the resulting drainage network will be modified to suit.

Figure 2.5: Proposed Drainage Network



2.3 Flooding Impacts Assessment

As part of the investigation into the feasibility of development across the various parcels of land comprising the study area, an assessment of flood waters impacting the site and potential impacts of development on flooding is required. This assessment includes the review of previous studies, analysis of site controls and flooding constraints, and discussion of options relating to the development of land subject to flooding.

2.3.1 Site Exposure to flooding

The site is located within The Ponds Creek catchment, a tributary of Subiaco Creek which discharges to the Lower Parramatta River. The Ponds Creek main creek line generally runs outside the boundary of the study area to the south-east, however it crosses through the site in one location near the intersection of Kissing Point Road and Sturt Street. In this location there are flooding controls on development due the flooding behaviour of creek adjacent, and these controls are discussed in section 2.3.5 of this report.

2.3.2 Previous Flood Modelling

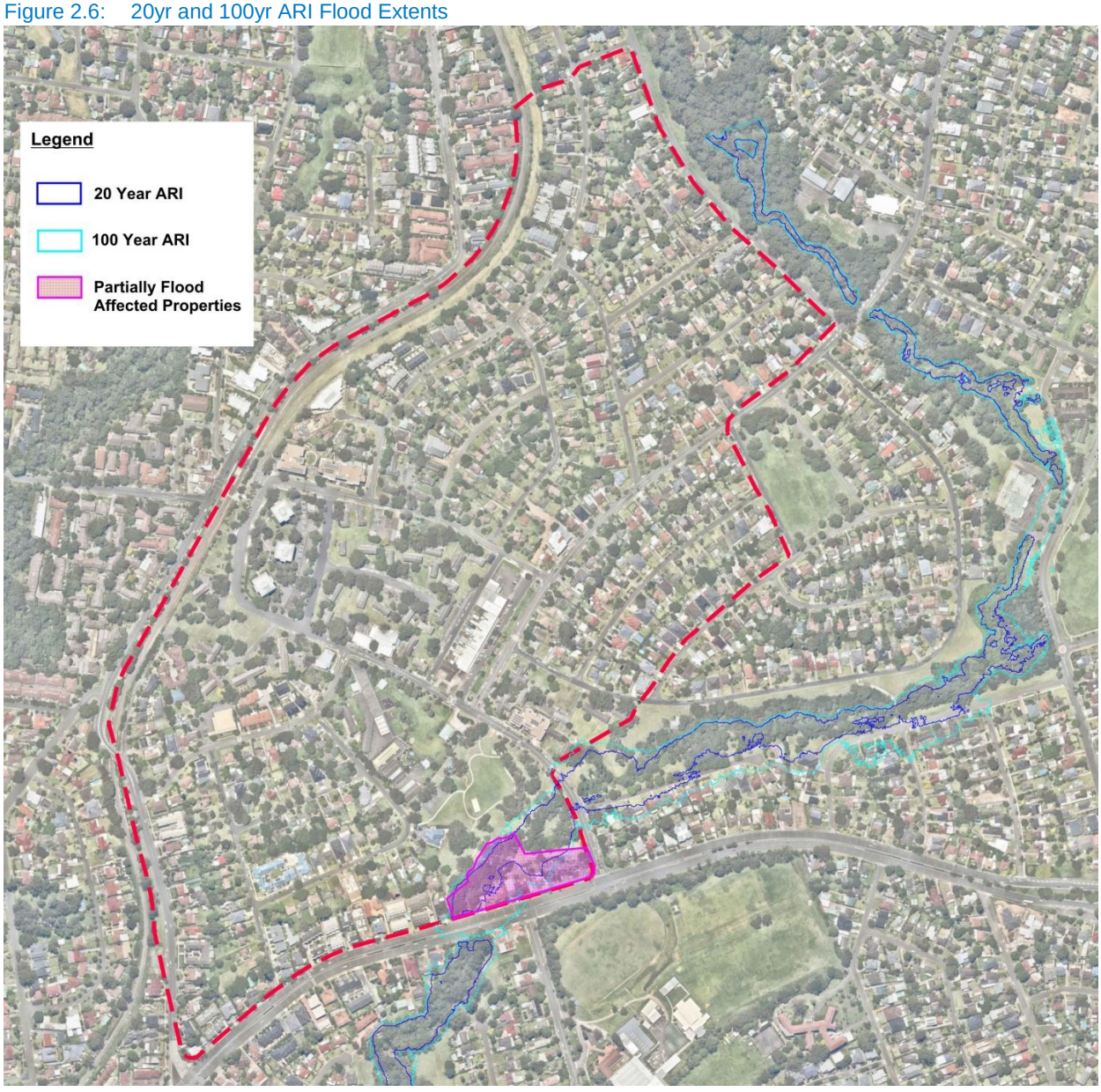
The Ponds and Subiaco Creeks have been the subject of a review into the management of water quantity and quality commissioned by City of Parramatta Council (COPC) and completed by Sinclair Knight Mertz (SKM). A report titled "*Subiaco Creek Sub-Catchment Management Plan*" summarises this review into the management of the sub-catchment with particular focus on the following areas:

- Analysis of drainage infrastructure
- Flood Study
- Water quality study
- Identification of catchment management issues; and
- Establishment of management strategies.

This report details the results of the flooding study for The Ponds Creek, performed through development of a 1-dimensional flooding model using Mike-11 software. Figure 2.6 below indicates the calculated flood extents of 20 year and 100 year ARI storm events.

Based on the results of the assessment, it is apparent that the majority of the study area is outside of the 100 year ARI flood extents and requires no management procedures. There is however, a small section of flood affected properties near the intersection of Kissing Point Road and Sturt Street. To determine the constraints and opportunities for this parcel of land a review of development controls and relevant statutory instruments follows in section 2.3.3 of this report.

Figure 2.6: 20yr and 100yr ARI Flood Extents



Source: *Subiaco Creek Sub-Catchment Management Plan*, SKM (2006)

2.3.3 Relevant documentation and standards

- NSW Floodplain Development Manual

The NSW Government's *Floodplain Development Manual – the Management of Flood Liable Land (2005)* is concerned with the management of the consequences of flooding as they relate to the human occupation of urban and rural developments. The manual outlines the floodplain risk management process and assigns roles and responsibilities for the various stakeholders.

The manual applies to the development, in particular in Appendix L – *Hydraulic and Hazard Categorisation* for ensuring safe overland flow paths are provided (see Figure L1 below). This categorisation has been applied to the results of the previous modelling for The Ponds Creek and is indicated in Figure 2.8.

