



Parramatta Light Rail **TREE OFFSET STRATEGY**

Version 05 | 31 MAY 2021

Prepared for



Prepared by

spackman mossop michaelis

In collaboration with



SPACKMAN MOSSOP MICHAELS
115 Flinders Street
Surry Hills, NSW 2010
P +61 2 9361 4549
E info@sm2group.com.au
www.spackmanmossopmichaels.com

ISSUE	VERSION	DATE	PREPARED BY	REVIEWED BY
Preliminary draft	01	13.12.2019	JF	MS
Progress print	02	04.06.2020	JenF	JuF
Final Draft	03	06.11.2020	TfNSW	TfNSW
Final Draft for review	04	26.11.2020	TfNSW	TfNSW
Final Draft for review	04B	29.03.2021	TfNSW	TfNSW
Update ER Review	05	31.05.2021	TfNSW	TfNSW

CONTENTS

List of Figures	IV
List of Tables	IV
Glossary	V
1. CHAPTER 1. INTRODUCTION	2
1.1. Purpose of this report	2
1.1.1. How to use this report	2
2. CHAPTER 2. OVERVIEW	4
2.1. Parramatta Light Rail	4
2.1.1. Overview and key features	4
2.1.2. Project Objectives	6
2.1.3. PLR background and aims	6
2.1.4. Key Benefits of Parramatta Light Rail	6
2.2. Project Conditions of Approval	6
2.3. Tree and vegetation impacts	10
2.3.1. Impact minimisation	10
2.3.2. Impact mitigation	10
2.3.3. Impact compensation	10
2.3.4. Tracking the project's impact on trees	11
2.3.5. Tree impact compensation targets	11
2.4. How this strategy was developed	12
2.4.1. Consultation and partnerships	12
2.4.2. PLR tree planting and neighbourhood improvement program	13
3. CHAPTER 3. BACKGROUND	14
3.1. Why offset tree planting – the benefits of urban trees for Parramatta Light Rail	16
3.1.1. The benefits of trees	16
3.1.2. Mitigating urban heat	18
3.2. Guiding documents	20
3.2.1. Sydney Green Grid West Central District	20
3.2.2. Greener Places	22
3.2.3. Parramatta Ways	23
3.2.4. Active Transport	23
3.3. Other relevant documents	23
3.3.1. Parramatta Light Rail – Urban Design Requirements Report (UDDR)	25
3.3.2. Parramatta Light Rail – Urban Design Requirements Report 'BLUE BOOK'	25
3.3.3. TfNSW Vegetation Offset Guide	26
3.3.4. Biodiversity Assessment Report. Parramatta Light Rail	26
3.3.5. Life in our City. Parramatta Biodiversity Strategy 2015–2025	27
3.3.6. City of Parramatta Environmental Sustainability Strategy 2017	27
3.3.7. Parramatta Light Rail. Selected pedestrian network audit	28
3.3.8. Benchmarking Heat in Parramatta	31
4. CHAPTER 4. OFFSET PLANTING OBJECTIVES AND PRINCIPLES	34
4.1. Offset planting locations	34
4.1.1. Key opportunities	34
4.1.2. Principles for locating offset trees and constraints	34
4.1.3. Priority planting locations	35
4.2. Tree species for offset planting	38
4.2.1. Principles for selecting offset tree species	38
4.2.2. Choosing the right tree for the right place	40
4.2.3. Location types	41
4.2.4. Street tree typologies	44
4.2.5. Open space types for offset tree planting	45
4.2.6. Maintenance of offset trees	46
5. CHAPTER 5. OFFSET PLANTING STRATEGY	50
5.1. Priority street tree locations – detailed maps	51
5.2. Street typologies – detailed maps	55
5.3. Offset tree species lists	59
5.3.1. Street tree planting species lists	59
5.3.2. Open space tree planting species lists	59
5.4. PLR tree offset master species list	64
6. CHAPTER 6. NEXT STEPS TO IMPLEMENTATION	82
6.1. Tree procurement and supply	82
6.1.1. Initial tree supply quantities	82
6.1.2. Tendering and commercial availability – initial tree supply	82
6.1.3. Final project tree register and residual tree supply	83
6.1.4. Summary of tree procurement actions	83
6.2. PLR corridor planting opportunities	84
6.2.1. Summary of actions	84
6.3. Roll-out and installation	84
6.3.1. Ground-truthing	85
6.3.2. Summary of tree installation actions	85
6.4. Consultation	86
6.4.1. Opportunities for community partnerships	86
6.5. Tracking progress and reporting	86
7. CHAPTER 7. REFERENCES/FURTHER READING	88
7.1. References/image sources	88
7.2. Further reading/resources	89
8. CHAPTER 8. APPENDIX 1	92
8.1. CBD and connected urban streets	92
8.2. Urban heat streets	94
8.3. Parramatta Ways	96
8.4. Parramatta cycle network	98
8.5. Land use	100
8.6. Verge widths	102
8.7. Open space and biodiversity	104
9. CHAPTER 9. APPENDIX 2	106
9.1. Potential offset tree locations	107
9.1.1. Potential offset tree locations	107
9.1.2. Unique offset strategies	109
9.1.3. Alternate offset options	109



List of Figures

Figure 1:	Key elements of PLR	5
Figure 2:	Parramatta Light Rail Project Objectives.....	5
Figure 3:	Indicative time line for growing advanced street trees for offset planting.....	12
Figure 4:	Locations and images of Pilot Tree Planting Program plantings (source: City of Parramatta 2019)	13
Figure 5:	The temperature difference between shaded and unshaded parts of streets (source: e2designlab.com.au)	16
Figure 6:	The multiple benefits of urban trees (source: Government Architect's Office 2018, p21).....	18
Figure 8:	Number of days above 35°C in Harbour CBD, Greater Parramatta and Penrith (source: Greater Sydney Commission 2018).....	18
Figure 7:	Climate variations across Greater Sydney (source: Greater Sydney Commission 2018)	18
Figure 9:	Factors contributing to the urban heat island effect (source: National University of Singapore 2016)	18
Figure 10:	The impacts of heat (source: City of Parramatta 2017, p 40)	19
Figure 11:	Late afternoon temperature variations in the city due to the urban heat island effect.....	19
Figure 12:	Parramatta River Foreshore Potential Focus Areas (source: TyrrellStudio 2017, p 59)	21
Figure 13:	Parramatta Ways major, intermediate and local routes (source: City of Parramatta 2017, p 38)	24
Figure 14:	Network prioritisation (source: Cardno 2019, p 63)..	29
Figure 15:	Verge widths (source: Cardno 2019, p 37).....	30
Figure 16:	Mean and maximum air temperatures under a range of tree species (source: Pfautsch, S and Rouillard, S 2019, p 36).....	31
Figure 17:	Trends in air temperature according to tree height and canopy density (source: Pfautsch, S and Rouillard, S 2019, p 37)	31

Figure 18:	Temperature mitigation by trees (source: The Nature Conservancy and Resilient Melbourne 2019, p 32) ..	32
Figure 19:	Achieving multiple benefits with offset tree planting ..	34
Figure 20:	Priority offset planting locations for street trees	36
Figure 21:	Priority offset planting locations for open space areas	37
Figure 22:	Potential benefits - and costs - of street trees (source: Aecom 2017, p 7)	38
Figure 23:	Existing tree diversity audit	40
Figure 24:	Choosing the right tree	41
Figure 25:	Heritage Conservation Areas in the Parramatta LGA ...	42
Figure 26:	Location types – street typologies (to be verified at future design investigation ground-truthing)	43
Figure 27:	Priority offset planting locations for street trees. Sheet 1 of 4	51
Figure 28:	Priority offset planting locations for street trees. Sheet 2 of 4.....	52
Figure 29:	Priority offset planting locations for street trees. Sheet 3 of 4	53
Figure 30:	Priority offset planting locations for street trees. Sheet 4 of 4	54
Figure 31:	Street typologies. Sheet 1 of 4.....	55
Figure 32:	Street typologies. Sheet 2 of 4.....	56
Figure 33:	Street typologies. Sheet 3 of 4.....	57
Figure 34:	Street typologies. Sheet 4 of 4.....	58
Figure 35:	Species selection process.....	59
Figure 36:	IAP2 spectrum of public participation (source: Town of Cochrane 2018).....	86
Figure 37:	The selected pedestrian network, modified to suit PLR offset planting constraints	93

Figure 38:	Parramatta streets with highest temperatures due to the urban heat island effect.....	95
Figure 39:	Parramatta Ways routes relative to the PLR walking catchment and urban renewal areas	97
Figure 40:	The Parramatta cycle network	99
Figure 41:	Built form analysis to inform street typologies.....	101
Figure 42:	Verge width analysis analysis to inform street typologies.....	103
Figure 43:	Remnant ecological communities	105

List of Tables

Table 1:	Report structure	2
Table 2:	Compliance matrix for tree offset Conditions of Approval	7
Table 3:	Indicative quantity of offset trees required	11
Table 4:	Consultation Log (City of Parramatta and PLR Independent Arborist)	12
Table 5:	Green infrastructure principles and design actions	22
Table 6:	Parramatta sustainability themes and actions.....	28
Table 7:	Street typologies and location-specific tree attributes (to be verified at future design investigation ground-truthing).....	44
Table 8:	Street tree size and spacing	45
Table 9:	Open space types and location-specific tree attributes	45
Table 10:	Recommended pot sizes for open space planting...	46
Table 11:	Street Type 1: medium centre trees - species list....	59
Table 12:	Street Type 2: large centre trees - species list	59

Table 13:	Street Type 3: medium urban trees – species list	60
Table 14:	Street Type 4: large urban trees – species list	61
Table 15:	Street Type 5: park edge trees – species list	62
Table 16:	Open Space type 1: recreation park trees – species list	63
Table 17:	Open space type 2: biodiversity area trees – species list	64
Table 18:	Trees suitable for use under overhead power lines .	64
Table 19:	Trees suitable for heritage planting	65
Table 20:	Master list of offset tree species for PLR	65
Table 21:	Priority tree procurement quantities	82
Table 22:	Priority tree procurement by container size.....	82
Table 23:	Key actions to secure tree supply and responsibilities	83
Table 24:	Corridor planting opportunity investigation actions	84
Table 25:	Key actions to ensure timely tree installation and responsibilities	85
Table 26:	Indigenous ecological communities and signature tree species	104
Table 27:	Potential offset tree locations	107
Table 28:	Unique offset strategies	109

Glossary

Meanings of acronyms used in this report.

Acronym	Meaning
AQF	Australian Qualifications Framework
BAR	Biodiversity Assessment Report
CoA	Project Conditions of Approval, issued by the NSW Minister for Planning
CoPC	City of Parramatta Council
CSSI	Critical State Significant Infrastructure CSSI is infrastructure that is deemed by the Minister for Planning to be essential for the State for economic, environmental or social reasons. CSSI includes major transport and services developments that have a wider significance and impact than just the local area. CSSI is identified in Schedule 5 of the NSW Environmental Planning Policy (State and Regional Development) 2011, as amended.
DBH	Diameter at breast height Refers to the diameter of tree trunks and is used when calculating tree protection zones. DBH is measured 1.4m above the ground, as per Australian Standard AS 4970-2009 – Protection of trees on development sites
DPI	NSW Department of Primary Industries
DP+E	Former NSW Department of Planning and Environment. Now DPIE
DPIE	NSW Department of Planning, Infrastructure and Environment
EIS	Environmental Impact Statement
EOI	Expression of Interest
GPOP	Greater Parramatta and Olympic Peninsula Priority Growth Area
GSC	Greater Sydney Commission
IAP2	International Association for Public Participation
LGA	Local Government Area
OEH	Office of Environment and Heritage
OGA	Office of the Government Architect
PLR	Parramatta Light Rail
SPIR	Submissions Report (incorporating Preferred Infrastructure Report) for Parramatta Light Rail Stage
TfNSW	Transport for New South Wales
UDLP	Urban Design and Landscape Plan
UHI	Urban heat island
UTM	Urban Tree Management



[Blank Page]

1 INTRODUCTION



Chapter 1.

Introduction

1.1. Purpose of this report

This report constitutes the Tree Offset Strategy for Parramatta Light Rail (the project). It was prepared by Spackman Mossop Michaels on behalf of Transport for NSW (TfNSW). The primary purpose of this report is to meet the requirement of project approval for the preparation of a tree offset package. The aim of the tree offset package is to identify how the impact of the project on existing trees and vegetation will be mitigated, managed, and compensated. The relevant project conditions of approval are discussed in [section 2.2](#).

The major focus of this report is to identify strategies to compensate for, or offset, existing trees required to be removed for the project. The report regards the tree offset package as an opportunity for the project to work with stakeholders and the Independent Arborist to create a greener, more liveable City of Parramatta and a better light rail experience for Customers. To this end, this report uses an evidence-based approach drawing on existing research into the benefits of urban tree cover to provide principles and a framework for:

- › Determining numbers and locations for compensatory tree planting
- › Identifying a range of suitable tree species and sizes to be used in compensatory planting
- › Actions that need to be taken to implement compensatory tree planting within the required time frame.

1.1.1. How to use this report

This Tree Offset Strategy has been developed to inform the Department of Planning, Industry and Environment (DPIE), TfNSW and key project stakeholders how the project's tree impact management requirements will be met. The report contains six key sections; the content and purpose of each section are described in [Table 1](#).

The Tree Offset Strategy is a 'whole of project' plan that will be delivered through TfNSW, including the Parramatta Light Rail works packages and other partnerships, most notably with the City of Parramatta (CoPC) and the Independent Arborist – also refer to [section 2.4.1](#).

Table 1: Report structure

Tree Offset Strategy report section	Purpose
2. Overview	Provides a brief overview of the Parramatta Light Rail project, its impacts on trees and vegetation and how they are to be mitigated and compensated. This section lists the relevant project Conditions of Approval, and where they have been addressed in this report. It also provides a time line for offset tree planting, a description of offset planting already carried out through a pilot planting program, and a brief overview of how this strategy was developed.

Tree Offset Strategy report section	Purpose
3. Background	This section provides an overview of the benefits of offset tree planting and urban tree planting more generally. This is followed by a summary of documents that have guided the preparation of this strategy.
4. Offset planting objectives and principles	Based on the guidance documents, this section outlines the principles and process adopted for locating offset trees, as well as for choosing tree species and sizes for offset planting.
5. Offset Planting Strategy	This section contains detailed maps identifying offset tree planting locations within both streets and open space areas, as well as detailed maps showing location types that correspond to a range of species suitable for planting. A species list is provided for each location type. This is followed by a master species list for all PLR tree planting works and a brief section on maintenance requirements.
6. Next steps to implementation	This section outlines the five major steps to be undertaken towards implementation of this Tree Offset Strategy.
7. References/ Further reading	Lists documents used in the preparation of this strategy, as well as other resources for further reading/information.
8. Appendix 1	Contains a series of step-by-step maps that illustrate the process of identifying priority planting locations and location types.
9. Appendix 2	Outlines additional offset strategies

2 OVERVIEW



Chapter 2.

Overview

2.1. Parramatta Light Rail

2.1.1. Overview and key features

Parramatta Light Rail (PLR) is one of the NSW Government's major infrastructure projects serving a growing Sydney. PLR is the first stage of the project, connecting Westmead to Parramatta and Carlingford via Camellia. PLR is expected to open in 2023.

Light rail will create new communities, connect great places and help both locals and visitors move around and explore what the region has to offer. The route will link Parramatta's CBD and train station to a number of key locations including the Westmead health precinct, the former Parramatta North urban transformation area, the new Western Sydney Stadium, the Camellia precinct, the new Powerhouse Museum and Riverside Theatre Cultural Hub, the private and social housing redevelopment at Telopea, Rosehill Gardens Racecourse and three Western Sydney University campuses.

Key features of PLR – Stage 1 include – refer [Figure 1](#):

- › A new light rail network of 12 kilometres in length, including approximately:
 - Seven kilometres within existing road corridors
 - Five kilometres within the existing Carlingford Line and Sandown Line, replacing current heavy rail services
- › 16 light rail stops that are fully accessible and integrated into the urban environment
- › High frequency 'turn-up-and-go' services seven days a week from 5am to 1am. Services will operate around every 7.5 minutes in the peak period between 7am and 7pm
- › Modern and comfortable air-conditioned vehicles, 45 metres long and driver-operated
- › Interchanges with existing rail, bus and/ or ferry facilities at Westmead, Parramatta CBD, and Carlingford
- › Creation of two light rail and pedestrian zones (no general vehicle access) within the Parramatta CBD:
 - Along Church Street, generally between Market and Macquarie Streets
 - Along Macquarie Street, generally between Horwood Place and Smith Street
- › Stabling and maintenance facility located in Camellia for light rail vehicles to be cleaned and maintained
- › Light rail control centre
- › New bridge structures along the alignment including over James Ruse Drive and Clay Cliff Creek, Parramatta River (near the Cumberland Hospital), Kissing Point Road and Vineyard Creek, Rydalmere
- › Alterations to the existing road network including line marking, additional traffic lanes and turning lanes, new traffic signals, and changes to traffic flows
- › The heavy rail line between Camellia and Clyde will close permanently, meaning traffic will no longer be held up at the railway crossing on Parramatta Road, improving traffic flow on one of Sydney's major arterial roads
- › Active transport corridors and additional urban design features along sections of the alignment and within stop precincts
- › Integration with the Opal card electronic ticketing system
- › Real time information will be provided on the light rail vehicle and stops via visual displays and audio.