Figure 2.7: Velocity Depth Relationships

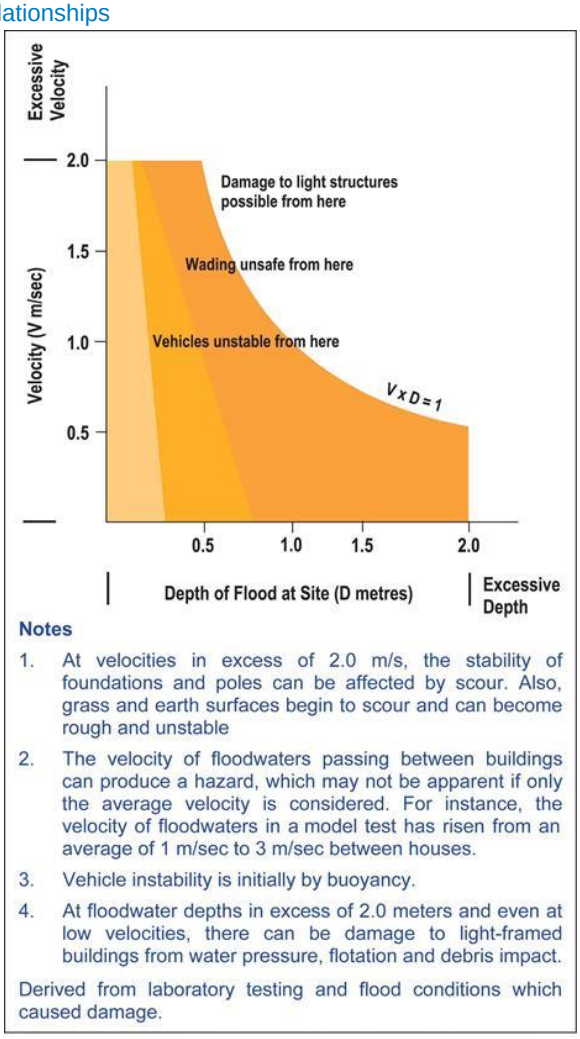


FIGURE L1 - Velocity & Depth Relationships

Source: NSW Floodplain Development Manual, 2005

- Upper Parramatta River Catchment Trust (UPRCT) On Site Detention Handbook

This document provides guidance on the detention targets for developments within the Parramatta River Catchment. The handbook aims to achieve the objectives of the City of Parramatta Council DCP in that 'all development sites manage and drain stormwater adequately to avoid or minimise local area flooding and associated damage to downstream properties and Council assets'. The underlying principle is to achieve no net increase in flooding through development.

- Australian Rainfall and Runoff – Volume 1 (2001, and subsequent project updates)

Prepared by the Institution of Engineers, Australia Australian Rainfall and Runoff – *A Guide to Flood Estimation* was written to "provide Australian designers with the best available information on design flood estimation". It contains procedures for estimating stormwater runoff for a range of catchments and rainfall events and design methods for urban stormwater drainage systems.

According to the document, good water management master planning should take into account:

- hydrological and hydraulic processes;
- land capabilities;
- present and future land uses;
- public attitudes and concerns;
- environmental matters;
- costs and finances; and
- legal obligations and other aspects.

- Parramatta Development Control Plan (DCP) 2011

An integral part of the master planning process for developments, the *Parramatta Council DCP 2011* provides the necessary controls for the redevelopment of the site. Particular water management requirements include:

- compliance with Council's Design Guidelines;
- compliance with the demands of the BASIX system; and
- adoption of the principles of the Upper Parramatta River Catchment Trust Handbook and WSUD (including a water cycle management plan).

- Parramatta Floodplain Risk Management Policy

The policy is an overarching document which informs the development of controls for incorporation into Council's DCP. The primary objective of the policy is to encourage measures that: "Reduce or eliminate the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and reduce private and public losses resulting from floods."

The policy aims to achieve this objective through the classification of land in terms of flood risk and the guidance on Council's development controls to ensure that flood prone land is assessed on merit and not sterilised unnecessarily, or conversely, developed when not an appropriate outcome for the wider community.

2.3.4 Development Impacts on Flooding

Under City of Parramatta Council's DCP and the requirements of the UPRCT On Site Detention Handbook, developers of sites within the LGA are to provide their own OSD facilities which will improve/reduce stormwater runoff from the overall study area. The additional provision of proposed drainage augmentation/realignment in the Telopea Precinct will be designed in accordance with these guidelines. The improvements to the drainage infrastructure and addition of detention on an individual site basis will attenuate/reduce the peak runoff flow rates such that they do not worsen flooding downstream. With these improvements to peak runoff volumes there will be no negative impacts to flooding behaviour. As such for the purposes of this investigation it is assumed that the existing flood study undertaken by Council will provide the worst case flood impacts for assessment.

2.3.5 Flooding Impacts on Development

The flood study and review of The Ponds Creek and Subiaco Creek has been assessed to determine if appropriate for use in making recommendations for the subject site in terms of its future development potential. Upon inspection of the modelling and cross-checking of the parameters and general arrangement of the model it was determined to be an accurate and valid model of the catchment, and suitable for the purposes of planning future changes to land use/development.

Figure 2.8 identifies the impact the current flood extent has on the development parcels adjacent Kissing Point Road. Based on the flood results available from the previous study, the parcels of land are affected by flooding from The Ponds Creek can be classified into the three different areas of hydraulic hazard as defined in City of Parramatta Council's Floodplain Risk Management Policy and Plan. Varying levels of development can occur within each of these hazard zones subject to the approval of Council. The following summary of general development controls within the hazard categories is provided,

- **High Hazard**

These areas are within the 100 year ARI flood extents and are characterised by high depths, velocities, or velocity-depth product (hazard indicator). Development is not permitted in these areas, subject to the discretion of Council.

- **Low Hazard**

These areas are within the 100 year ARI flood extents but are not affected by flood waters with a high hazard categorisation. Development can be supported in this area subject to adoption of the Council's flood risk planning matrix. Any proposed developments in these areas are to ensure that all habitable floor levels are above the 100yr flood level plus 500mm freeboard. Development works are not to cause any adverse impacts on neighbouring properties by way of flood affectation and loss of flood storage volumes.

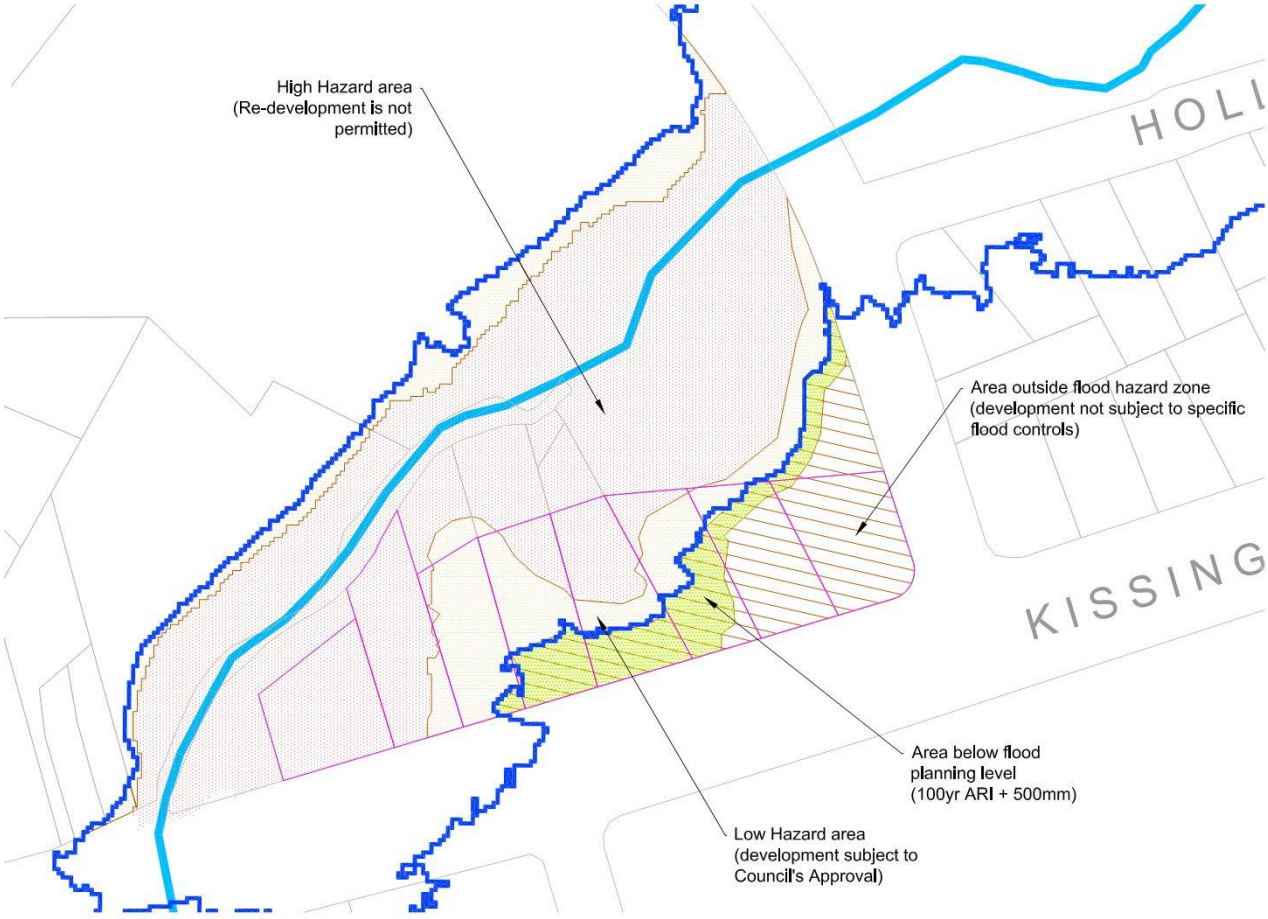
- **Areas subject to Flood Planning Level**

These areas are outside the 100 year ARI flood extents but are within the 100yr plus 500mm freeboard level. Development is permitted within these areas however filling for development may be required to ensure any potential habitable floor levels are raised to satisfy the minimum 500mm required freeboard.

- **Areas outside flood hazard zone**

There are no flood specific controls on development in this area relevant to the 100 year ARI event results. Controls for extreme floods in excess of the 100 year ARI are still applicable in the form of flood evacuation management procedures.

Figure 2.8: Flood Affected Properties



2.3.6 Residual Flood Risk to Development

Council policies on stormwater detention, flood planning levels, and the guidance on the management of overland flows for the safety of people and vehicles prove to limit the hazards for flooding events up to and including the 100 year ARI. Extreme floods in excess of the 100 year ARI are also relevant in the determination of appropriate development types outside the limitations of the planning controls. For any new developments safe evacuation can be achieved within the Telopea Site for events up to and including the Probable Maximum Flood (PMF) by evacuating to the North-East of the site towards Adderton Rd.

2.4 Water Quality Management

Telopea Precinct is situated within the Parramatta River Catchment and similarly with many other urbanised areas in Sydney, the study area at times can result in poor water quality from roads and open spaces, particularity after heavy rain. This untreated runoff in the localised catchment also contributes to the overall water quality in the Parramatta River, which is the main tributary of Sydney harbour. As part of the master planning of Telopea Precinct Water Sensitive Urban Design (WSUD) procedures have been incorporated to improve water quality in local waterways in accordance with Council's DCP requirements.

2.4.1 Water Quality 'MUSIC' Modelling Methodology

Water quality treatment is assessed in a different manner to onsite detention. Water quality is assessed based only on the proposed work and not relative to the previous use of the site. Based on this methodology the proposed master plan can be categorised into the following development types with the associated water quality controls applying to the development:

- **New medium and high density development:** These areas will provide their own onsite water quality treatment devices to achieve Council's objectives. These areas have been excluded from this assessment as they will be assessed during their individual DA lodgement.
- **New Roads:** New roads are to incorporate water quality treatment devices within the road corridor to achieve Council's objectives before entering the Ponds Creek. These areas have been assessed as part of this study. Where existing roads are relocated or constructed at different surface levels, these have been considered as new roads for the purpose of water quality treatment.
- **Residual existing areas:** no ameliorative works are proposed for existing private properties, existing roads and existing open space areas. It is however acknowledged that Council are in the process of developing a wider strategy for improving the overall health of the Parramatta River. Results of this project will apply to the larger UPRCT area and recommended mitigation measures will be implemented by Council separate to this Telopea Study. These areas are excluded from the study as no works are required.
  The existing/proposed railway corridor and future greenway are separate projects to this study and it is understood that water quality treatment will be provided for their site areas separately.