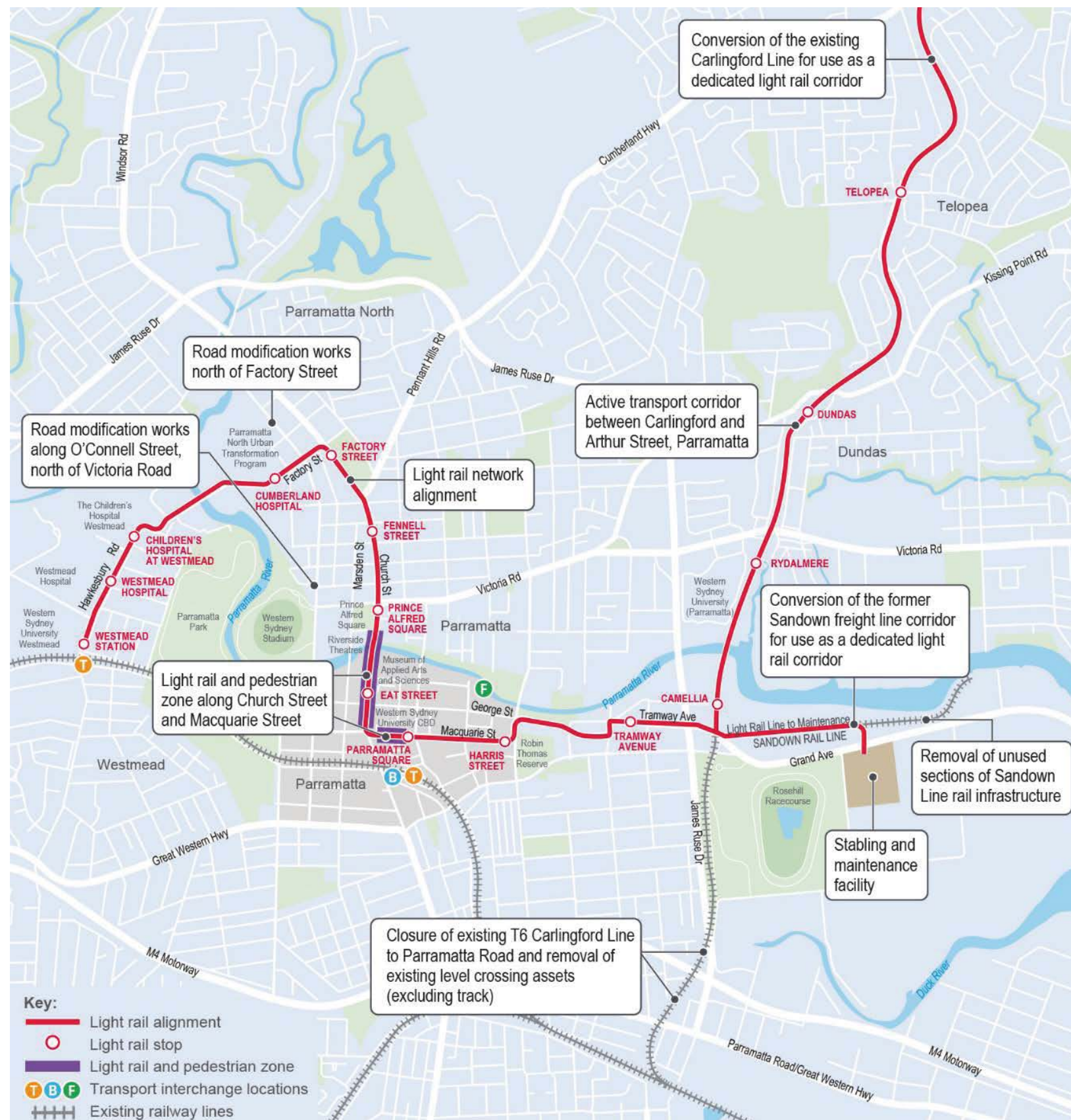


Figure 1: Key elements of PLR

2.1.2. Project objectives

2.1.2.1. Parramatta Light Rail Objectives

The vision for the whole Parramatta Light Rail is to deliver integrated light rail services that support the government's vision for the Greater Parramatta to Olympic Peninsula Priority Growth Area (GPOP).

A key consideration for defining the vision has been balancing the specific scope of the Parramatta Light Rail being light rail services at the core, integrated with other transport services, and supporting the significant land use outcomes envisaged for the study area.

Five project objectives that apply specifically to the project have been identified across four category areas of city shaping, connectivity, place and choice – refer Figure 2.

City Shaping	- Support the vision for Parramatta as a 21st century city – attracting new investment and economic development - A catalyst for shaping new growth – activating underutilised lands and providing the transport capacity needed to support sustainable population and employment growth in the area
Connectivity	Connecting people and places – supporting the diverse mix of customer journeys that links employment, cultural, educational, health and sporting precincts with existing and new communities
Place	Contribute to the creation of local hubs – supporting the creation of attractive and memorable public spaces that are better utilised by communities
Choice	Providing attractive transport choices for customers – 'turn up and go', safe, reliable, all day light rail service that is integrated with roads, buses, trains and active transport

Figure 2: Parramatta Light Rail Project Objectives

2.1.3. PLR background and aims

2.1.3.1. NSW Government transport strategy

The *NSW Long Term Transport Master Plan* identifies a ‘three-tiered network’ to expand the capacity of Sydney’s transport system comprising a mass transit network linking regional cities and major centres, an intermediate transit network linking town centres, and a local transit network linking local villages.

Parramatta Light Rail is a key element of the *NSW Long Term Transport Master Plan*, which will provide a new intermediate transit network that will improve access, connectivity and public transport capacity through the GPOP.

2.1.3.2. Aims of Parramatta Light Rail

Western Sydney; the engine room of the nation’s economy, is where more than two million people live and increasingly work. By 2036, more than half of all Sydneysiders will call Western Sydney home, a population shift that is pulling the heart of metropolitan Sydney to the west and elevating Parramatta’s status as Australia’s next great city. In the next 20 years, the population of the Parramatta Local Government Area (LGA) will undergo extraordinary growth from 240,000 residents in 2016 to more than 415,000 by 2036. Employment opportunities in Greater Parramatta will also grow, from around 96,000 jobs to around 160,000 jobs by 2036.

Parramatta Light Rail will deliver an integrated light rail service that supports population and employment growth as well as the development expected throughout the GPOP. The light rail will also integrate with existing and future modes of transport including roads, buses, trains, ferries and active transport across the area.

2.1.4. Key Benefits of Parramatta Light Rail

PLR – will be accessible to an estimated 130,000 people within walking distance of 16 light rail stops by 2026. This will increase to 180,000 people by 2041, more than half the population in the area.

The project will support the Greater Sydney Commission’s vision for the GPOP priority growth area which envisages significant growth in population and jobs over the next 25 years. Consistent with the project objectives (refer [Figure 2](#)), the project would result in the following key strategic benefits to the broader community and to the economy:

- › **City-shaping benefits:**
Reduced urban sprawl, improved housing affordability and reduced socio-economic disadvantage
- › **Place making benefits:**
Improved amenity for customers and residents, improved cycling and pedestrian environments and health benefits from increased active transport
- › **Productivity benefit:**
Reduced transport and logistics costs for businesses, assisting in a transition to a knowledge economy and increased agglomeration benefits from knowledge transfer
- › **Transport benefits:**
Travel-time savings, reduced crowding, reliability improvements and reduced future road congestion

Other benefits flowing from the PLR include:

- › Supporting the development of Parramatta as Sydney’s second CBD and providing a catalyst for further investment in the area by providing critical infrastructure and public transport options for workers and the community
- › Better connections between venues such as the new Western Sydney Stadium and Rosehill Gardens Racecourse with extra services provided during special events
- › Easier to travel between Parramatta’s CBD and destinations like the Westmead Health precinct, the former Parramatta North urban transformation area, the new Powerhouse Museum and Riverside Theatres Cultural Hub, the three Western Sydney University campuses, the Camellia Precinct and the suburbs of Carlingford, Dundas, Telopea and Rydalmere
- › Improved travel time reliability compared with bus and existing heavy rail on the Carlingford T6 Line
- › Reduced congestion by providing an attractive alternative to private vehicles, assisting in minimising car dependence for intermediate trips in the GPOP
- › Active transport corridors to enable new walking and cycling networks
- › Road network changes to address car and freight movements that presently occur in and around the Parramatta area.

2.1.4.1. PLR delivery

PLR is being delivered via a number of contracts, including early and enabling works and the two major contracts to:

- › Design and build the light rail system (Downer and CPB Contractors Joint Venture)
- › Supply and operate the network, as well as to design and build the light rail stops, depot and power systems (Great River City Light Rail Consortium).

This is of relevance to the tree offset strategy as each contract includes landscape works. Based on the agreed scope of each contract, the total tree planting delivered under the contracts will fall short of the number of offset trees required to be planted under the project conditions of approval – refer [section 2.2](#).

As detailed designs for the project progresses and construction is underway, the actual number of trees requiring removal for the project will be finalised. This process will identify the number of additional trees that need to be provided under this offset strategy.

2.2. Project Conditions of Approval

This report has been developed in alignment with the NSW Minister for Planning’s Conditions of Approval (CoA), as set out in the *Instrument of Approval Parramatta Light Rail – Stage 1 (SSI-8285)* dated 29 May 2018 and subsequent administrative modifications dated 21 December 2018 and 25 January 2019.

Specifically, this report has been prepared in response to *Biodiversity and Revegetation* CoA E107 which requires the preparation of a tree offset package. A number of additional CoA are also of relevance to this report. The relevant conditions are shown in [Table 2](#), together with the sections of this report where they are described and a summary statement of how they have been addressed.

Table 2: Compliance matrix for tree offset Conditions of Approval

CoA (#)	Requirement	Relevant report section	How addressed
Tree Offset Package			
E107	The Proponent must prepare and implement a Tree Offset Package for the CSSI in consultation with the independent Arborist required by Condition E102, and Relevant Council(s).	section 2.4	The Tree Offset Strategy is one part of the Tree Offset Package. The Package includes this Strategy as well as the implementation/delivery of the offset trees in accordance with the planning approval requirements. This Strategy report has been prepared in consultation with the Independent Arborist and City of Parramatta Council.
	The Package must consider the objectives and opportunities identified in <i>Sydney Green Grid West Central District</i> (Department of Planning and Environment, 2017), <i>Greener Places</i> (NSW Government Architect, 2017), and <i>Parramatta Ways (Implementing Sydney's Green Grid)</i> (City of Parramatta, 2017).	section 3.2.1 section 3.2.2 section 3.2.3 section 4.1.1	Review of relevant background documents including summary of objectives and opportunities.
	The package must:	section 3.1	Summary of the benefits of urban tree cover.
	a) identify how impacts on trees and vegetation will be mitigated, managed, and compensated;	section 2.3 section 2.3.4 section 6.5	Discussion of project tree and vegetation impacts and impact management strategies. Tracking of strategy progress
	b) ensure that where trees are removed, they are replaced at the following ratios regardless of their value, near the impact or, where this is not practicable, within other areas of the LGA or surrounding LGAs, in consultation with the relevant authority(ies):	section 4.1 section 4.2	Development of tree offset principles to guide species selection and offset locations.
	- large trees (DBH greater than 60cm) – plant minimum of eight trees; - medium trees (DBH greater than 15cm, but less than 60cm) – plant minimum of four trees; and - small young trees (DBH less than 15cm) – plant minimum of two trees.	section 2.3 section 4.1	Development of principles and a process for determining appropriate locations for offset tree planting, through consultation with CoPC. Trees that are removed as part of the Project will be replaced in accordance with the tree offset ratios (Condition E107b) or alternative offset options described in Appendix 2 .

CoA (#)	Requirement	Relevant report section	How addressed
	c) ensure a mix of species and a range of mature heights to provide visual diversity and benefits, in consultation with Relevant Council(s);	section 2.4 section 4.2	Development of principles to inform tree species selection and to determine appropriate locations for various species, in consultation with the City of Parramatta and the Independent Arborist.
	d) street tree plantings are to have a minimum pot size of:	section 5.3 section 4.2.3	Recommended species for a range of settings or location types.
	200 litres in the Parramatta CBD precinct; and 75 litres in other streets;	section 4.2.4.3	Minimum pot sizes are specified for all tree offset planting locations.
	e) tree planting in parks, open space, bushland, and within the Carlingford Line corridor, should be sized to suit local the location, species and planting style, in consultation with the relevant authority(ies); and	section 2.4 section 4.2.5.1 section 5.3.2	Recommended sizes for a range of different sites and conditions. Recommended species for different types of open space areas including recreation parks and bushland.
	f) ensure at least 80% offset works must be completed before CSSI operations commence.	section 2.3.5.2 section 6.1 section 6.3	Offset planting Identification of steps to be taken towards tree offset planting procurement and installation, considering procurement lead times.
	Where the requirements of this condition cannot be met, the Proponent must provide documented evidence demonstrating how the matters in (a) to (f) were considered and provide information and justification for an alternative offset option for the Secretary's approval.	section 2.4.2	Undertake a tree planting pilot program to develop suitable processes and agreements.
		Appendix 2	Details of alternative tree offset options are proposed in Appendix 2. These alternative options include for example matters of biosecurity or where mature tree offsets (>1000l) are proposed. In accordance with Condition E107, this Tree Offset Strategy is submitted to the Secretary for approval including use of the alternative tree offset options.

CoA (#)	Requirement	Relevant report section	How addressed
Streetscape Trees			
E102	The Proponent must commission a suitably qualified and experienced Arborist with a minimum AQF Level 5 qualification in Arboriculture, that is independent of the design and construction personnel for the duration of construction. The Arborist must be approved by the Secretary before works commence and commissioned for the duration of construction.	section 2.4.1.1	TfNSW has commissioned an independent Arborist ahead of the commencement of this Strategy, and before works commenced to provide independent arboriculture advice and determination to the Parramatta Light Rail project.
E103	The Arborist must: - be the principal point of advice in relation to the assessment and management of CSSI impacts on trees; - prepare a Tree register of all trees within the CSSI footprint (either for the entire CSSI or separate areas where tree removal and/or pruning is proposed) before the removal of any trees; - identify those trees within the footprint that must be removed for construction to proceed or for CSSI operations; and - identify those trees where their fate is uncertain and may be retained, removed or pruned (either for construction or for ongoing maintenance operation).	section 2.4	Preparation of the Tree Register in parallel to this strategy, and to inform the strategy in respect of the likely quantity of offset trees required. The Project Independent Arborist currently maintains the Tree Register for trees removed by the Project. Consultation with the Arborist, TfNSW and CoPC to identify processes for tracking the number of trees installed against those required by Condition E107.

CoA (#)	Requirement	Relevant report section	How addressed
E104	The Tree Register must include: - the georeferenced location of each tree; - those attributes as defined in AS 4970-2009 Protection of trees on development sites - the tree retention value; - the outcomes of a visual assessment of the condition of the tree; - where a tree requires removal, whether, in the opinion of the Arborist, it can be successfully transplanted; - the extent of the proposed impact (complete removal and extent of pruning); - measures for the management, protection and monitoring of compensatory vegetation, for a minimum of two years from being planted; and - timing and responsibilities for the implementation of compensatory vegetation.	section 2.4 section 6.5	Engagement of the Arborist by TfNSW as per Condition E102, to inform the preparation of this strategy. The Independent Arborist (IA) Tree Register will inform the number of offsets required. A Register of Planted Trees will be maintained to track the progress of the implementation of compensatory vegetation.

CoA (#)	Requirement	Relevant report section	How addressed
Operational Maintenance			
E108	The ongoing maintenance and operation costs of urban design and landscaping items (including tree offsets) and works implemented as part of this approval remain the Proponent's responsibility until satisfactory arrangements have been put in place for transfer to the relevant authority. Before the transfer, the Proponent must maintain items and works to the design standards established by the Urban Design Requirements Report, and the Tree Offset Package.	section 5.4	Identification of maintenance requirements until hand-over, to ensure satisfactory tree condition prior to acceptance by CoPC.
Revised Environmental Management Measures			
REMM TR-5	Where the loss of trees is unable to be mitigated, trees removed as a result of the project would be offset in accordance with the Transport for NSW's Vegetation Offset Guide (2016). The proposed offsetting activities would be documented in the Tree Offset Strategy to be developed for the project. The City of Parramatta Council's Parramatta Ways: Implementing Sydney's Green Grid would be considered as part of the development of a Vegetation Offset Strategy for the project.	section 3.2	The PLR Tree Offset Strategy (this report) has been prepared in consideration of the relevant guidelines.
REMM TR-8	Selection of tree species, size and planting locations would be carried out in close consultation with local council and in accordance with the UDLP to be developed for the project.	section 3.3.1 (reference to UDLP), 6.4 consultation	This Strategy has been prepared in consultation with CoPC as demonstrated in section 6 and the consultation log. The TfNSW Urban Design Requirements (the "Blue Book") is considered and referenced in section 3.3.1. This document forms a key part of the Urban Design Requirements Report (UDRR) to be developed in accordance with Conditions E87 and E88. The requirement for a UDLP has been covered by the UDRR.

2.3. Tree and vegetation impacts

The project *Submissions Report (incorporating Preferred Infrastructure Report)* (SPIR) identified that construction of project will require the removal of up to 2,650 trees. It also identified that the project may significantly impact the structural root zone of nearby trees, including for trees of moderate and high retention value. TfNSW is committed retaining trees where possible and to enhancing biodiversity outcomes as part of the project.

Managing the project's tree impacts involves three strategies:

- › Impact minimisation
- › Impact mitigation
- › Impact compensation.

They are described in the following sections.

2.3.1. Impact minimisation

Impact minimisation involves investigating and considering options to avoid or minimise impacts on trees, including the degree of encroachment onto the root zone. The primary process for impact minimisation is the detailed design and construction processes. TfNSW is committed to exploring opportunities to minimise impacts to trees, in particular large trees and trees of medium or high retention value, through both design modifications during detailed design and the construction methods used (refer SPIR section 7.2.5.3 and 8.2.1), as follows:

- › Avoidance of impacts in detailed design where possible
- › Minimising construction impacts and protecting trees during construction.

Impact minimisation through the development of the detailed design is being undertaken outside the scope of this report. This process will determine the actual numbers of trees to be impacted, including those requiring removal. This in turn will determine the final number of trees required to be offset by this tree offset strategy.

2.3.2. Impact mitigation

Impact mitigation or on-site compensation involves implementing measures to reduce the impacts of existing tree removal by reinstating areas to pre-construction site conditions. As such, impact mitigation is focused on improving areas located within and immediately adjacent to the construction footprint of the project where existing trees need to be removed. Impact mitigation includes measures such as integrating landscaping and tree planting into the design of the project, to reinstate vegetation cover near the removal sites.

Impact mitigation will be carried out through the detailed design and construction process (also refer [section 2.1.4.1](#)) which includes the preparation of:

- › Detailed landscape design plans for areas disturbed by project construction
- › The Urban Design Requirements Report (UDRR) required by Conditions E87 and E88. The UDRR would include recommended tree species to be used for replacement planting in each of the precincts.
- › Selection of tree species, size and planting locations would be carried out in close consultation with City of Parramatta Council.

TfNSW's commitment to impact mitigation is outlined in SPIR section 5.17.2.3:

The project team is collaborating with the City of Parramatta Council and other stakeholders to identify opportunities to plant trees or carry out landscaping in the early stages of the project to proactively mitigate impacts of vegetation removal. Opportunities identified to date include:

- › Planting street trees in the early stages of the project in areas away from project construction impacts, such as on approaches to project stops (e.g. side streets), and along off-corridor works areas.
- › Incorporating landscaping and tree offsets to minimise the visual impact of construction and operation of project facilities such as the stabling and maintenance facility.
- › Early engagement with nurseries to cultivate trees to the maturity required for street tree plantings.

Tree sizes would be determined as suitable for the planting landscape, and advanced plantings will be considered in certain locations. Selection of tree species, size and planting locations would be carried out in consultation with Council and in accordance

with the Urban Design and Landscape Plan to be developed for the project.

Additional impact mitigation opportunities are identified by this Strategy based on consultation with the detailed landscape design contractor. Opportunities include sites within the project construction footprint that would be able to accommodate tree planting but where tree planting would be outside the scope of the construct contract.

2.3.3 Impact compensation

Impact compensation seeks to offset the impacts of existing tree removal through additional compensatory planting away from the project footprint in new locations, primarily in the Parramatta Local Government Area (LGA). The identification of suitable and appropriate compensatory planting locations as well as appropriate species is outlined within this Strategy. Through the SPIR TfNSW outlines its commitment to impact compensation. SPIR section 5.17.1.3 states:

Where impacts to native vegetation and trees along the project alignment are unavoidable, Transport for NSW's *Vegetation Offset Guide* and the City of Parramatta's *Parramatta Ways: Implementing Sydney' Green Grid* would be used as a framework to develop a Vegetation Offset Strategy.

The delivery of this strategy would include consideration of a range of options including:

- › Planting trees or landscaping along the alignment.
- › Planting trees or landscaping in a public space within the Parramatta LGA.
- › Working with Council to implement a program of rehabilitation to a natural environment such as a forested reserve or waterway within the Parramatta LGA.
- › Reservation of land for conservation or buying and retiring credits under the NSW Government BioBanking scheme.
- › Rehabilitation and weeding
- › Civil works such as walking tracks or erosion management
- › Contributions towards biodiversity improvement actions by others or existing tree planting programs
- › Ecological research and education (such as the provision of interpretive signage or publicly accessible online educational material).

This commitment is complemented by CoA E107 which requires between 2 and 8 new trees for every tree removed by the project, as outlined in [Table 2](#).

2.3.4. Tracking the project’s impact on trees

2.3.4.1. Preliminary precinct-based arboricultural assessment

Preparation of the Environmental Impact Statement (EIS) for the project involved a precinct-based arboricultural impact assessment. The study area for this assessment was determined based on trees within and immediately adjacent to the disturbance footprint that would be potentially impacted by the project. This includes disturbance by any physical works (such as light rail tracks, stops and overhead wires), construction compounds, access roads and any other areas that would be physically disturbed during construction of the project, including off-corridor works.

The diameter at breast height (DBH) of the trees was also assessed consistent with TfNSW categories identified in its *Vegetation Offset Guide*. The aim of this was to provide information on tree maturity, based on the diameter of tree trunks:

- 1. Large mature tree: diameter at breast height (DBH) of greater than 60 centimetres
- 2. Medium tree: DBH between 15 and 60 centimetres
- 3. Small young tree: DBH less than 15 centimetres.

The arboricultural assessment identified the potential impacts on trees as a result of the project including:

- Preliminary identification of trees that would experience:
 - A minor impact, in terms of the percentage of root zone likely to be encroached on by the project
 - A more than minor impact
- An indicative estimate of the number of trees to be removed by the project
- Environmental management measures that would be implemented to mitigate potential impacts.

2.3.4.2. Independent Arborist Tree Register

The preliminary arboricultural assessment provided the starting point for the preparation of the Independent Arborist’s Tree Register developed by the Independent Arborist, as required by approval conditions E102 and E103 – refer **Table 2**.

The IA Tree Register will be the primary tool for managing the project’s impacts on trees. It will constitute a complete register of all trees within the project footprint, including whether they will be retained, removed or pruned as a result of construction. The IA Tree Register will be a ‘live’ tool that will be continually kept up-to-date

throughout development of the detailed design and construction of the project. It will also contain information on tree attributes such as DBH, visual and tree retention values, and potential for transplanting (for trees requiring removal).

As the number of offset trees required for the project is linked to the number of existing trees removed and their DBH, the IA Tree Register is a key document which forms the implementation of the tree offset strategy, as it provides the essential information to calculate the final number of offset trees that need to be planted to meet planning approval offset ratio requirements.

2.3.5. Tree impact compensation targets and time line

2.3.5.1. Magnitude of the tree offset program

The SPIR identified that construction of project will potentially remove of up to 2,650 trees. It is noted that this number is currently being refined through impact minimisation measures (refer **section 2.3.1**) and through completion of the tree register in parallel (refer **section 2.3.4.2**).

Project approval requires between 2 and 8 new trees for every removed tree. To gain an understanding of the likely magnitude of the tree offset planting program, a compensation ratio average of four (4) new trees per removed tree has been used to determine an indicative quantity of trees to be planted – refer **Table 3**. This also considers the total number of trees to be planted under the various PLR – Stage 1 delivery contracts (refer **section 2.1.4.1**), and the number of trees already planted under the PLR tree planting pilot program (refer **section 2.4.2**).

Table 3: Indicative quantity of offset trees required

		Lower EIS estimate	Upper EIS estimate
A	Trees removed by the project	1,900	2,650
B	Indicative number of compensatory trees required (B = A x 4)	7,600	10,600
C	Trees delivered by PLR – Stage 1 contracts	1,801	1,801
D	Trees planted (pilot program)	120	120
E	Indicative number of offset trees still be to be planted (E = B – C – D)	5,679	8,679

Ultimately, the final quantity of offset trees required to be provided to meet the requirements of Condition E107b, are that for:

- Large trees (DBH greater than 60cm) – plant minimum of eight trees;
- Medium trees (DBH greater than 15cm, but less than 60cm) – plant minimum of four trees; and
- Small young trees (DBH less than 15cm) – plant minimum of two trees.

Or as approved using the alternative tree offset options as outlined in Section 9.1.3 of Appendix 2 for weed trees and mature tree offsets (>1000L).

2.3.5.2. Offset Planting time line

Condition E107 requires that 80% of new trees must be planted prior to the project commencing operations, scheduled for 2023. Based on the indicative tree quantities in **Table 3**, approximately 7,335 trees would need to be installed by mid 2023. While this number is indicative, it is highly unlikely that the preferred tree species would be commercially available to purchase “off the floor” in any quantity resembling the required number of offset trees.

Forward planning and procurement of tree stock is therefore essential in order to secure the required number of trees of the desired species and at the appropriate level of maturity. Based on initial discussions with commercial growers, the time required to grow street trees from seed to the required size is approximately:

- 85 weeks (over a year and a half) for 75L trees
- 130 weeks (around 2 and a half years) for 200L trees.

Factors that could extend this time frame include:

- Seed is not available in stock and needs to be collected. This is more likely to be an issue for species that are not readily grown commercially, though species in high demand could also be affected. Seed collection would need to be done following the flowering season. The time of year depends on the species chosen.

Factors that might reduce the time frame include:

- Availability of stock in smaller pot sizes in nurseries that could be grown on to the final size

The time of year of ordering tree stock is also important to consider as it could either reduce or extend the time frame required, depending on the timing of the order relative to the growing season. For example, an order placed in late autumn or winter may require additional time, due to the relatively limited growth of plants over the cooler months.

Figure 3 shows an indicative time line from early 2020 to 2023. It identifies that in order to secure advanced 75L and 200L offset trees in time for planting prior to operation of the project, procurement of tree stock is a priority for the project in early 2020.

2.4. How this strategy was developed

2.4.1. Consultation and partnerships

This strategy was developed in a process of consultation with the key stakeholders including: the City of Parramatta, the Independent Arborist and detailed design teams.

2.4.1.1. Independent Arborist

Parramatta Light Rail Independent Arborist, required under Condition E102. .

2.4.1.2. Consultation activities

Consultation activities included a series of meetings and presentations in parallel with the development of this strategy. The purpose of the consultations was to:

- Share and exchange relevant and background information to inform and guide the Strategy
- Keep stakeholders informed on the progress and direction of the Strategy
- Obtain input into the development of the Strategy, and to ensure agreement on the offset planting principles and

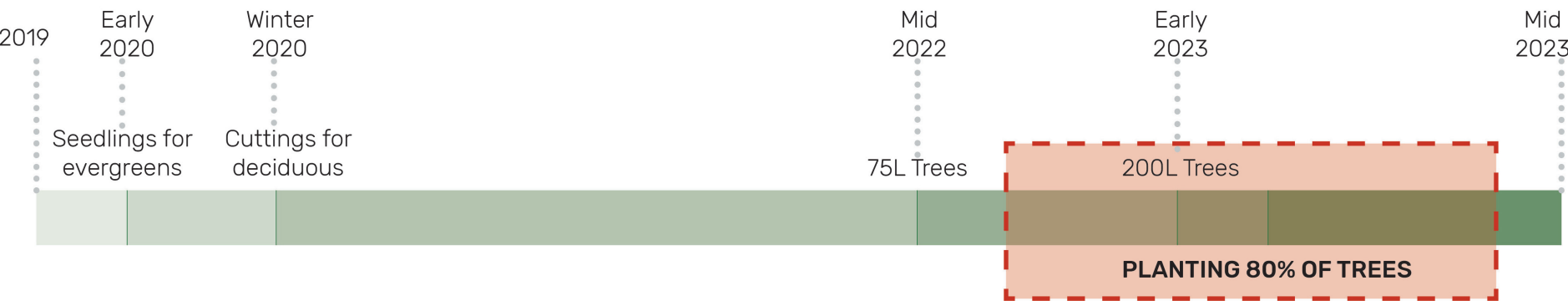


Figure 3: Indicative time line for growing advanced street trees for offset planting

objectives, including the proposed priority locations and suggested offset tree species.

During the period of preparing this Strategy, a number of consultation activities were undertaken. These are outlined below and the key meetings / tasks listed in Table 4.

Table 4: Consultation Log (City of Parramatta and PLR Independent Arborist)

Mechanism / Stakeholder	Date	CoPC	PLR Ind. Arb.
Tree Offset Strategy - Project Overview with City of Parramatta	03/10/2019	✓	
Tree Offset Strategy Inception Meeting / Workshop	29/10/2019	✓	✓
City of Parramatta Council Project team meetings	15/10/2019 29/10/2019	✓	
Independent Arborist meetings/discussions	21/10/2019 21/11/2019		✓
Draft Content Page and document structure for document sent out for review and comment	03/10/2019	✓	

Mechanism / Stakeholder	Date	CoPC	PLR Ind. Arb.
Tree Offset Strategy Main Works Contract / trees within the alignment	20/10/2019	✓	
Tree Offset Strategy Planting Locations and Species Meeting / Workshops	11/11/2019 21/11/2019	✓	✓
Draft Tree species list sent out for review and comments	21/11/2019		
Tree Audit (City of Parramatta Council) sent out for information.	21/11/2019	✓	
Review of preliminary offset strategy information including draft report table of contents, findings from background document review, draft principles and objectives and draft species list	09/07/2019	✓	✓
Review and feedback on the draft Tree Offset Strategy report including a project team meeting workshop to agree the necessary refinements and amendments to finalise the report.		✓	✓
Exchange of design information including proposed tree species lists and rational for species choices.	ongoing throughout development of Strategy	✓	✓
Tree Offset Strategy Presentation by PLR Tree Offset Strategy Consultant sent out for review and comments.	09/01/2020	✓	✓
Draft Tree Offset Strategy report issued to CoPC for review.	16/07/2020	✓	
Tree Offset Strategy - close out comments sessions	23/04/2020 27/08/2020 03/11/2020 16/11/2020	✓	
Liaison via phone and email outside of the meetings to provide further clarity and information in relation to comments as part of the document review process.	Throughout 2019 - 2020	✓	✓

2.4.2. PLR tree planting and neighbourhood improvement program

The PLR project team in consultation with CoPC has developed a draft framework for the delivery of offset trees. A small percentage of offset trees have been planted through a pilot program with CoPC. This offset tree planting has been monitored by the PLR Planning Team for conformance with CoA requirements. It is anticipated that more PLR offset tree planting will be undertaken in late 2019 and over the next 3–4 years. A database of offset trees is held by TfNSW and will contribute to realising the required number offset trees as per **Table 3**.

2.4.2.1. Description of the Pilot Offset Tree Planting Program

The Parramatta Light Rail Tree Planting and Neighbourhood Improvement Program is a four year pilot program conducted by TfNSW in partnership with CoPC. The pilot tree planting constitutes the first package of PLR Offset Tree Planting. The pilot tree planting includes installation and two years maintenance by landscape contractors of 120 semi-mature trees in Westmead and North Parramatta streets. The streets are adjacent to Parramatta Light Rail early works and enabling works projects around Hawkesbury Road, Westmead and O’Connell Street, North Parramatta – refer **Figure 4**.

The street trees range in size from 75 litres to 200 litres and include native and non-native species. CoPC in collaboration with TfNSW selected the species and the planting locations, consistent with the PLR CoA.

Considerations for species selection included:

- › Site constraints such as underground utilities, overhead powerlines and verge widths
- › Scale of streets and built form
- › Creating diversity and seasonal variety
- › Existing tree species and streetscape character
- › Soils, hydrology and natural landscape character.

The pilot planting was completed around April 2019, with positive responses from the local community and business owners, and endorsement within TfNSW and CoPC.

Maintenance of the offset trees will be completed around mid-2021. Any trees that perish during this period must be replaced. Each tree planted has an identification tag to help track its development. Residents are encouraged to help maintain the wellbeing of these trees by taking note of the tag number and reporting any concerns.

Community mail-outs and a media release for the pilot tree planting were prepared and coordinated by TfNSW Communications and Public Affairs Team and CoPC’s Media Team.

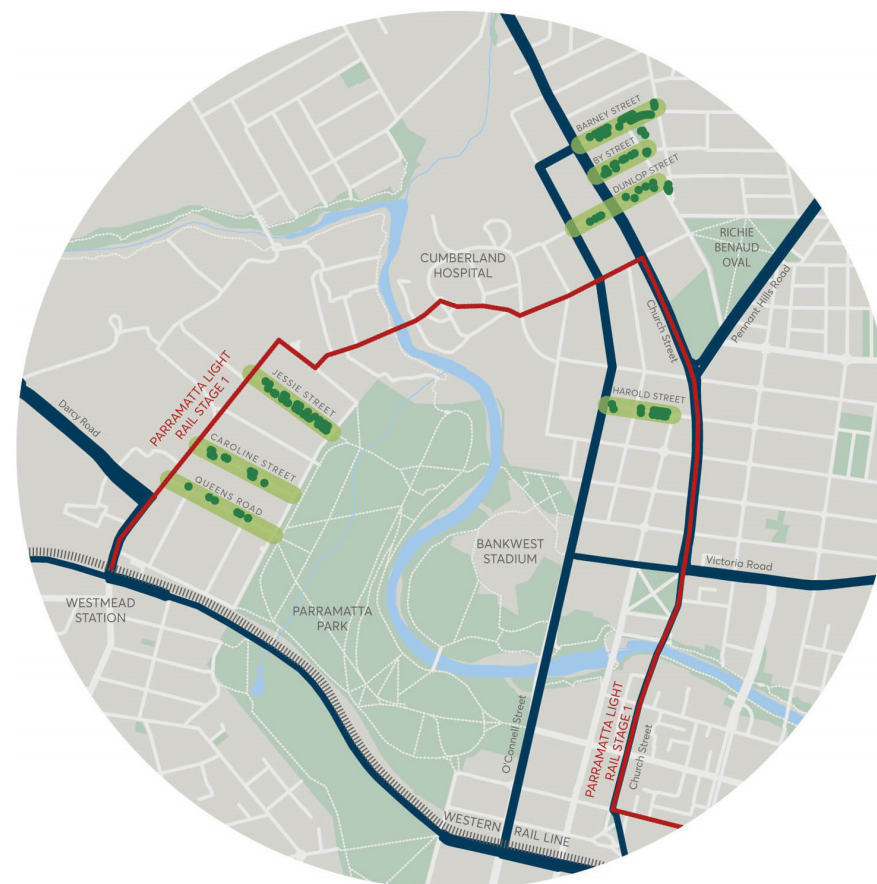


Figure 4: Locations and images of Pilot Tree Planting Program plantings (source: City of Parramatta 2019)

[Blank Page]

3 BACKGROUND



Chapter 3.

Background

3.1. Why offset tree planting?

There are a multitude of social, economic and environmental benefits associated with Parramatta Light Rail offset tree planting. They include:

- › Improved heat island outcomes, shade, air quality and ambient air temperatures
- › Improved community health
- › Increased habitat for local fauna
- › Improved light rail customer experience and comfort
- › Improved perceptions of Parramatta Light Rail
- › Positive partnership opportunities with City of Parramatta and other key Parramatta Light Rail stakeholders
- › Planning approvals for Parramatta Light Rail

These are significant benefits that support, and are supported by, a number of strategic planning policies and directions for Greater Sydney. This is further described in the following sections.