The above development categories and treatment procedures are designed to ensure no adverse impacts are applied to the watercourse or downstream of the site.

The links between Eyles Street and Evans Road and Sturt Street have been modelled in this report as road connections, however, these may be provided as a pedestrian link. Modelling of the connections as roads provides a worst case scenario for development with regard to stormwater management. In the event that pedestrian access ways are provided the level of water quality treatment proposed can be reduced commensurate to the proposed development.

A MUSIC (Version 6.2.0) model was created for the study area, specifically looking at the new roads, to ensure the treatment measures provided onsite achieve the pollutant removal objectives as set by City of Parramatta Council.

2.4.2 Water Quality Objectives

In accordance with COP's Development Control Plan, the performance objectives for water quality management within the study area are detailed below in Table 2.1.

Table 2.1: Stormwater Treatment Targets for Development

Pollutant	Performance Target Reduction Loads
Total Suspended Solids	85% reduction in the post development mean annual load of Total Suspended Solids (TSS)
Total Phosphorus	60% reduction in the post development mean annual load of Total Phosphorus (TP)
Total Nitrogen	45% reduction in the post development mean annual load of Total Nitrogen (TN)
Gross Pollutants	90% reduction in the post development mean annual load of total gross pollutant load (greater than 5mm)

Source: Parramatta Development Control Plan 2011 Part 3 Development Principles

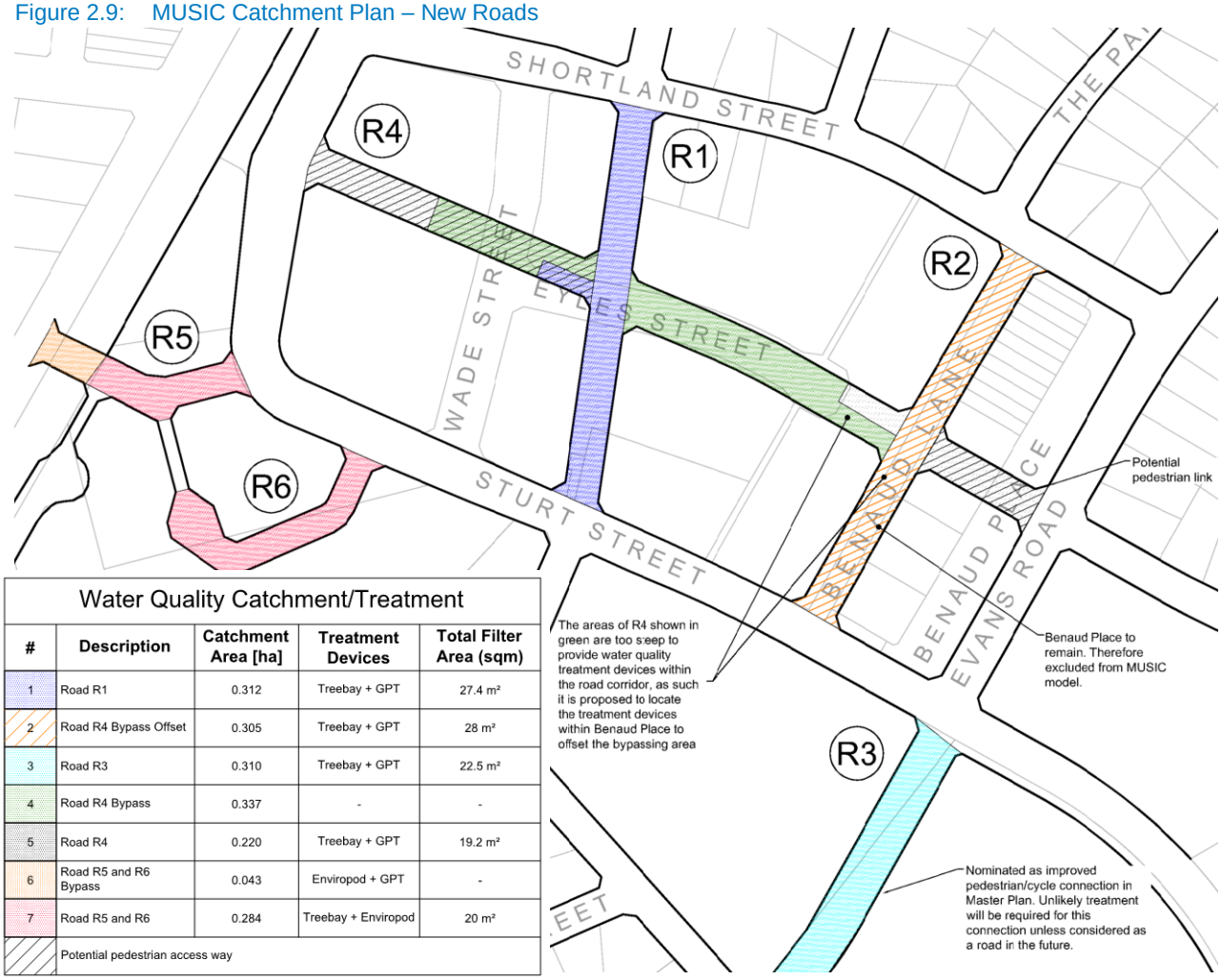
The NSW MUSIC Modelling Guidelines have been used where finer detail of modelling parameters is not covered in the DCP.

2.4.3 Catchment Analysis

As only the new roads areas are being assessed, the following catchment plan only indicates treatment catchments associated with the new roads. An 85% fraction impervious has been adopted for all new roads. The catchments have been delineated based on the ability to direct surface water to treatment devices so that the proposed treatment train is achievable in practice.

The areas of R4 shown below in 'green' are too steep to implement effective water quality treatment devices within the road corridor. It is therefore proposed to offset the untreatable 'green' areas by locating compensatory treatment devices within Benaud Lane where the road grades are favourable.

Figure 2.9: MUSIC Catchment Plan – New Roads



Water Quality Catchment/Treatment

#	Description	Catchment Area [ha]	Treatment Devices	Total Filter Area (sqm)
1	Road R1	0.312	Treebay + GPT	27.4 m²
2	Road R4 Bypass Offset	0.305	Treebay + GPT	28 m²
3	Road R3	0.310	Treebay + GPT	22.5 m²
4	Road R4 Bypass	0.337	-	-
5	Road R4	0.220	Treebay + GPT	19.2 m²
6	Road R5 and R6 Bypass	0.043	Enviropod + GPT	-
7	Road R5 and R6	0.284	Treebay + Enviropod	20 m²
	Potential pedestrian access way			

2.4.4 Water Quality Treatment Train

In general, stormwater runoff generated can be categorized into two streams:

- Road and pavement (hardstand area), which can be treated by pit inserts or a GPT before discharging to the existing pipe network. This option is used for areas where road grades will not permit the use of raingardens, and
- Road and pavement (hardstand area), which can be treated by bio-retention devices (tree bays) then a GPT or pit inserts before discharging to the existing pipe network.

2.4.4.1 Bio-retention devices (bio filters/tree bays)

Bio-retention devices are proposed to treat rainwater runoff from catchment within the project site using a landscaped natural process. Raingardens are planted filtration systems where water is allowed to permeate through the ground allowing pollutants to be removed through natural processes. As the proposed treatment devices are to be incorporated into the new road corridors it is proposed that tree bay filters are used to treat the rainwater runoff from road areas. Ecosol's bio filters are used as a reference in the MUSIC model, which is subject to future refinement at detailed design stage. The devices collect surface water from the Kerb and Gutter and direct the flows into a raingarden behind the kerb

A summary of all bio-retention devices is shown in the results section of this report.

2.4.4.2 Gross Pollutant Trap (GPT)

GPTs are to be used to treat rainwater runoff before discharging into natural watercourses. For sub-catchments where raingardens are incorporated in the proposed treatment train, GPTS have been placed at the end of the new roads along the pipe network prior to connecting into the existing network. Indicative locations of GPTs on the water cycle management drawing set and are subject to future refinement when detailed information becomes available.

Pollutant removal rates are based on the default inputs specified in the Draft NSW MUSIC Modelling Guidelines as indicated in Table 2.2 below.

Table 2.2: GPT MUSIC Input Parameters

Pollutant	Input (mg/L)	Output (mg/L)
Total Suspended Solids	1000	350
Total Phosphorus	1.00	0.85
Total Nitrogen	5.0	4.3
Gross Pollutants	15	1.5

Source: Draft NSW MUSIC Modelling Guidelines

2.4.4.3 Enviropods (Pit Inserts)

Enviropods are used in a similar manner to GPT's however they are designed to fit inside stormwater pits and filter stormwater before it proceeds down the pipe network. Enviropods have been proposed in some locations where road grades are not favourable for the use of bio-filters.

The following MUSIC modelling parameters (Table 2.3) are used for the treatment devices in accordance with regulatory requirements.

Table 2.3: Design Parameters of Proposed Treatment Devices

Treatment Devices	Design Parameters	Compliance
Bio-retention (Treebay)	Extended Detention Depth = 0.3 m Filter Depth = 0.4 m Saturated Hydraulic Conductivity = 120 mm/hr TN Content of Filter Media = 800 mg/kg Orthophosphate Content of Filter Media = 35 mg/kg	The design parameters are in compliance with the NSW MUSIC Modelling Guideline
Enviropods	High Flow Bypass = 0.02 m^3/s	The MUSIC node is provided by Stormwater360 and in compliance with the NSW MUSIC Modelling Guideline
GPTs	High Flow Bypass = 0.054 m^3/s	The MUSIC node is designed as per Rocla's GPT CDS0708
	High Flow Bypass = 0.022 m^3/s	The MUSIC node is designed as per Rocla's GPT CDS0506

2.4.5 Proposed Treatment Devices

Based on the pollutants generated in each individual catchment, the following treatment devices are required as indicated in Table 2.4.

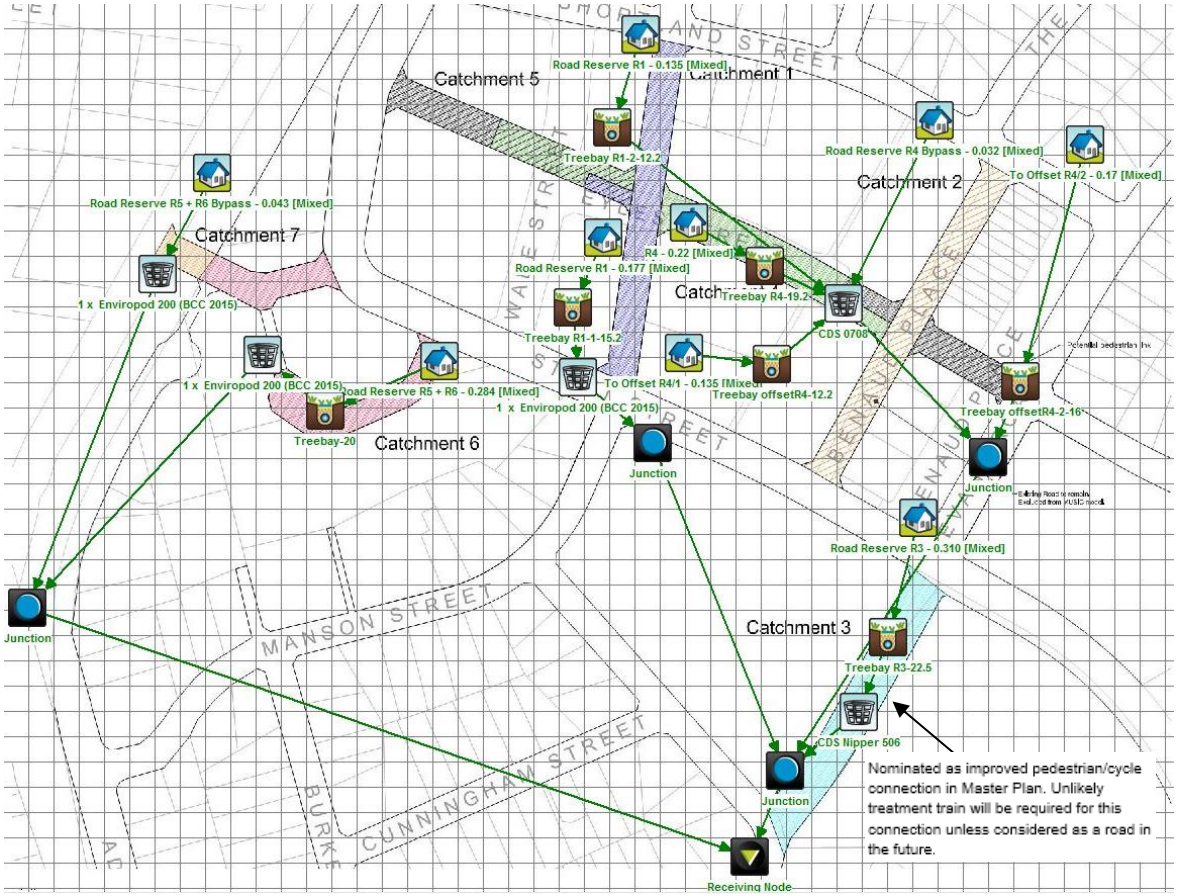
Table 2.4: Proposed Water Quality Treatment Devices