The potential for urban tree cover to influence health, climate adaptation and resilience outcomes in Parramatta is one of the key drivers that has influenced this strategy.

3.1.1. The benefits of urban trees

Trees have the potential to transform the quality of life in Australian cities. This has been documented by a wealth of research and recognised by the Greater Sydney Commission (GSC), the organisation established by the NSW Government to lead metropolitan planning for the Sydney region.

The GSC's aim is to make Greater Sydney more productive, sustainable and liveable. The vision, strategic directions and objectives to achieve this aim are outlined in *A Metropolis of Three Cities*, also known as the *Greater Sydney Region Plan* (the Plan). The Plan sets a 40-year vision (to 2056) and establishes a 20-year plan to manage growth and change for Greater Sydney in the context of social, economic and environmental matters.

The Plan identifies a requirement to expand urban tree canopy in the public realm (Objective 30). The Plan states:

As Greater Sydney grows and urban areas become denser, extending urban tree canopy is one of the most effective ways to improve amenity. A target has been set to increase tree canopy cover to 40 per cent, up from the current 23 per cent. Urban tree canopy can be complemented by green ground cover, rain gardens, green roofs and green walls.

The Plan identifies multiple benefits of urban tree canopy cover, including – also refer **Figure 6**:

- › Environmental benefits: providing habitat and protecting the health of waterways
- › Improvements to air quality through the removal of fine particles from the air, and through the conversion of carbon dioxide to oxygen
- › Economic benefits: a 10% increase in tree canopy has been shown to increase property values by an average of \$50,000 (based on 2017 figures) – and potentially more in western Sydney

- › Place-making benefits: trees enhance the quality of the public domain
- › Amenity benefits: trees, through the provision of shade and reduced UV exposure, increase the attractiveness of walking and cycling as a means of transport
- › Urban landscape benefits: increased urban tree canopy cover also contributes to realising other key planning objectives including the implementation of the *Sydney Green Grid* (Plan Objective 32), an initiative to connect communities to the landscape with multiple benefits including better access to open spaces, encouraging healthy lifestyles, supporting walking and cycling, supporting ecological resilience and enhancing bushland and habitat corridors
- › Mitigating urban heat: trees provide shade which reduces the ambient air temperature. It is estimated that every 10 per cent increase in tree canopy cover can reduce land surface temperatures by 1.13° Celsius.



Figure 5: The temperature difference between shaded and unshaded parts of streets (source: e2designlab.com.au)

A substantial and growing body of research has identified the following additional benefits derived from an increase in street tree canopy cover (refer Aecom 2017, Gallagher 2014, City of Melbourne 2012 and others):

- › Doubling the leaf canopy has the potential to reduce heat-related deaths by up to 28 percent
- › Reduction in air temperature: Streets with 28 percent canopy coverage were found to have an average temperature 4°C lower than streets with 20 percent canopy coverage
- › Reduction in surface temperature of concrete and asphalt by at least 14°C in the shade. In one street, the surface temperature of asphalt exposed to direct sunlight was 54.6°C, compared with 35.6°C in the shade of a tree – also refer Figure 5
- › Fewer cardio-metabolic health problems
- › Increase mental health and wellbeing
- › Increased pedestrian safety by slowing traffic and providing a buffer between vehicles and pedestrians
- › Removal of carbon from the air (carbon sequestration) at a rate of up to 2,241 tonnes of carbon per tree each year
- › Reduction in stormwater run-off, reducing stormwater alleviation costs
- › Reduced maintenance cost and increased life spans of buildings and pavements through shading: A study has shown that trees can protect asphalt pavements, halving the number of times maintenance workers must seal the pavement over a 30-year period
- › Reductions in the cost of using air-conditioners to cool buildings: Blacktown City Council estimated that by adjusting the number and type of street trees the average yearly household electricity bill might be reduced by \$249.

While there are a number of costs associated with the installation and management of urban trees, and in particular street trees, the research now concludes that, based on the above social, environmental, health and economic benefits, there is an overall net benefit to cities of increasing urban tree canopy cover.

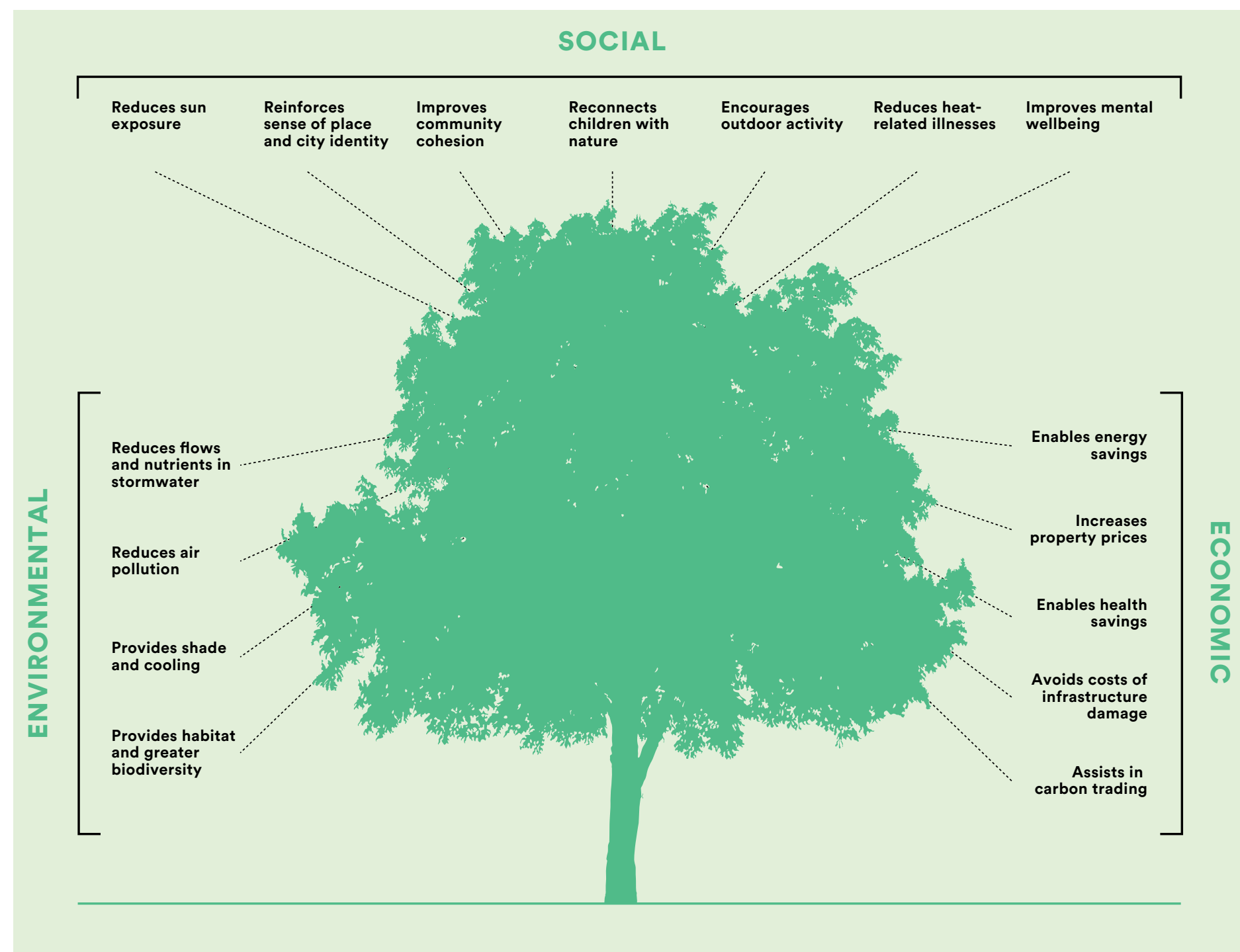


Figure 6: The multiple benefits of urban trees (source: Government Architect's Office 2018, p21)

3.1.2. Mitigating urban heat

The mitigation of urban heat is becoming an increasingly pressing concern for Australian cities. Increasing urban tree canopy cover has been identified as one of the most effective means to reduce city temperatures and counteract urban heat.

3.1.2.1. Heatwaves, urban heat islands and adapting to climate change

As established by *A Metropolis of Three Cities*, communities in Sydney are exposed to both heatwaves (more than three consecutive days of abnormally high temperatures) and extreme heat (days above 35° C). Parramatta is more exposed to extreme heat than coastal parts of Sydney – refer **Figure 7**. While the frequency of very hot days varies from year to year, the number of very hot days in Greater Parramatta has doubled since the late 1960s (GSC 2017) and is about four times higher than in the Sydney CBD – refer **Figure 8**.

Climate change is likely to increase exposure to extreme heat and heatwaves. Climate projections from the NSW and ACT *Regional Climate Modelling Project* suggest that very hot days will become increasingly common. The frequency of very hot days in inland locations may increase at more than double the rate of locations close to the coast (GSC 2017). Between 2010 and 2030, the number

	Western Parkland City	Central River City	Eastern Harbour City
Average annual rainfall	683 mm Badgerys Creek	973 mm Parramatta	1,215 mm Observatory Hill
Average annual days over 35°C	21 days Penrith	11 days Parramatta	3 days Observatory Hill
Tree canopy 2011*	16%	17%	32%

Figure 7: Climate variations across Greater Sydney (source: Greater Sydney Commission 2018)

of days above 40°C in Parramatta is projected to increase from 13 to 21, and rising to 49 by 2070 (Gallagher 2014).

In addition, the phenomenon known as the *urban heat island effect* can further increase localised exposure to heat, exacerbating the impact of heatwaves in cities (E2designlab 2017) – refer **Figure 9**. The term urban heat island (UHI) refers to the greater capacity of urban areas to absorb, hold and emit the sun’s heat, compared to rural areas. This absorption of energy can increase temperatures in cities by several degrees, particularly at night (E2designlab 2017, City of Melbourne 2012).

Factors contributing to UHI include the loss of vegetation, built form, large areas of dense impervious surfaces (roads, car parks, roofs, etc), waste heat generated by air conditioners and vehicle emissions, solar radiation from buildings, and the prevalence of heat-storing materials such as concrete, asphalt and bricks (National University of Singapore 2016, Gallagher 2014, City of Melbourne 2012 and others) – refer **Figure 10**.

Heatwaves and extreme heat have a significant impact on human health – refer **Figure 11**. Heatwaves and extreme heat:

- Are estimated to cause more deaths in Australia than any other natural hazard including bushfires, cyclones, earthquakes, floods and severe storms combined. The

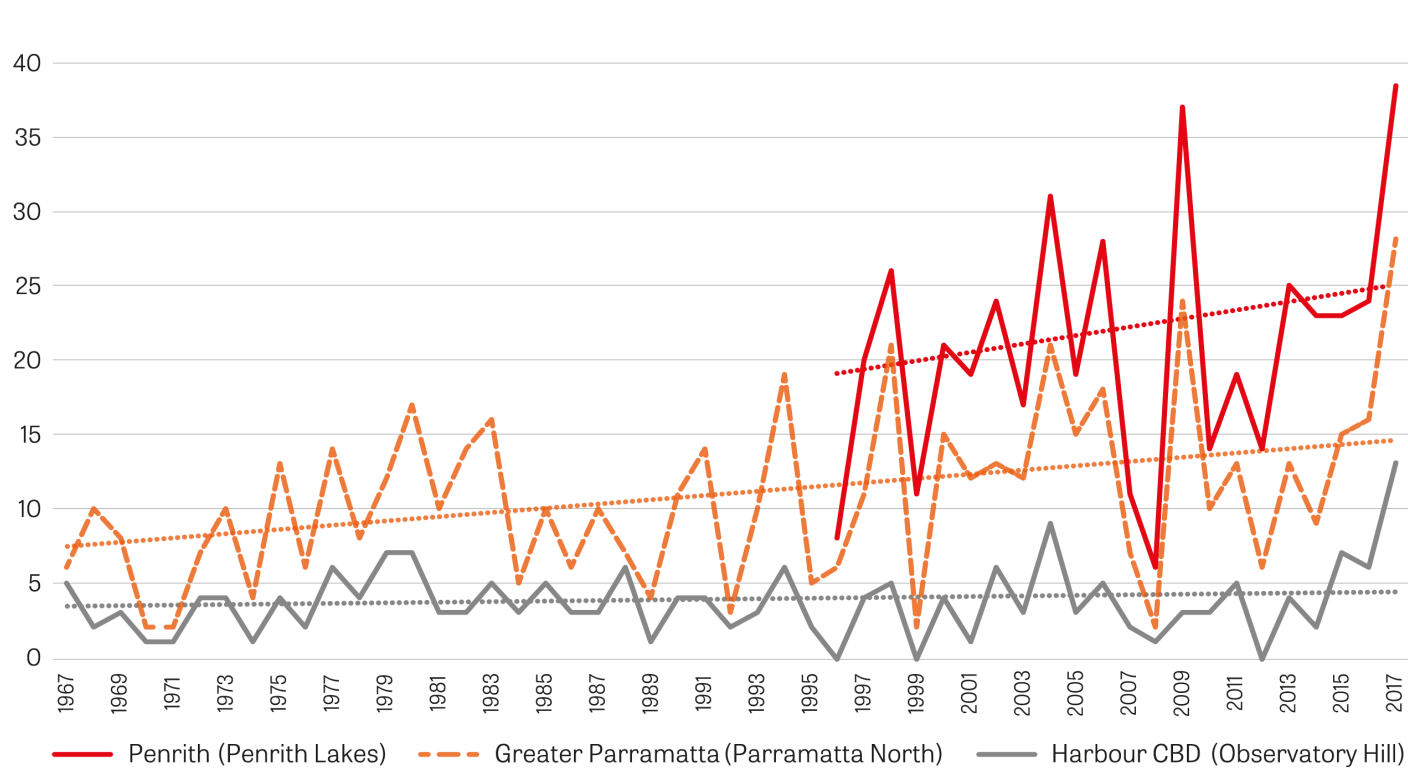


Figure 8: Number of days above 35°C in Harbour CBD, Greater Parramatta and Penrith (source: Greater Sydney Commission 2018)

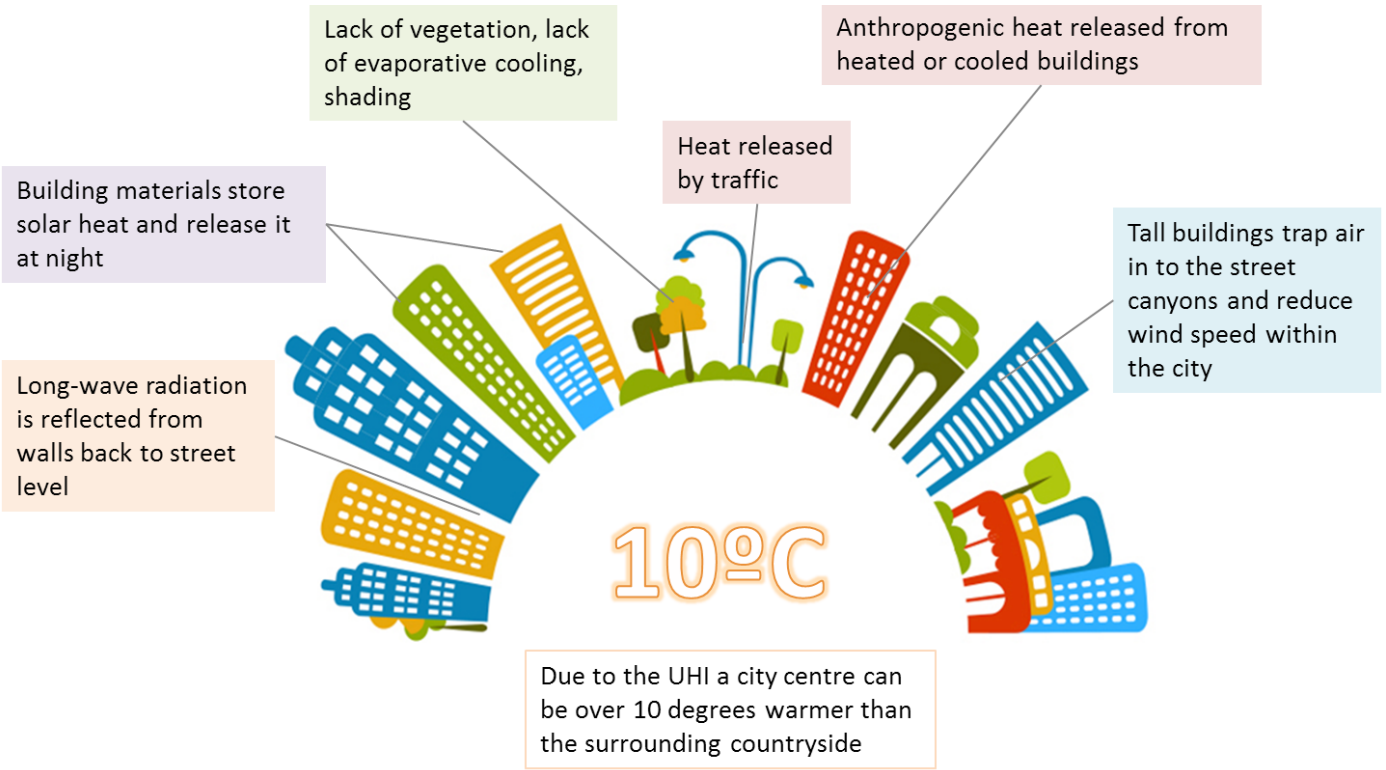


Figure 9: Factors contributing to the urban heat island effect (source: National University of Singapore 2016)

Commonwealth Government estimates that the number of heat-related deaths could potentially double by 2050, relative to 2011 figures)

- › Disproportionately affect vulnerable people including the elderly, people with health conditions (including mental health conditions) and young children
- › Lead to more illness including dehydration, heat cramps, heat exhaustion, heat stroke and worsening of existing medical conditions
- › Higher night-time temperatures affect the body's ability to recover from daytime extremes, with adverse effects on human health
- › Place pressure on communities, the health system and emergency services through increased presentation at hospitals, for both heat-related illnesses and pre-existing medical conditions
- › Reduce urban air quality through chemical reactions that lead to high ozone concentrations and smog
- › Increase the risk of bushfires, impacting on human health and safety
- › Place pressure on infrastructure, particularly on the electricity network during times of peak demand, driving up infrastructure costs and impacting on patients' capacity to access critical health treatments and medical supplies
- › Can lead to power shortages and black-outs, placing further stress on vulnerable people and communities
- › Increase demand for electricity for air-conditioning and other forms of cooling. This in turn contributes to increased greenhouse gas emissions, further exacerbating extreme heat linked to climate change.
- › Increased costs of living through higher energy demand to power air-conditioning units disproportionately affects people from lower socio-economic groups. This is of particular relevance in Greater Sydney where areas of highest socio-economic disadvantage are concentrated in suburbs most vulnerable to increased heat, including much of western Sydney
- › Can have indirect social impacts by discouraging people from walking and cycling and spending time outdoors, potentially contributing to isolation in economically disadvantaged people
- › Have a considerable economic impact: in the 2014-2015 financial year the cost to the Australian economy through work absenteeism alone was \$6.7B.

Adapting to climate change is therefore critical to Greater Sydney's future resilience. The 2015 *National Climate Resilience and Adaptation Strategy* outlines the risks of climate change to cities and the built

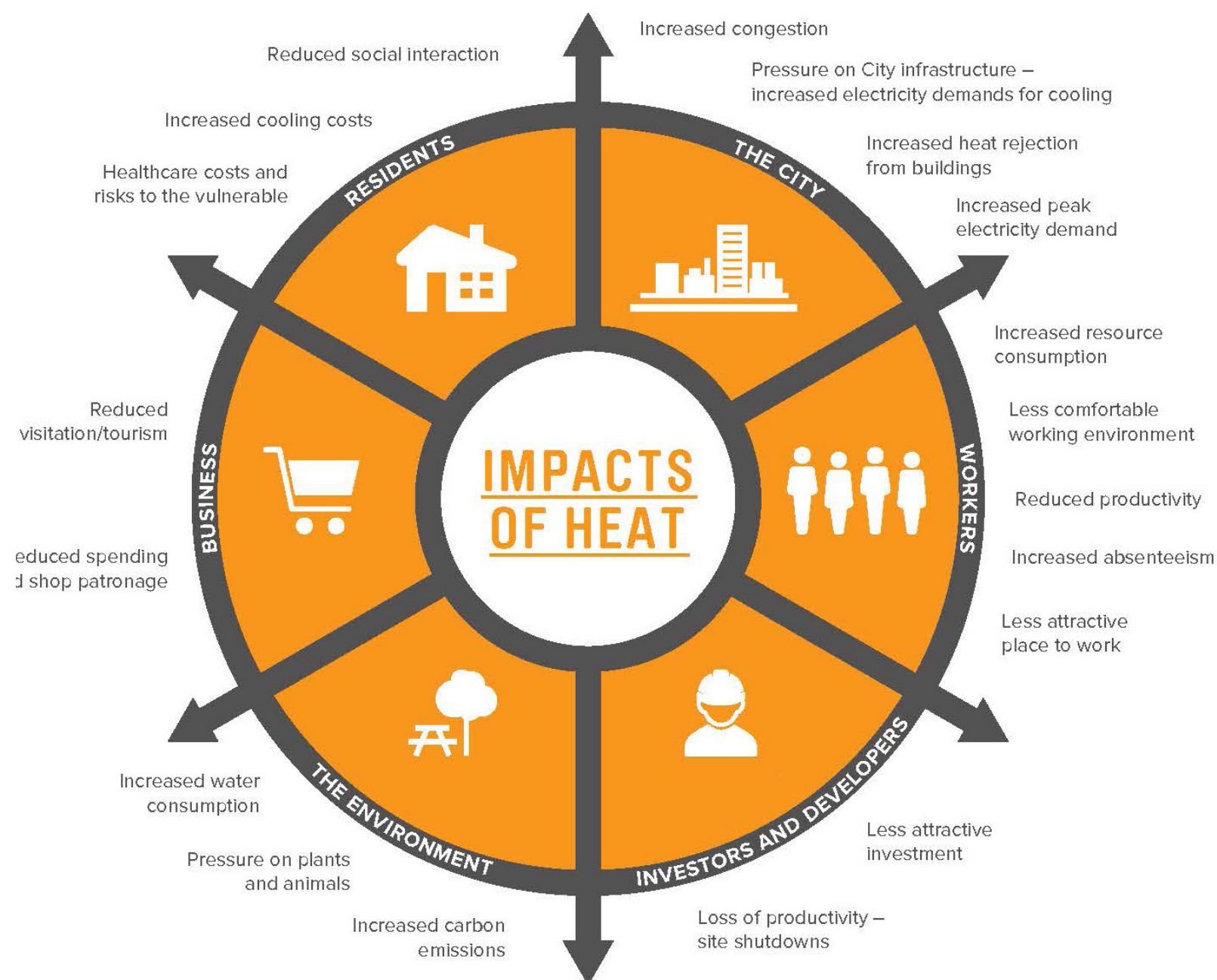


Figure 10: The impacts of heat (source: City of Parramatta 2017, p 40)

environment including greater risks of human injury, disease and death.

In response, "green infrastructure" – the network of green spaces, natural systems and semi-natural systems – is identified by the GSC as a fundamental tool to creating a high quality of life and to ensure that Greater Sydney is climate resilient and adaptable to future needs (GSC 2017). Urban tree canopy is an essential element of green infrastructure, in particular as a tool for climate adaptation and resilience – also refer to [section 3.2.2](#).

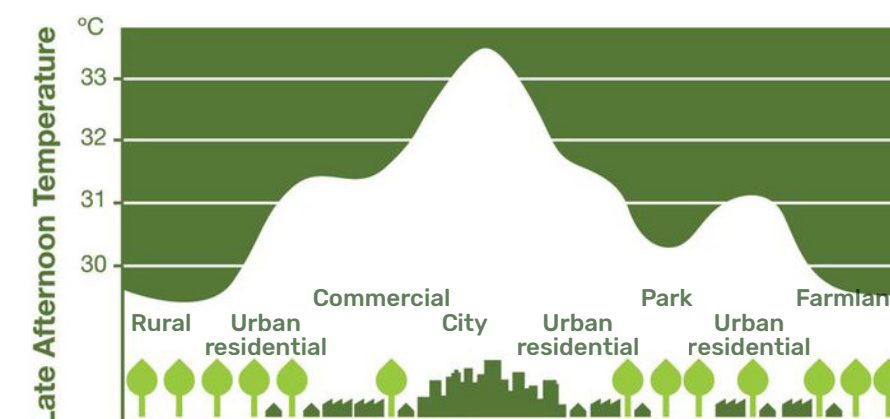


Figure 11: Late afternoon temperature variations in the city due to the urban heat island effect

3.2. Guiding documents

A number of documents were identified as having particular relevance in guiding the PLR – Stage 1 Tree Offset Strategy. Integration of the principles and objectives outlined in these documents is a key requirement of project approval. The documents are consistent with NSW government planning policy and integrate a wealth of the existing research on the benefits of urban tree canopy cover, as summarised in [section 3.1](#). The guiding documents are:

- › Sydney Green Grid West Central District
- › Greener Places
- › Parramatta Ways. Implementing Sydney's Green Grid

The following sections summarise the objectives and opportunities identified in these documents as they are of relevance to this Tree Offset Strategy.

3.2.1. Sydney Green Grid West Central District

3.2.1.1. Introduction to the Sydney Green Grid

The Greater Sydney Green Grid is a long-term vision for a network of high quality green areas that connect town centres, public transport and public spaces to green infrastructure and landscape features. Within the public realm it includes enhanced waterway corridors, transport routes, suburban streets, footpaths and cycleways (GSC 2017).



2.3.5.2. About this document

The *West Central District. Sydney Green Grid Spatial Framework and Project Opportunities* was prepared by TyrrellStudio for the Department of Planning and Environment (DP+E) and the Office of the Government Architect (OGA) in 2017.

The report builds on work carried out by OGA in the development of District Plans by DP+E. Based on the vision and objectives of the Greater Sydney Green Grid, it identifies an overview of the green infrastructure needs and character of the West Central District, which includes the local government areas (LGA) of Auburn, Blacktown, Cumberland City, Parramatta and The Hills Shire. Using existing hydrological, recreational and ecological data, the report identifies a series of Green grid project opportunities and preliminary priorities for implementation, developed in consultation with key stakeholders. The priorities are based on the overall objectives and principles of the Sydney Green grid, as well as projects' identified strategic potential of the projects to act as catalysts for the establishment of an interconnected high performance green infrastructure network that will support healthy urban growth.

Both Green Grid principles and objectives and project opportunities are outlined below. It is noted that since the publication of *West Central District. Sydney Green Grid Spatial Framework and Project Opportunities*, CoPC has undertaken additional design investigations to inform the implementation of the Greater Sydney Green Grid within Parramatta – refer [section 3.2.3](#). In the development of this Tree Offset Strategy, the more detailed work by CoPC is considered to take precedence over the higher level strategic planning.

2.3.5.3. Green Grid principles and objectives for the West Central District

The report outlines the following key principles and objectives for the Green Grid of relevance in relation to the PLR – Stage 1 project site and surrounding areas:

- › Increase access to open space:
 - Connect Westmead and Parramatta North urban renewal areas with the Parramatta River foreshore
 - Reinforce a linear park along the Parramatta River, linking Sydney Olympic Park and the world heritage listed Parramatta Park, creating a contiguous open space network focusing on key spaces along the Parramatta River Foreshore

- › Promote healthy and active living:
 - Provide links between the places people live and work and the places that people want to visit
 - Improve cycleway and footpath networks linking key open spaces and the Parramatta River
- › Create new high quality public realm:
 - Create high quality public domain and civic space at key locations associated with areas of urban renewal such as Parramatta, North Parramatta, Camellia, Castle Hill, Norwest and Rouse Hill.

2.3.5.4. Green Grid project opportunities in the West Central district

Within proximity to PLR – Stage 1, the following Green Grid project opportunities were identified:

- › Parramatta River Foreshore
- › Parramatta Light Rail
- › Carlingford Rail Line
- › Clay Cliff Creek and Jubilee Park
- › North Parramatta and Dundas Creeks

The Parramatta River Foreshore is the major priority project identified in proximity to PLR – Stage 1. It includes a number of focal areas or key opportunity sites (refer [Figure 12](#)) that may hold potential for synergies between Sydney Green Grid implementation and the delivery of offset tree planting under this strategy. These sites are further investigated for potential tree offset planting in [section 4.1](#). They are:

- › Lake Parramatta to North Parramatta link
- › Cumberland Hospital site, Westmead
- › Charles Street and Queens Wharf
- › Clay Cliff Creek and James Ruse Drive
- › Carlingford Rail Line, Subiaco Creek and Rydalmere Industrial Area
- › Subiaco Creek and Camellia Waterfront.

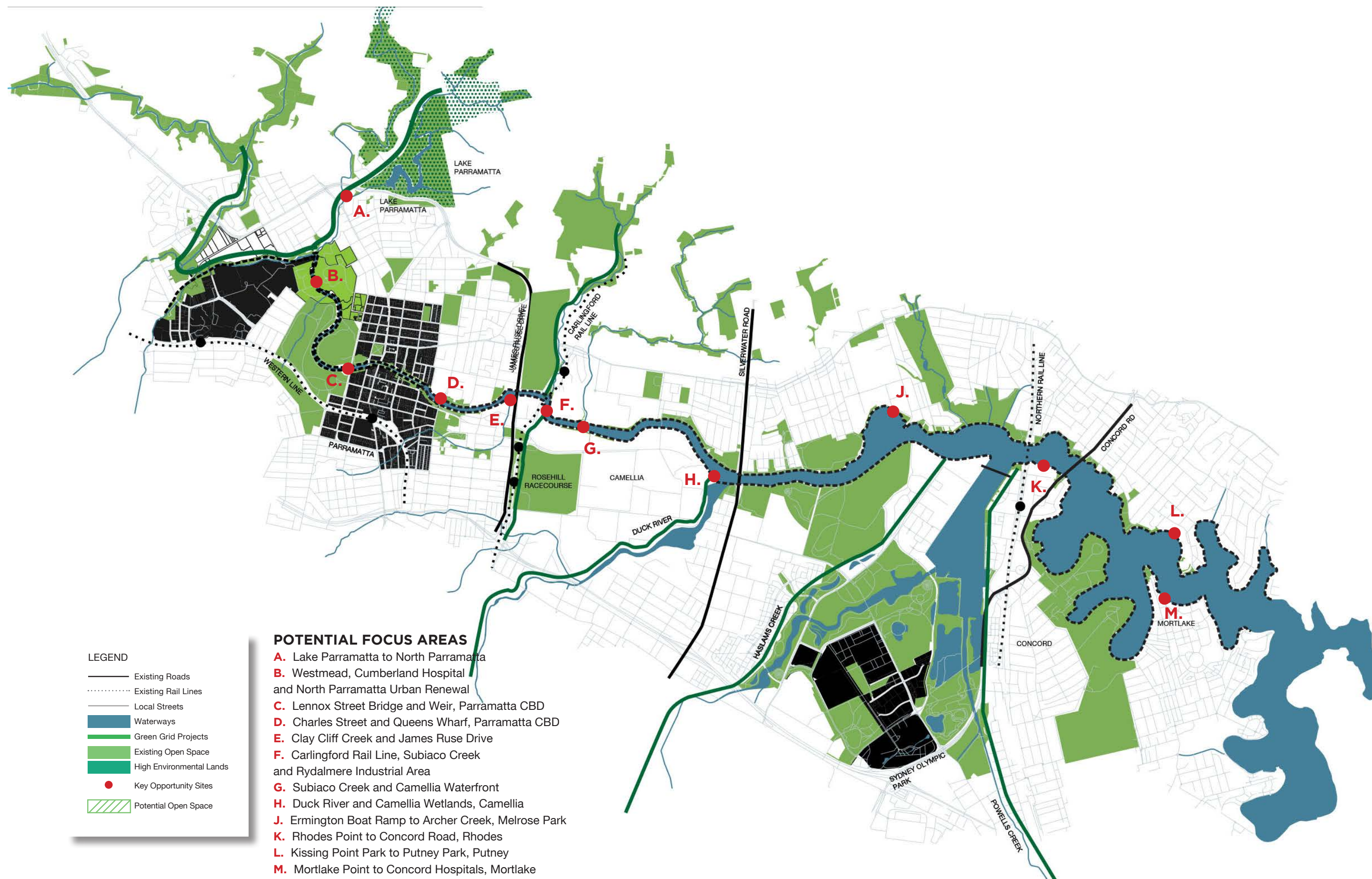


Figure 12: Parramatta River Foreshore Potential Focus Areas (source: TyrrellStudio 2017, p 59)

3.2.2. Greener Places



3.2.2.1. About this document

Greener Places: Establishing an urban green infrastructure policy for New South Wales was prepared by OGA in 2017. It constitutes the NSW Government’s draft green infrastructure policy with the purpose of guiding the planning, design and delivery of green infrastructure.

The draft policy defines green infrastructure as

The network of green spaces, natural systems and semi-natural systems including parks, rivers, bushland and private gardens that are strategically planned, designed, and managed to support good quality of life in the urban environment (p 11).

Due to the multiple benefits derived from green infrastructure, it is regarded as equally crucial to cities as types of infrastructure which it complements including transport, cultural and communications infrastructure.

The aim of *Greener Places* is to create healthier and more liveable cities and towns by improving community access to recreation and exercise, supporting walking and cycling connections, and improving the resilience of our urban areas.

The key to better management of landscape values in cities lies in understanding how Green Infrastructure strategies can enhance the places and spaces of NSW. ‘Greener Places’ makes a case for the importance of green space, how integration is essential and how greener thinking can make our cities healthier and more successful places.

3.2.2.2. Green infrastructure principles

Well-designed green infrastructure responds to four key principles that together define an approach that promotes nature as a driver of quality high performing design. For each principle there are a series of corresponding design actions. **Table 5** summarises the principles and the design actions that have the potential to be implemented within the scope of the PLR – Stage 1 Tree Offset Strategy.



PRINCIPLE 1.
Integration
combine green infrastructure with urban development and grey infrastructure



PRINCIPLE 2.
Connectivity
create an interconnected network of open space



PRINCIPLE 3.
Multifunctionality
deliver multiple ecosystem services simultaneously

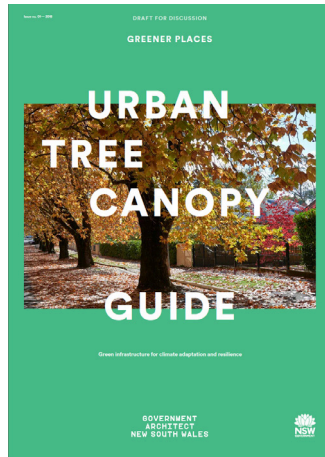


PRINCIPLE 4.
Participation
involve stakeholders in development and implementation

Table 5: Green infrastructure principles and design action

#	Principle	Design actions of relevance to PLR
1	Integration The integration of green space with urban development and ‘grey’ infrastructure to achieve multi-purpose infrastructure that provides ecosystem services and promotes healthy and active living.	Balance recreational and functional requirements of parks with greening objectives to increase canopy cover.
2	Connectivity Create a high quality green network linking open spaces, town centres, public transport hubs, rivers, creeks and employment and residential areas, benefiting people and wildlife.	Investigate and enhance physical and functional connections between different green spaces to create an interlinked system Design networks that serve humans and wildlife. Link physical sites that support ecological and social connectivity. Enhance connections to recreational trails, particularly in and around high-density precincts. Increase planting along stormwater, gas and power easements, main roads and rail corridors. Enhance streets by planting alongside all available footpath locations.
3	Multifunctionality Deliver multiple ecosystem, environmental, social and economic services simultaneously.	Understand and support the development of multifunctional landscapes that offer ecological, socio-cultural and economic benefits. Design spaces that foster interaction and stewardship, community identity, sense of connectedness and community capacity.
4	Participation Involve stakeholders in the development and implementation of Green Infrastructure policies and actions.	Enable as many different government and community groups as possible to contribute in design and planning processes for Green Infrastructure projects. Discover and balance the interest of many different stakeholders to maximise benefits.