Catchment		Recommended Treatment Devices		Description
1	Road R1	*Connecting to Sturt Street drainage:* Bio-retention with a total filter area of 12.2 m^2	3 x	Treebay with a dimension of 2.7 x 1.5
		Connecting to Eyles Street drainage: Bio-retention with a total filter area of 15.2 m^2	3 x	Treebay with a dimension of 3.3 x 1.5
		Pit inserts	1 x	Enviropods to be placed at the end of the treatment train before runoff entering the existing drainage network at Sturt Street
2	Road R3	Bio-retention with a total filter area of 22.5 m^2	5 x	Treebay with a dimension of 3 x 1.5
		GPT	1 x	CDS0506 to be placed at the end of the treatment train before runoff entering the existing drainage network
3	Road R4	Bio-retention with a total filter area of 19.2 m^2	4 x	Treebay with a dimension of 3.2 x 1.5
		GPT to be shared with Catchment 4 and 5	1 x	CDS0708 to be placed at the end of the treatment train before runoff entering the existing drainage network at Evans Road
4	Existing Road to Offset R4 Bypass	*Connecting to Shortland Street drainage:* Bio-retention with a total filter area of 16 m^2	4 x	Treebay with a dimension of 2.7 x 1.5
		Connecting to Eyles Street drainage: Bio-retention with a total filter area of 12.2 m^2	3 x	Treebay with a dimension of 2.7 x 1.5
5	Residual R4 Bypass	Bypass	-	-
6	Road R5 + R6	Bio-retention with a total filter area of 20 m^2	5 x	Treebay with a dimension of 2.7 x 1.5

Catchment		Recommended Treatment Devices		Description
		Pit inserts	1 x	Enviropods
7	Road R5 + R6 Bypass	Pit inserts	1 x	Enviropods

The following MUSIC modelling schematic is provided for reference.

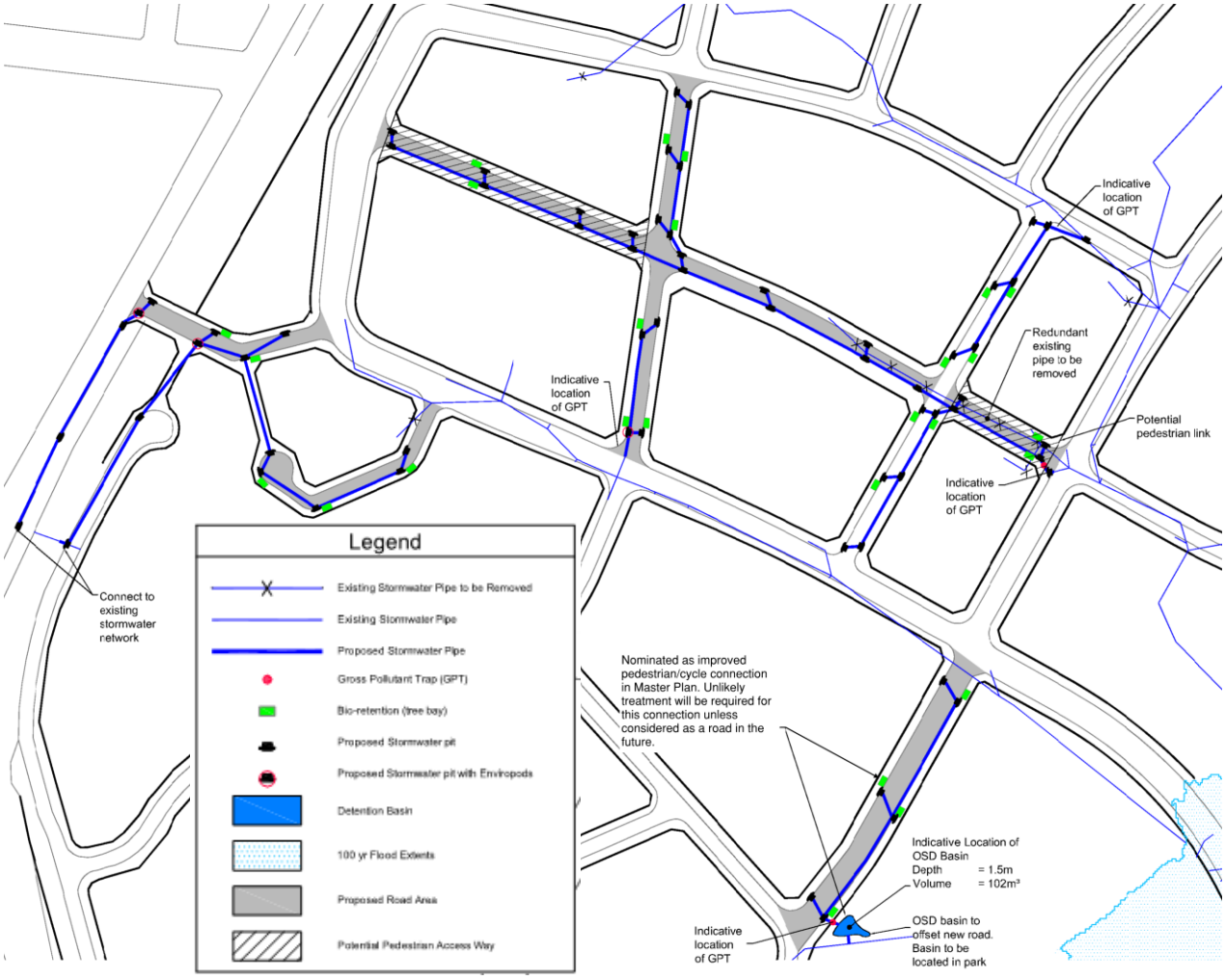
Figure 2.10: Proposed MUSIC Model



GPTs will be installed upstream of existing stormwater pipes to capture suspended solids and gross pollutants whereas Treebays are used as a bio-retention device within the road reserve areas to capture finer pollutants generated, such as Phosphorus and Nitrogen. It is noted that the proposed road R4 has a maximum slope up to 10%, bio-retention devices should not be placed on steep slopes (>5%) which can become unstable when saturated. Due to the road slope and curvature constraints, the majority of R4 surface runoff will bypass the bio-retention devices. As discussed above proposed to offset the untreatable 'green' areas by locating compensatory treatment devices within Benaud Lane where the road grades are favourable, the overall results at downstream of R4 will satisfy Council's statutory requirements.