3.2.2.3. Urban tree canopy guide



The *Greener Places urban tree canopy guide*. *Green infrastructure for climate adaptation and resilience* was published by OGA in 2018, as a supporting manual or “toolkit” to *Greener Places*. The *Urban tree canopy guide* provides information on the capacity of urban tree canopy to improve urban climate, ecosystem and human health, and to enhance communities. It includes strategies and advice to local councils, State agencies and other stakeholders to provide a consistent approach for protecting,

maintaining and enhancing existing urban tree canopy, as well as for the development of interconnected urban tree canopy across NSW.

The aim of the guide is to provide a framework for new governance arrangements, collaborations and the identification of roles and responsibilities required to facilitate and implement *Greener Places* and realise a target of 40% canopy cover across NSW, up from about 17% in 2018.

The Urban tree canopy outlines a number of actions for State and local government. Some of these are of relevance to the PLR – Stage 1 Tree Offset Package as they include guidance in respect of selecting tree species, locating tree planting and engaging with communities and stakeholders, as follows:

Guidelines for selecting trees:

- ▶ Tree canopy comprising medium and large trees will provide the most effective shade and urban heat benefits
- ▶ Select a diverse range of species of varying families and genera can improve urban tree canopy resilience and enhance habitat, and reduce susceptibility to pests and diseases.

Guidelines for locating trees:

- ▶ Identify areas of deficiency
- ▶ Plan for tree canopy in areas with potential for substantial change such as urban renewal areas
- ▶ Maximise tree canopy cover in priority zones including areas with low canopy cover and high levels of urban heat
- ▶ Connect the network of green corridors and active transport

- ▶ Respond to variations in neighbourhood conditions and development context, i.e.
 - >15% canopy cover in the CBD
 - >25% canopy cover in medium to high density areas
 - >40% in suburban areas/low density neighbourhoods

Guidelines for working with community/stakeholders:

- ▶ Implement coordinated community engagement to improve awareness of benefits of urban tree planting
- ▶ Provide opportunities for community involvement through local tree funding, planting and management initiatives.

3.2.3. Parramatta Ways

The draft *Parramatta Ways. Implementing Sydney’s Green Grid* was published by CoPC in April 2017. Building on earlier planning work by DP+E and OGA, Parramatta Ways is a local strategy seeking to deliver the Sydney Green Grid within the Parramatta LGA. It supports planning for the Parramatta LGA by identifying opportunities and priorities for Green Grid connections, thereby assisting to deliver the infrastructure required to support future growth, and encourage



greater street life.

The overarching aim of *Parramatta Ways* is to improve walkability in Parramatta to better connect communities with their local area. Walkability defined as the “measure of how pleasant and attractive an area is to walk. Internationally, it is recognised as one of the key aspects that make a city liveable.”

Street trees are identified as the infrastructure element with the greatest potential to support increased walking by enhancing comfort and amenity. As a result *Parramatta Ways* is also a strategy for increasing urban greening and local centre amenity, by improving the quality of streetscapes, open spaces and waterways to make Parramatta more attractive for walking.

Informed by the underlying landscape structure *Parramatta Ways* identifies three priorities for Green Grid connections in Parramatta that integrate the natural terrain with existing local centres and patterns of use: major, intermediate and local routes – refer **Figure 13**. These routes have been integrated into the priority locations for offset tree planting – refer **section 4.1** and **section 5.1**.

The strategy recognises the city shaping potential of urban renewal and infrastructure projects planned or underway in the Parramatta LGA. They include PLR and the particular potential it holds for shifting car dependency through an alternative transport option and more pedestrian-oriented and lively streets. *Parramatta Ways* therefore recognises the potential for PLR to affect existing patterns of use, and to create new opportunities and priorities for walking connections and urban greening.

3.2.4. Active Transport

Active transport refers to human powered forms of transport involving physical activity, namely walking and cycling. It is an increasingly popular transport option for shorter trips. Similarly to walking, cycling amenity and comfort is heavily influenced by environmental factors including temperature. Exposure to extreme weather (including heat and rain) act as major deterrents even where dedicated cycling infrastructure exists. In order to improve the attractiveness of cycling as a mode of transport, the identification of potential offset planting locations has therefore considered Parramatta Council’s existing and planned cycle network. The cycle network is shown on **Figure 41** in Appendix 1.

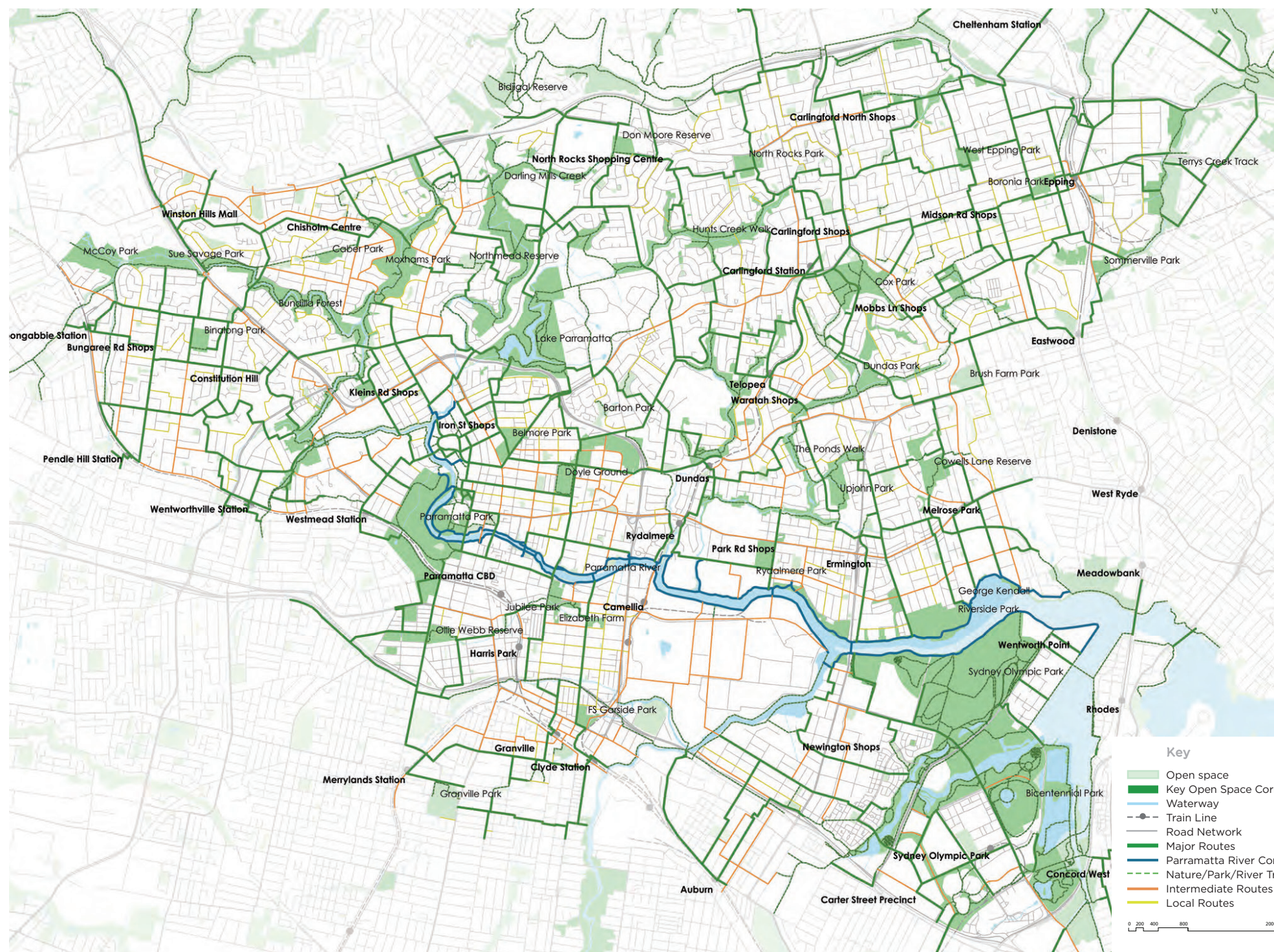


Figure 13: Parramatta Ways major, intermediate and local routes (source: City of Parramatta 2017, p 38)

3.3. Other relevant documents

In addition to the mandated documents in section 3.2, there are a number of existing documents that are of relevance to the development of this Tree Offset Strategy. They are

- Transport for NSW documents:
 - Parramatta Light Rail – Stage 1 Urban Design Requirements
 - Vegetation Offset Guide
 - Biodiversity Assessment Report. Parramatta Light Rail
- City of Parramatta Council documents:
 - *Life in our City* – Parramatta’s Biodiversity Strategy
 - Parramatta Environmental Sustainability Strategy
 - *Benchmarking Heat in Parramatta*
 - Parramatta Light Rail. Selected pedestrian network audit

These documents are summarised in the following sections.

3.3.1. Parramatta Light Rail - Urban Design Requirements Report (UDRR)

The Parramatta Light Rail - Urban Design Requirements Report (UDRR) was developed on behalf of Transport for NSW to satisfy the requirements of Conditions of Approval E87 and E88. The UDRR was developed in consultation with the PLR Design Review Panel (DRP) between December 2019 and April 2020; and approved by the Department of Planning Industry and Environment on 8 July 2020.

The UDRR identifies the key requirements underpinning the detailed design for public domain, architecture, landscape architecture, identity and place making with a specific focus on stop access and design. The UDRR must inform the detailed design to:

Also known as the “Blue Book”, the report outlines a set of place-specific design requirements that were developed in consultation with key stakeholders and that:

- Demonstrate responsiveness to local streetscape and landscape character; b) integrate with, or allow for, known land use changes, masterplans and developments;
- Contribute to the character and identity of the local area
- Respond to the character, setting and fabric of heritage elements and landscapes;
- Demonstrate material selection and detailing (including consideration of anti-graffiti measures);
- Achieve a safe, secure, functional and efficient transport network for all street users;

- › Maintain community amenity and privacy;
- › Maintain local access and circulation for residents, business and road users;
- › Address sensitive receivers to minimise noise, vibration, electromagnetic interference, light spill and nuisance;
- › Minimise the loss of existing trees, maximise urban tree canopy, including street trees and soft landscaping;
- › Address flooding and drainage issues;
- › Contribute to the activation of precincts;
- › Maximise local connectivity and minimise barriers;
- › Maximise walk-in catchments and offer legible, direct pedestrian connections;
- › Demonstrate clear wayfinding;
- › Maximise user safety, crime prevention and comfort; and
- › Consider the Camellia Town Centre Masterplan and the Telopea Masterplan, and Westmead Alliance master planning.
- › As part of the UDRR it recommends tree species to be used for replacement planting in each of the precincts. The aim of this is to focus on creating a consistent and continuous ecosystem. The UDRR is used to inform the detailed design development of the Parramatta Light Rail, in conjunction with the Tree Offset Strategy.
- › The UDRR incorporates the requirements of the Parramatta Light Rail – Stage 1 Urban Design Requirements “Blue Book” which identifies the overarching objectives, principles and many of the design requirements for the project

3.3.2. Parramatta Light Rail – Urban Design Requirements Report ‘BLUE BOOK’

The Parramatta Light Rail – Stage 1 Urban Design Requirements report was prepared for TfNSW in 2018. It establishes the urban design framework for the project, setting the principles, objectives and design responses to achieve design excellence.

Also known as the “Blue Book”, the report outlines a set of place-specific design requirements that were developed in consultation with key stakeholders and that:

- › Guide the detailed design development and refinement for the project
- › Seek to balance the engineering, transport and other project constraints with the creation of positive place making outcomes

- › Constitute the minimum standard that must be achieved by the project, while maintaining opportunities to further improve urban design outcomes through the detailed design work and ongoing stakeholder consultation.

While the *Parramatta Light Rail – Stage 1 Urban Design Requirements* is generally focused on the project corridor, a number of components have influenced the preparation of this Tree Offset Strategy, namely:

- › **Precinct design plans:**
The report identifies, for each precinct, important public domain connections and interfaces to surrounding areas, including opportunities to strengthen integration between the project and surrounding areas. They include the Parramatta Ways priority green linkages and other active transport and pedestrian connections around each light rail stop
- › **Requirements for tree offsets:**
The report requires all trees removed as part of the project to be offset in accordance with TfNSW’s *Vegetation Offset Guide* – refer [section 3.3.2](#)
- › **Tree planting requirements:**
The report identifies a series of tree planting principles and design criteria that provide a suitable starting point for the selection of species to be used for offset planting – refer [section 3.3.1.1](#) and [section 4.2.1](#)
- › **Design principles for heritage items:**
The report outlines design principles for work around heritage items. Some of these are of relevance when location tree offset plantings. Relevant principles are summarised in [section 3.3.1.2](#)



3.3.2.1. Tree planting principles and design criteria

Relevant design for locating tree planting include:

- › Create shaded streets and open spaces along the light rail route by increasing urban tree canopy, reducing heat island effect, fostering a pleasant microclimate, and improving the amenity of the streets
- › Assist in meeting the City of Parramatta Council’s 40% canopy target
- › Tree density and siting will balance shading with solar access
- › Provide medium and large size trees wherever possible in streets, parks and urban spaces.

Relevant design principles for selecting tree species include:

- › Align tree planting and vegetation selection with desired character of each precinct and the project’s environmental objectives
- › Plantings will seek to provide and enrich urban habitat
- › Ensure resilience of the urban forest by providing a diversity of tree species.
- › Species selection will consider form, scale, mature height, colour, and texture
- › Species selection will consider growth rate, longevity in the local climate and soil and drainage context.

3.3.2.2. Design principles for heritage items

Design principles for heritage items of relevance to this strategy include:

- › Maintain significant views and vistas to and from items and places of significance
- › Consider landscape and public domain design as an important mechanism for interpreting cultural landscapes along the light rail corridor and strengthening these settings through the delivery of sensitive cultural planting
- › Seamlessly integrate into the public domain of heritage precincts and places through sensitive design approach which responds to place and minimises visual clutter
- › Respond to the prevailing geometry of built form and public domain elements
- › Review and respond to conservation management plans for precincts and buildings along the light rail corridor

- › Interpret the overall form of the site by responding to both the specific place needs and its broader precinct context.

Further information on heritage conservation areas is provided in [section 4.2.2.4](#).

3.3.3. TfNSW Vegetation Offset Guide

3.3.3.1. About this document

The TfNSW *Vegetation Offset Guide* provides a framework for a consistent approach to offset vegetation impacts on applicable TfNSW projects, where statutory offsets do not apply. The aim of the guide is to:

- › Assist in delivering ‘maintained or improved’ ecological outcomes in relation to the potential impacts associated with a project
- › Assist in choosing an offset site or option
- › Provide a robust framework for calculating native vegetation and tree offsetting requirements early in the environmental assessment of the project.

3.3.3.2. Principles of offsetting

The guide provides the following principles for offsetting removed vegetation, where avoidance or mitigation was not possible:

- › Native vegetation:
 - Offset 100% of any native vegetation cleared
 - Achieve an improved or maintained ecological outcome
- › Offset the heritage, public amenity and/or visual landscape values of any trees removed where they may not have ecological value.

3.3.3.3. Offsetting pathways

The guide identifies three offsetting pathways in relation to removed vegetation:

- › Statutory offsets are triggered by the identification of an impact on native vegetation through the environmental assessment process. PLR – Stage 1 impacts on native vegetation are identified in the *Biodiversity Assessment Report (BAR)* – refer [section 3.3.3](#). The BAR also identifies the statutory offset requirements. These requirements will be addressed through the project’s Biodiversity Offset Strategy, as required by the project approval conditions. However, there are opportunities for this Tree Offset Strategy to assist and further enhance biodiversity outcomes.

- › Primary offsets are used to offset impacts on native vegetation that is not listed as a threatened ecological community. They constitute a direct offset that reserves land for conservation by placing a covenant on the land or transferring the land to a local, state or commonwealth reserve system.
- › Secondary offsets predominantly include planting/rehabilitation/landscaping on site or in an area nearby, but may also include, weeding, civil works, research and education. They are employed under three circumstances:
 - Removed vegetation has little ecological value but has heritage or visual amenity, community or intrinsic value regardless of whether the vegetation is native
 - The primary offset site only partly fulfils the calculated area required: a secondary offset can be adopted to supplement the primary offset
 - Native vegetation is removed and there is no ‘reasonable or feasible’ primary offset site available or the primary offset does not meet the area required to offset the vegetation removed.

Tree offset planting delivered under this Tree Offset Strategy is considered a secondary offset in accordance with the *Guide*.

3.3.3.4. Locating tree planting for secondary offsets

The first preference for planted secondary offsets is on-site landscaping. The following guidelines apply for locating tree planting where planting on site is not possible:

1. Identify alternative offset locations in consultation with Council and/or other relevant stakeholders
2. Considering the amenity value of the trees (heritage or visual), plant the offset number in an area where the respective heritage or visual amenity can be planted ‘like for like’ or improved
3. Plant trees in a public space within close proximity of the tree removal site
4. Plant trees in a public space within the same LGA as the site
5. Coordinate with Council to implement a program of rehabilitation to a natural environment within the LGA. This should be targeted at a site which is in a more natural state such as a forested reserve or a waterway. For example, landscaping of a sports field would not be considered rehabilitation.

3.3.3.5. Selecting tree species for secondary offsets

The following principles guide the selection of offset tree species:

- › The preference, wherever possible, is to use locally native species
- › Trees identified as noxious weeds (as listed in Council schedules under the NSW *Noxious Weeds Act 1993*) or environmental weed species should not be planted under any circumstances
- › Tree species that pose potential health risks should be avoided including species with toxic components or common allergens
- › Offsetting with exotic trees may be appropriate where the landscape is characterised by exotic tree planting, for example in the curtilage of listed heritage items.

3.3.4. Biodiversity Assessment Report Parramatta Light Rail

3.3.4.1. About this document

The *Biodiversity Assessment Report. Parramatta Light Rail (BAR)* was prepared for TfNSW in 2017. It investigates terrestrial and aquatic flora and fauna and their habitats within the project area and identifies the potential biodiversity impacts that would occur as a result of the construction and operation of the project. It also summarises the proposed mitigation measures.

3.3.4.2. Biodiversity of the project area

Biodiversity identified in the project area comprised:

- › No threatened flora species
- › One threatened fauna species: the Grey-Headed Flying Fox
- › The protected habitat Estuarine Mangrove Forest along the lower Parramatta River
- › A number of disturbed and fragmented remnant patches of native vegetation within the study area including four threatened ecological communities:
 - Swamp Sclerophyll Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions – found at Rydalmere
 - Sydney Turpentine-Ironbark Forest – found at Telopea
 - River-flat eucalypt forest on coastal floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions – found at North Parramatta.

3.3.4.3. Project biodiversity impacts

The BAR found that the key biodiversity impact of the project will be the loss of habitat and the clearing of 0.62 hectares of vegetation including four threatened ecological communities associated with a number of isolated and disturbed fragments of native vegetation within the study area.

In addition the project will result in a reduction in vegetation patch sizes resulting in

- › Minor increases in localised fragmentation of the regional wildlife corridor along the Parramatta River
- › Further reduction in already small fragmented patches in other areas.

3.3.4.4. Potential for tree offset planting to contribute to impact mitigation

The BAR identifies a series of measures to mitigate fragmentation and reduced habitat connectivity. Based on these, there are opportunities for this Tree Offset Strategy to support and further the biodiversity outcomes of the project. They include:

- › Establishing native vegetation to offset project impacts on habitat connectivity, through offset trees in open space areas and/or new street trees linking habitat areas
- › Establishing native vegetation around bushland remnants to maximise the size of fragmented patches of threatened ecological communities and reduce edge effects
- › Planting of winter-flowering trees to provide a winter food source for migratory and nomadic nectar-feeding birds and the Grey-headed Flying-fox
- › Strengthening links to the proposed Biobank Agreement Site in the adjoining Hills Shire Council through offset trees in open space areas and/or new street trees.



The BAR notes:

Offsets are likely to be of greater biodiversity value where they are located adjacent to remnant vegetation creating a larger remnant or where they provide linkages within an otherwise fragmented landscape. Compensatory habitat should act to consolidate existing corridors or, occur adjacent to existing area of native vegetation in order to maintain or increase their habitat quality and long-term viability (Appendix F, p 8).

3.3.5. Life in our City. Parramatta Biodiversity Strategy 2015-2015

3.3.5.1. About this document

Life in Our City is CoPC's Biodiversity Strategy for the period 2015 – 2025. It constitutes a framework to guide the conservation and enhancement of biodiversity in the Parramatta LGA. It is a tool to ensure that biodiversity is conserved while also considering social, health and economic issues and the increasing demands on land use within the LGA.

3.3.5.2. Key biodiversity targets

Most of Parramatta's biodiversity is contained within Council owned and managed land and the Strategy uses a strategic approach to managing natural assets. Key biodiversity targets identified in the Strategy are to increase:

- › Total vegetation cover by 1% across the LGA
- › Protection of the most significant vegetation to 75%.

The Strategy identifies a range of methods for conserving biodiversity. Of these, the following are relevant to this Tree Offset Strategy, as they highlight opportunities for offset tree planting to enhance biodiversity outcomes:

- › Expanding patch size of remnant vegetation
- › Reducing edge effects through the design of buffer zones adjacent to core habitat.

3.3.5.3. Potential for tree offset planting to contribute to enhanced biodiversity

Within proximity to PLR, the areas with greatest scope for enhancing biodiversity through offset tree planting are around the existing Carlingford Line and along the Parramatta River including open space and bushland areas in

- › Existing fauna hot-spots around Vineyard Creek and Galarangi and Cox Parks

- › Primary biodiversity corridors along Vineyard Creek, Subiaco Creek and The Ponds Creek
- › Primary biodiversity corridors along the Parramatta River Foreshore and Toongabbie Creek

The strategy notes the generally limited biodiversity value of street trees: "Street trees represent low biodiversity because a narrow linear corridor of street trees does not provide structural diversity (ground or mid layers for animals to hide and different plants to grow and may even encourage pest species of birds that chase other birds away" (p 28).

3.3.5.4. Native vegetation communities and species

The Strategy also identifies the native vegetation communities of Parramatta and the respective vegetation species that make up these communities. This Tree Offset Strategy has drawn on this information in the identification of suitable offset planting tree species.

3.3.6. City of Parramatta Environmental Sustainability Strategy 2017

The City of Parramatta Environmental Sustainability Strategy 2017. A great City grows better every day. Our plan to create a nature inspired, efficient and resilient City (the Strategy) seeks to ensure that to ensure that Parramatta grows economically, while also creating vibrant, smart, resilient neighbourhoods, and great places to play. It is built around four themes and associated actions. **Table 6** summarises key actions for each theme to which this Tree Offset Strategy can contribute.

Table 6: Parramatta sustainability themes and actions

Theme	Actions of relevance to this Strategy
A City in Nature:	➤ Continue to deliver the Council’s biodiversity strategy Life in our City
➤ Protect and enhance the health of our unique natural ecosystem	➤ Continue working with our neighbouring Councils to build connected habitat corridors
	➤ Continue managing the interface between conservation areas and other land uses
➤ Increase canopy cover in the urban forest to 40%	➤ Prioritise street tree planting along cycleways and the Parramatta Ways walking network
	➤ Plant more diverse street tree species to withstand pests, disease and the changing climate
	➤ Continue to plant tube stock in Council reserves.
Built for the Future:	➤ Energy Efficiency and thermal performance opportunities for existing buildings: offset tree planting can contribute to cooling and reduced energy use – refer section 3.1
➤ 60% emissions reduction by 2038	➤ Select tree species suited to the climate and urban landscape of Parramatta to ensure that offset trees, once mature, do not lead to an increase in potable water use.
➤ No net increase in potable water consumption by 2038	
Connected and resilient Communities:	➤ Encourage a greater share of trips undertaken by active transport through implementation of Parramatta Ways and the Epping to Carlingford cycleway connection: offset planting can support these connections by providing the respective shade and cooling
➤ 10% of trips made by walking and cycling in 2038	➤ Ensure that active transport connects to light rail stops and that high quality amenity is provided for user comfort: offset tree planting can support this goal
➤ Improve liveability by cooling the city and protecting people and communities from heat stress	➤ Enhance existing bushland, parks and green spaces
	➤ Continue to deliver the Cool Parramatta initiative.
Leading by Example:	➤ Offset tree planting has the potential to contribute to this goal through increased carbon sequestration as trees grow and mature
➤ Carbon neutral by 2022	➤ Continue to improve the water efficiency of parks through improvements to soil structure, irrigation systems, and management practices. Offset tree planting is to be carried out in accordance with Council’s preferred planting and tree pit details.
➤ No net increase in potable water consumption by 2038	

3.3.7. Parramatta Light Rail - Selected pedestrian network audit

The *Parramatta Light Rail. Selected pedestrian network audit* was commissioned by CoPC to help Council understand the condition, connectivity and extent of the pedestrian network that will support the walking catchment of PLR – Stage 1. This is in recognition of the potential for opportunities to improve the pedestrian network to support access to light rail stops, and the need to quantify what is involved with this task.

The particular relevance of the audit to this Tree Offset Strategy lies in the identification of the ‘selected pedestrian network’. The selected pedestrian network is the primary network that will support pedestrian access to the light rail stops. It consists of about 57 kilometres of road that are likely to have the highest pedestrian activity within walking catchments of the light rail stops. It was identified through a series of destination assessments relative to the PLR – Stage 1 corridor that captured route analysis, population density and points of interest and community infrastructure such as schools, centres and open spaces.

3.3.7.1. Priority routes for maximising customer confort

Based on a range of factors, the audit differentiated the selected pedestrian network into high priority routes and general priority routes – refer [Figure 14](#).

Based on the identified need to mitigate urban heat (refer [section 3.1.1](#)), and stated project benefit to deliver place making benefits such as improved customer amenity and comfort (refer [section 2.1.4](#)), the selected pedestrian network highlights priority areas for street tree planting under this Offset Strategy.

3.3.7.2. Available space for tree planting

The audit analysed the widths of verges within the selected pedestrian network, providing information on the overall verge width, as well as the width of footpaths and nature strips within the verges – refer [Figure 15](#). Using this data, general assumptions can be made about the potential of verges and/or nature strips to accommodate tree planting, based on the availability of space. This is further discussed in [section 4.2.2.2](#).

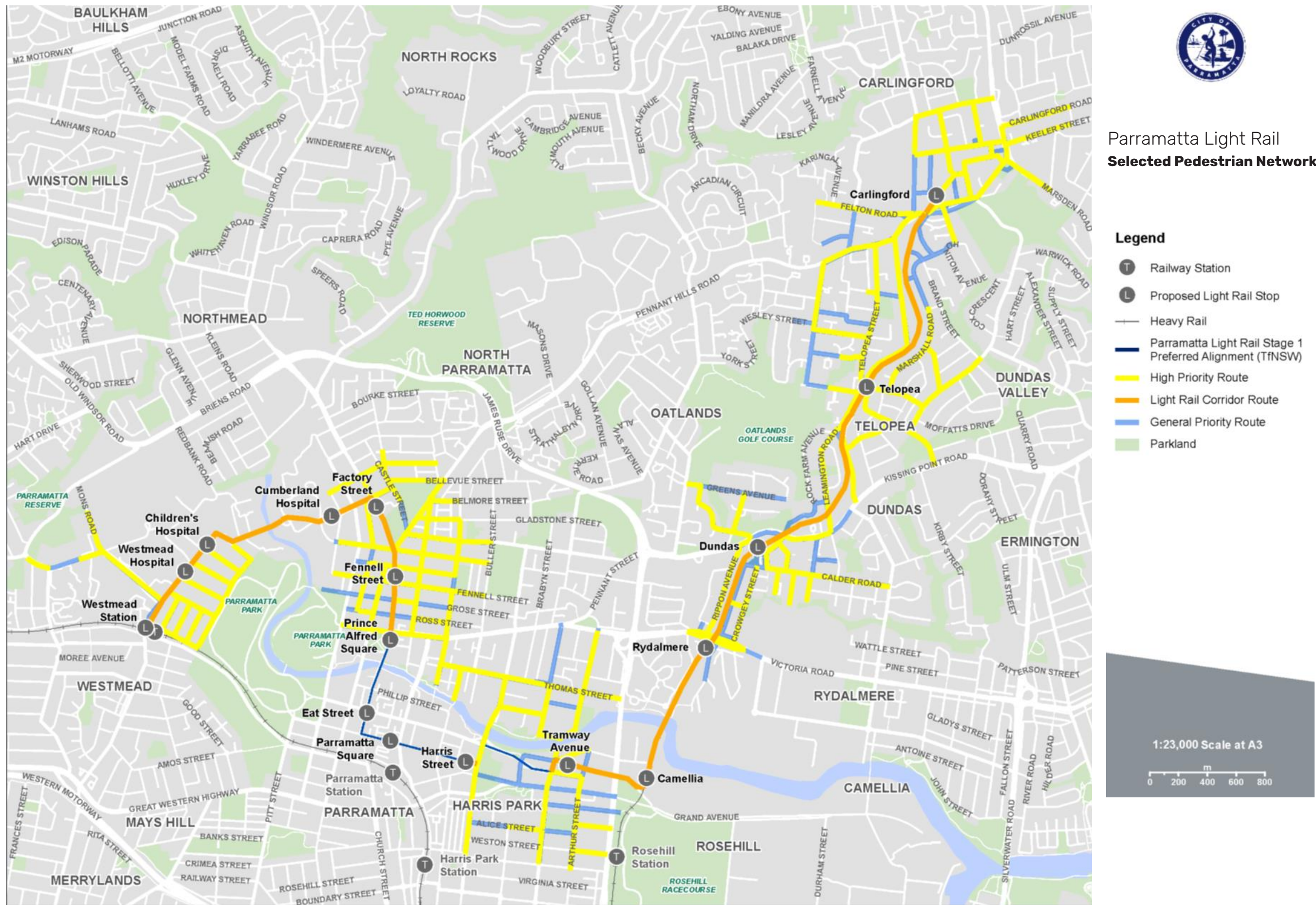
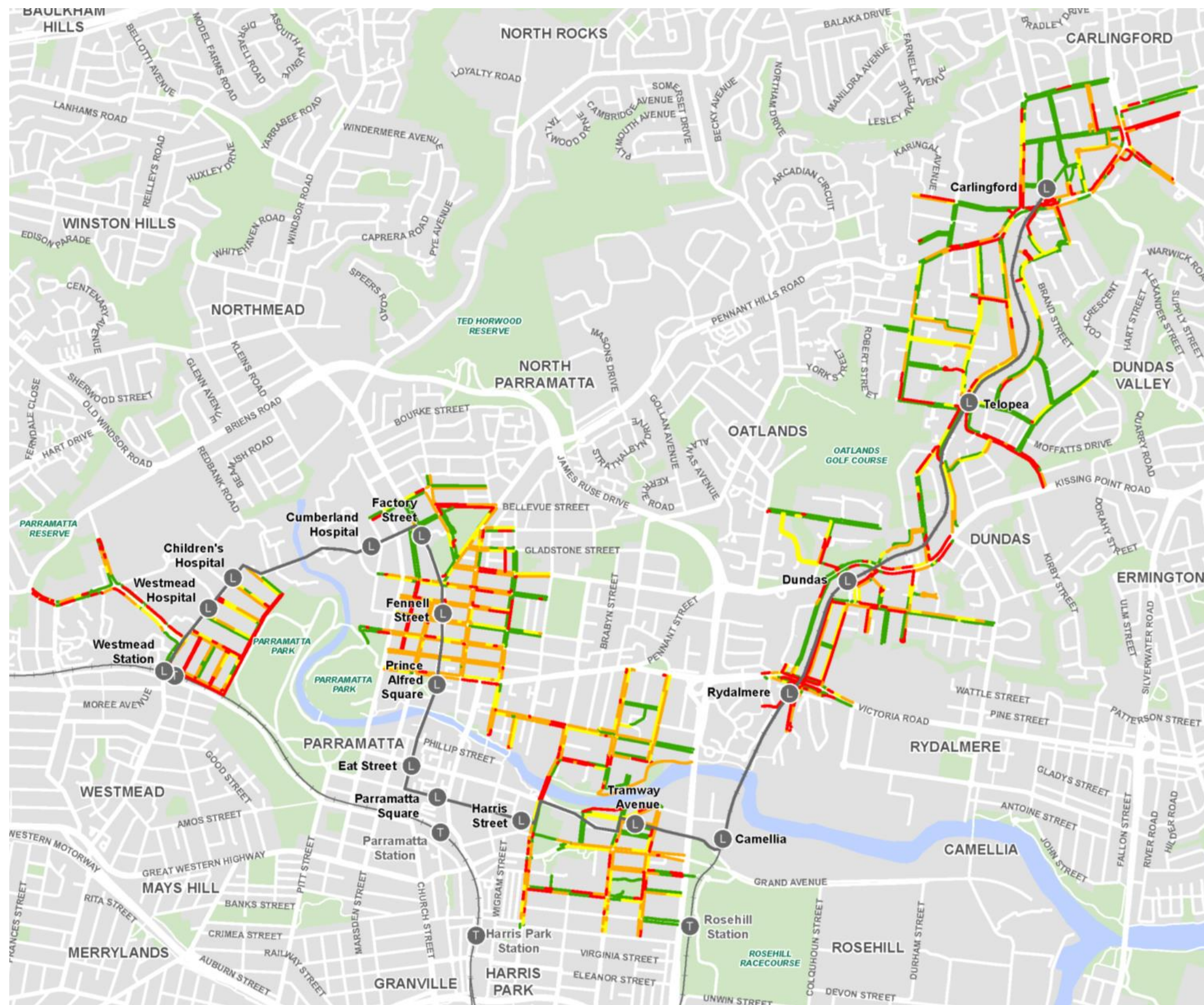


Figure 14: Network prioritisation (source: City of Parramatta Council)



Parramatta Light Rail Verge Widths

Legend

- Railway Station
 - Proposed Light Rail Stop
 - Heavy Rail
 - Parramatta Light Rail Stage 1 Preferred Alignment (TfNSW)
 - Parkland
- Verge Width**
- Less than 3.30m - Restrictive
 - 3.31 to 3.50m - Challenging
 - 3.51 to 3.80m -
 - Greater than 3.8m - Unrestrictive

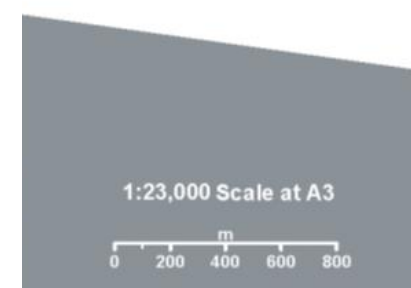


Figure 15: Verge widths (source: City of Parramatta Council)

3.3.8. Benchmarking Heat in Parramatta

3.3.8.1. About this document

Benchmarking Heat in Parramatta, Sydney’s Central River City was prepared by Western Sydney University for Parramatta Council in 2019. It documents the findings of a study into microclimatic variations across the Parramatta LGA during the summer 2018-2019. The findings have the potential to inform future planning and design through a better understanding of the effectiveness of interventions aimed to mitigate urban heat to reduce its impacts on people, infrastructure and the economy.