The indicative locations of Treebays, Enviropods as well as GPTs are identified on Figure 2.11 as below. It is understood that the location of water quality treatment devices are subjected to further refinement at the detailed design stage.

Figure 2.11: Indicative Locations of Water Quality Treatment Devices



The proposed treatment devices along Road R3 are currently contained within the road corridor however, during detailed design there may be opportunities to locate these in the adjacent park or OSD basin.

2.4.6 Results

The following results are provided based on the above modelling and proposed treatment train.

Table 2.5: Proposed Treatment Train Effectiveness

Catchment	Total Suspended Solids	Total Phosphorus	Total Nitrogen	Gross Pollutant
All Catchments Combined	**85%**	**63.3%**	**45.3%**	**99.6%**
Target	**85%**	**60%**	**45%**	**90%**

Based on the results of this assessment, the pollutant reduction rates satisfy the statutory requirement as per CoP's DCP.

As discussed in previous sections, it is anticipated that all the medium/high-density residential lots and commercial/retail development will incorporate their own water treatment facilities.

Whilst the above assessment provides one option for addressing water quality in the precinct a number of alternative combinations of treatment facilities can be provided such as the use of vegetative filter strips, infiltration swales and installation of rainwater ponds to address water quality, improve the local water quality and amenity. Alternative treatment trains may be proposed during detailed design to the satisfaction of Council.

Appendices

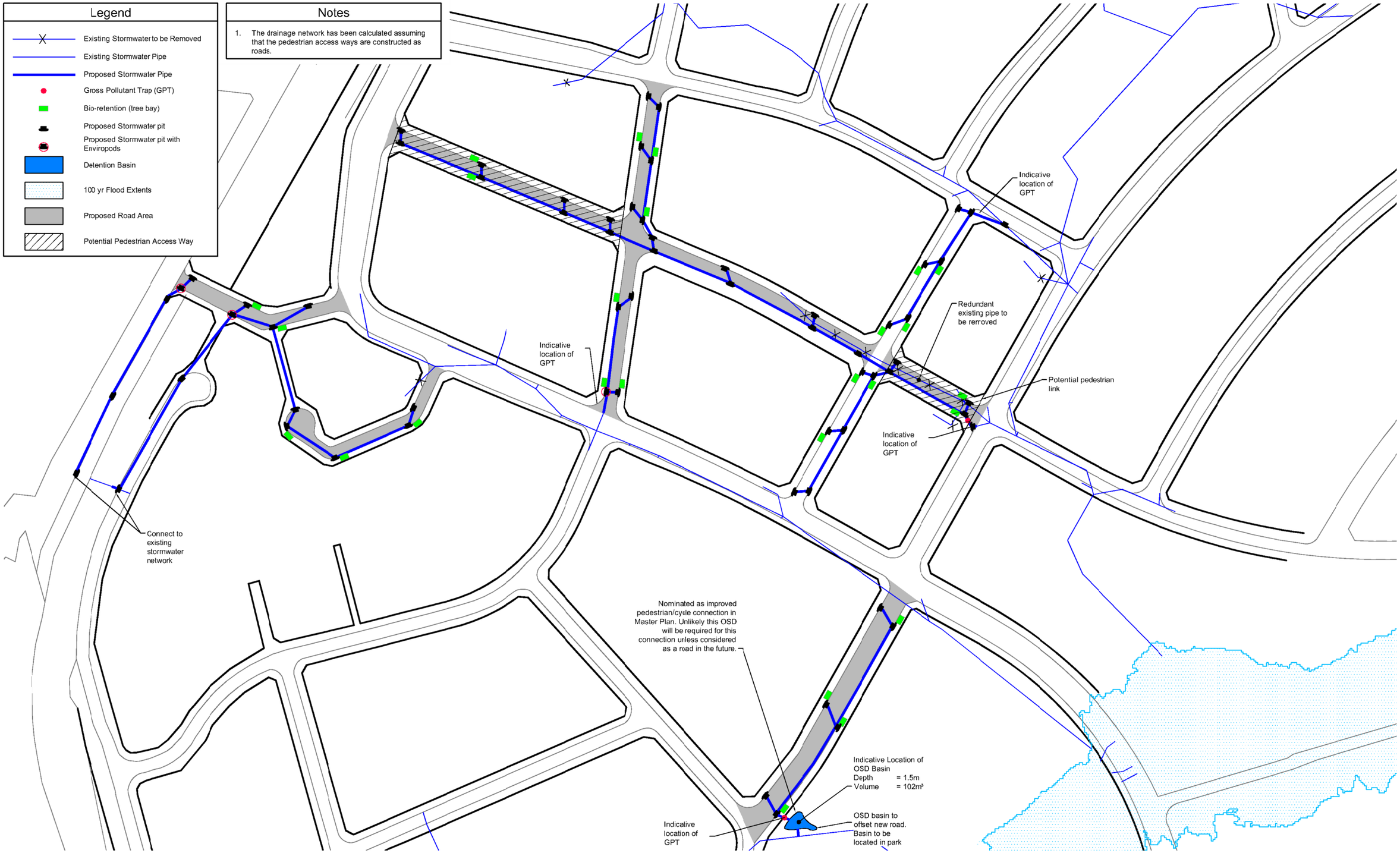
Appendix A. Water Cycle Management Plans

Legend

- Existing Stormwater to be Removed
- Existing Stormwater Pipe
- Proposed Stormwater Pipe
- Gross Pollutant Trap (GPT)
- Bio-retention (tree bay)
- Proposed Stormwater pit
- Proposed Stormwater pit with Enviropods
- Detention Basin
- 100 yr Flood Extents
- Proposed Road Area
- Potential Pedestrian Access Way

Notes

1. The drainage network has been calculated assuming that the pedestrian access ways are constructed as roads.



Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P3	27.04.17	JN	Issued for Information	GL	CJA
P2	29.07.16	ADS	Issued for Information	GL	CJA
P1	05.07.16	AMP	Issued for Information	GL	CJA

1:1000 0 50m 100m

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Client: NSW Land and Housing Corporation

Title: Telopea Precinct
Master Plan
Water Cycle Management
Plan

Designed	A Zoa		Eng check	G Lee	
Drawn	A Paciben		Coordination	G Lee	
Dwg check	G Lee		Approved	C Avis	
Scale at A1	1:1000	Status	PRE	Rev P3	Sec STD

Drawing Number: MMD-367300-C-SK-WM-SR-0120

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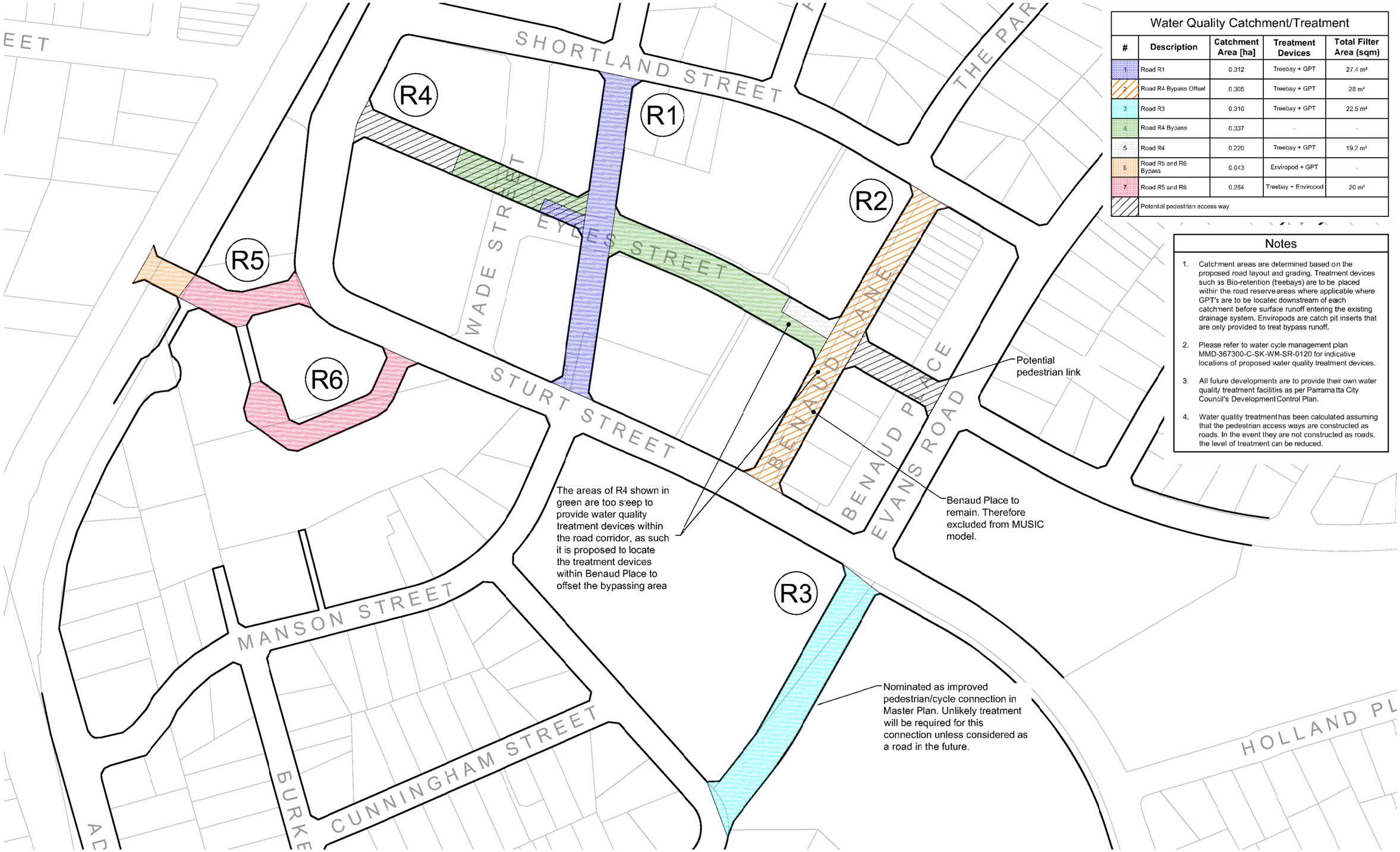

Water Quality Catchment/Treatment

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6	Road R5 and R6 Bypass	0.043	Enviropod + GPT	-
7	Road R5 and R6	0.284	Treebay + Enviropod	20 m²
	Potential pedestrian access way			

Notes

1. Catchment areas are determined based on the proposed road layout and grading. Treatment devices such as Bio-retention (treebays) are to be placed within the road reserve areas where applicable where GPT's are to be located downstream of each catchment before surface runoff entering the existing drainage system. Enviropods are catch pit inserts that are only provided to treat bypass runoff.
2. Please refer to water cycle management plan MMD-367300-C-SK-WM-SR-0120 for indicative locations of proposed water quality treatment devices.
3. All fulure developments are to provide their own water quality treatment facilities as per Parramatta City Council's Development Control Plan.
4. Water quality treatment has been calculated assuming that the pedestrian access ways are constructed as roads. In the event they are not constructed as roads, the level of treatment can be reduced.

Preliminary - Not for Construction

Rev	Date	Drawn	Description	Ch'k'd	App'd
P3	27.04.17	JN	Issued for Information	GL	CJA
P2	29.07.16	ADS	Issued for Information	GL	CJA
P1	05.07.16	AMP	Issued for Information	GL	CJA

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Client: NSW Land and Housing Corporation

Title: Telopea Precinct Master Plan MUSIC Catchment Plan

Designed	A Zou		Eng check	G Lee	
Drawn	A Paciben		Coordination	G Lee	
Dwg check	G Lee		Approved	C Avis	
Scale at A1	1:3000	Status	PRE	Rev	P3	Sec	STD

Drawing Number: MMD-367300-C-SK-WM-SR-0130

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P2	29.07.16	ADS	Issued for Information	GL	CJA
P1	05.07.16	AMP	Issued for Information	GL	CJA

1:3000 0 150m 300m

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Client: NSW Land and Housing Corporation

Title: Telopea Precinct
Master Plan
On-Site Detention Plan

Designed	A Zou	Eng check	C Avis
Drawn	A Paciben	Coordination	G Lee
Dwg check	G Lee	Approved	C Avis

Scale at A1	Status	Rev	Sec
1:3000	PRE	P3	STD

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