The study comprised of three sub-projects:

- 1. LGA wide heat mapping
- 2. Cool Parks
- 3. Cool Streets

Each sub-project has produced findings that are of relevance to this tree offset strategy, as they have the potential to inform priority tree planting locations and species selections aimed at mitigating urban heat. The relevant findings for each sub-project are summarised in the following sections.

3.3.8.2. Heat mapping

The project mapped daytime and night-time heat patterns across the Parramatta LGA, based on 95 different locations. It identified a clear temperature gradient across the LGA, with north-eastern suburbs (including Epping and Carlingford) cooler than southern and south-western suburbs (including Westmead and the Parramatta CBD) during both the day and night. On this basis the study recommends that “increasing canopy cover in this part of the LGA should have top precedence to reduce high vulnerability to heat in this part of the LGA” (p 46).

Heat mapping data was collected from locations in the canopies of trees across the LGA. This has also provided initial data on the effects of different categories of trees on temperatures. The study found that the capacity of trees to deliver thermal benefits differs according to their stature and crown architecture, with the best cooling benefits for urban landscapes derived from tall trees with dense canopies - refer Figure 16, Figure 17 and Figure 18.

The study collected a range of data including tree heights and canopy densities to determine tree species with the best cooling benefits. This data has informed the selection of offset tree species in section 4.2 and section 5.3.

Trait	Category	Mean air temperature (°C)	Maximum air Temperature (°C)	Minimum air temperature (°C)
Tree height	below 10 m (47)	24.2	41.2	12.9
	10 to 20 m (38)	24.1	40.8	13.1
	above 20 m (9)	24.0	39.9	13.0
Canopy density	low (27)	24.0	41.4	12.6
	medium (33)	24.0	40.7	12.9
	high (34)	24.3	40.7	13.3

Figure 16: Mean and maximum air temperatures under a range of tree species (source: Pfautsch, S and Rouillard, S 2019, p 36)

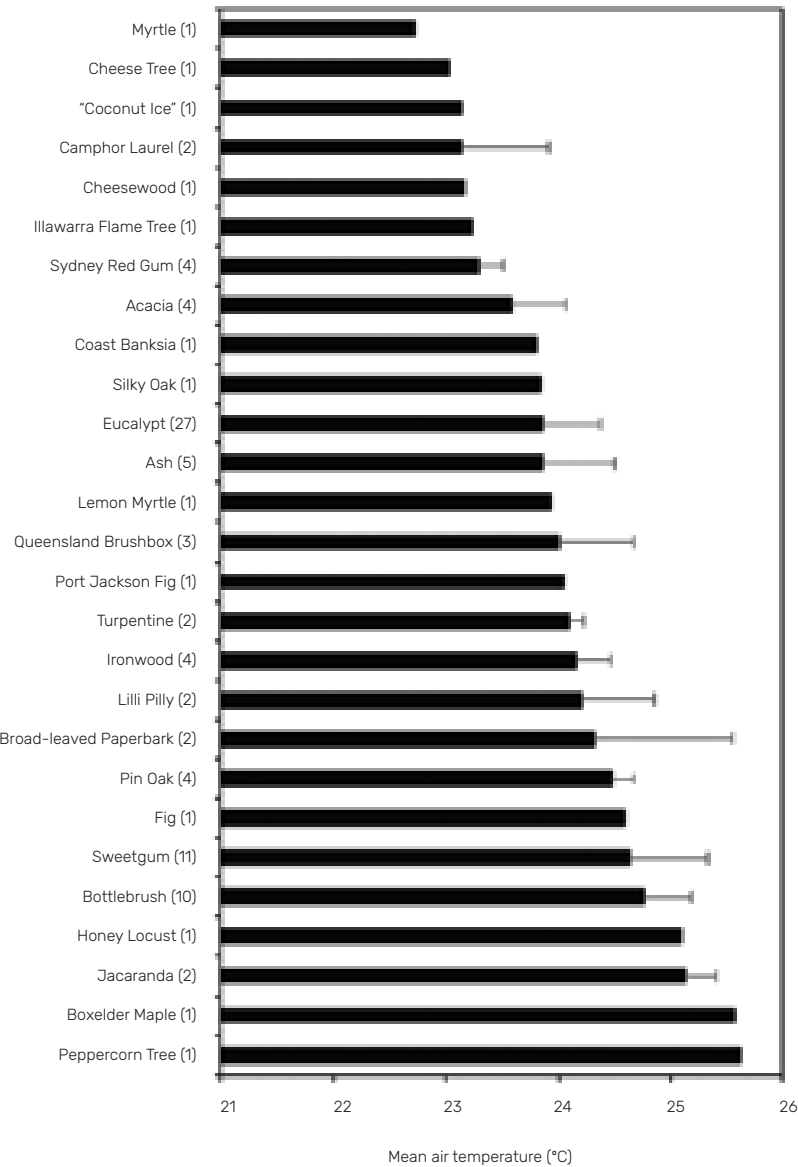
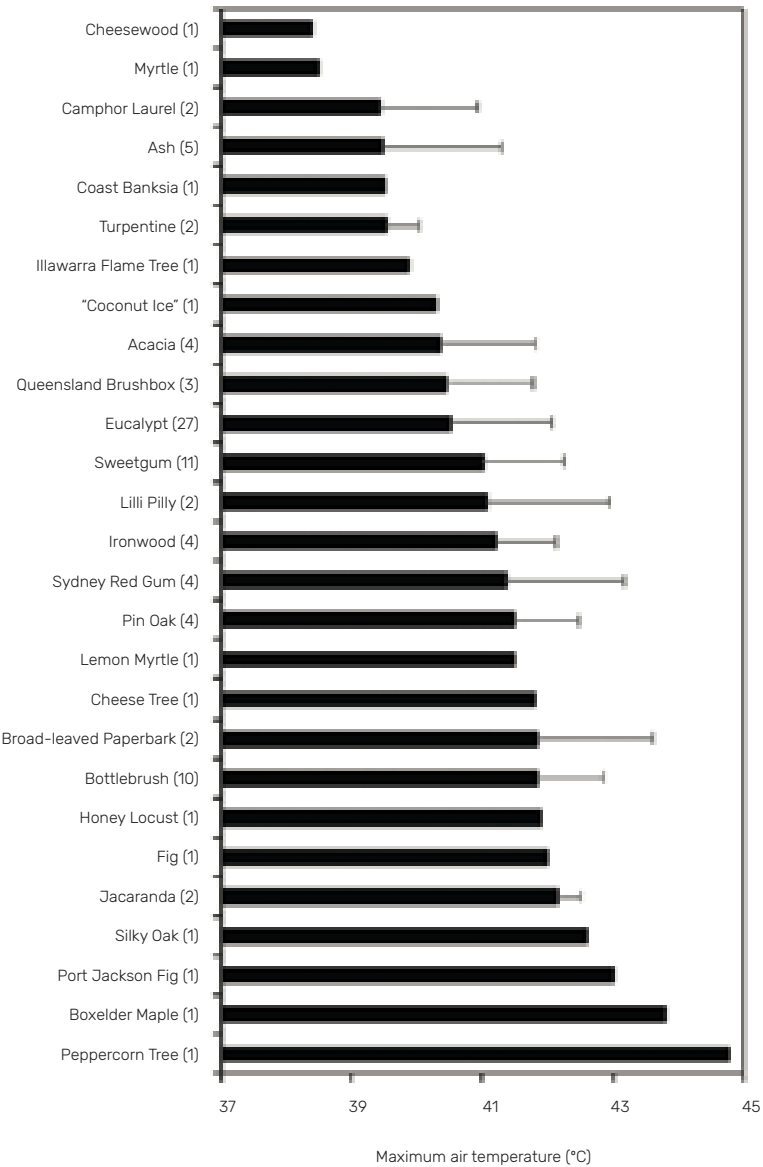


Figure 17: Trends in air temperature according to tree height and canopy density (source: Pfautsch, S and Rouillard, S 2019, p 37)



3.3.8.3. Cool Parks

This project studied air temperatures under 33 trees of six different species in two adjacent urban parks. Species included:

- › Eucalypts (*Eucalyptus species*)
- › Crepe myrtles (*Lagerstroemia species*)
- › Port Jackson fig (*Ficus rubiginosa*)
- › Ironwood (*Casuarina species*)
- › Plane trees (*Platanus species*)
- › Weeping fig (*Ficus benjamina*).

The project confirmed the findings of the heat mapping project that air temperatures are lower under tall trees with large, dense canopies than under trees with open canopies or short stature (such as in young trees). The difference between day-time temperatures increased even further during the hottest days, with temperatures below the weeping fig at least 5°C cooler than below a eucalypt – refer [Figure 16](#) and [Figure 17](#).

Variation of air temperatures was greater under trees with open canopies. Trees with open canopies will produce less shade, which leads to warmer air temperatures underneath their crowns during hot days but also cooler temperatures on cool days and during the night, as heat will dissipate faster under open canopy trees. However, the temperature difference at night was smaller than during the day, confirming the preference for tall trees with dense canopies because

- › Cooling benefits are more frequent than warming effects
- › Cooling benefits are more pronounced than warming effects
- › The total time of cooling far outweighs the total time for warming.

3.3.8.4. Cool Streets

This project assessed the cooling effect of canopy cover on air temperatures in three urban streets in the same suburb, characterised by different types and extents of tree canopy cover including juvenile versus mature trees and trees with dense versus open canopies.

Findings of the study essentially confirmed the findings of the other two sub-projects. It highlighted that canopy quality is more important than canopy quantity in mitigating air temperatures during the day – also refer [Figure 16](#):

- › More than twice as many days of 40°C were recorded where street trees were short and had small canopies, compared to where canopy cover was high and dense.

These benefits flow on into the night-time temperatures as dense canopies reduce the amount of energy stored during the day for release into the environment at night.

The study highlighted the need to consider the different rates at which species develop their crowns and expand their canopies. This means that the time between planting trees and obtaining measurable cooling benefits can vary between different species, and may be factor in species selection for mitigating urban heat.

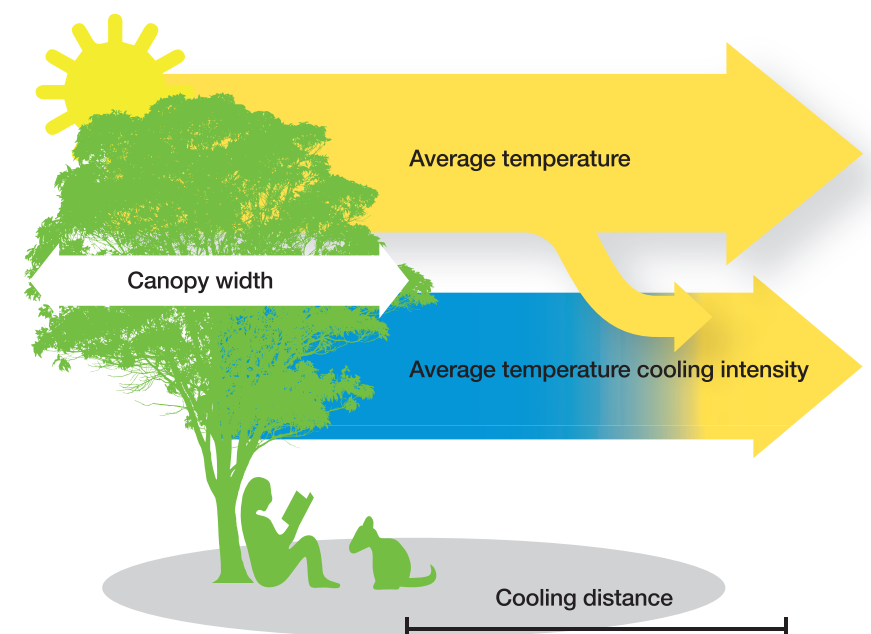


Figure 18: Temperature mitigation by trees (source: *The Nature Conservancy and Resilient Melbourne 2019, p 32*)

4 OFFSET PLANTING OBJECTIVES AND PRINCIPLES



Chapter 4.

Offset planting objectives and principles

4.1. Offset planting locations

4.1.1. Key opportunities and constraints

The review of background documentation together with stakeholder consultation has identified a number of major opportunities that guide and inform the location of the offset tree planting, these have been developed into key objectives as outlined below.

Objective One – Plant in areas of greatest **NEED**

- › Hot areas: Trees shading pavements or buildings are most efficient in mitigating heat
- › Areas of Areas of greatest customer demand (i.e. pedestrian volumes): selected pedestrian network
- › Existing and planned cycle routes, footpaths and walking trails

Objective Two –Plant in areas according to **EXISTING POLICY**

- › Greater Sydney Green Grid
- › Parramatta Ways

Objective Three –Plan for **CONNECTIVITY** – link people and wildlife

- › Between places of social interaction (public transport, schools, parks, centres etc)
- › To and along recreational trails

- › To and along linear systems: rivers, easements, road and rail corridors
- › Between habitats or fauna hotspots

Objective Four –Improve **CUSTOMER EXPERIENCE**:

- › Streets and open spaces in the vicinity of light rail stops and the light rail corridor
- › Pedestrian and cycle paths/routes.

Objective Five – Prioritise **PROXIMITY**:

- › Plant in close proximity of tree removal sites to ensure mitigation as close as possible to the sites of impact. Alternatively plant in a public space in the same LGA.

Objective Six – **BALANCE** needs

- › Parks: balance open space for recreation with shaded areas for amenity and thermal comfort
- › Balance shade and solar access
- › CBD/town centres: weigh pedestrian movement volumes and available footpath space to determine capacity to accommodate trees/tree pits within movement corridors
- › Maintain view corridors/significant views for example of heritage items.

Objective Seven – Prioritise areas of fewest **CONSTRAINTS**

- › Sufficient nature strip/verge width (to avoid root damage)
- › Avoid conflict with underground and overhead utility services
- › Driveways/sight lines/clear zones.

Objective Eight – Prioritise public Land **OWNERSHIP**:

- › Areas owned or controlled by CoPC or TfNSW represent the greatest opportunity within available time frames, avoiding the need for additional landholder agreements.

4.1.2. Principles for locating offset trees

As outlined in section 3.2.2, the overarching objective for green infrastructure is the concept of multifunctionality. According to the principle of multifunctionality, the greatest potential benefit from offset tree planting that realise multiple opportunities as outlined in section 4.1.1 above and illustrated in Figure 19. This can be achieved by prioritising locations existing tree removal sites and where



Figure 19: Achieving multiple benefits with offset tree planting

benefits to residents, light rail customers and the local environment overlap.

Based on the project's overarching objectives and as illustrated in Figure 19, offset tree planting will be prioritised in locations that meet three key principles:

- › Customer-focused – delivering benefits to light rail customers
- › Place-making /city-shaping – delivering benefits to residents and the local environment.
- › Achievable – providing certainty to meet project approval requirements.

Based on the above principles and through consultation with TfNSW and CoPC, the following preferences for locating offset tree planting were identified:

- CBD and connected urban streets with high urban heat**
Prioritise Parramatta Central Business District and urban street tree planting connected to the light rail corridor, within walking distance of light rail stops and where urban heat is highest
- Links to parks and community facilities**
Focus tree planting along streets to link local parks, education and community facilities to the Parramatta Light Rail, within the light rail walking catchment and prioritising planned

connections (Sydney Green Grid/Parramatta Ways) and areas of high urban heat

8. **Parks and open space areas**
Incorporate mass tree planting in parks and open spaces within the light rail walking catchment.
9. **Biodiversity planting**
Provide biodiversity planting primarily within the Carlingford corridor linked to existing ecological communities.
10. **Enhance active transport networks**
Encourage greater use of walking and cycling by locating trees to provide shade trees along existing footpaths, cycleways and recreational trails.

4.1.3. Priority planting locations

Based on the above principles and preferences priority planting locations were identified for both street tree and open space offset planting, using a series of GIS overlays to highlight areas of multiple benefits:

- › Priority locations for street tree planting are shown in Figure 20
- › Priority locations for planting in open space areas including general recreation parks and bushland areas, as shown in Figure 21.

These maps constitute composite maps identifying potential locations of greatest benefit at the whole of project level. Detailed maps are provided in section 5 and should be consulted to identify individual streets. A series of individual maps highlighting areas of potential benefit for particular aspects such as heat, walkability and *Green Grid* connections are included in Appendix 1. The locations have responded to the opportunities summarised in 4.1.1 in order to ensure the identified priority locations are feasible and achievable based on the available data.

4.1.3.1. Priority 1 and priority 2 locations

The maps identify priority 1 locations and priority 2 locations. Priority 1 locations are preferable, as these locations realise a greater number of potential benefits, relative to priority 2 locations. Therefore, offset tree planting should preferably focus on planting in priority 1 areas in the first instance.

4.1.3.2. Offset street tree capacity

Based on the available data, the identified priority planting locations offer the potential to plant:

- › 472 trees in CBD locations – refer Figure 32 and Figure 33
- › 9,582 offset trees on land located within the former Parramatta LGA boundaries, prior to Council amalgamations.

These quantities were determined through an analysis of CoPC i-Tree data, including an assessment of i-Tree data against the CoPC's *2019 Street Tree Audit* to arrive at a greater level of accuracy, based on ground-truthing conducted as part of the *2019 Street Tree Audit*.

It should be noted that:

- › i-Tree data is limited to land located within the former Parramatta LGA boundaries – also refer Figure 20 highlighting areas not included covered by the data
- › At the time of writing this report, the CoPC's *2019 Street Tree Audit* had not yet been completed for the entire Parramatta LGA.

As a result, the data on available tree planting sites is limited in Carlingford, Oatlands and Mays Hill. For the purposes of determining tree planting capacity within the identified priority planting sites in these suburbs, this Strategy has used the available vacant tree planting sites data within these suburbs to determine an average vacancy percentage in each suburb's streets. This percentage was applied to the identified priority planting streets to arrive at an estimate of the number of trees likely to be accommodated in areas for which no data currently exists.

Based on this process, the following additional street tree planting capacity is estimated to be available:

- › Carlingford: 592
- › Oatlands: 120
- › Mays Hill: 15.

The overall capacity of priority planting streets is therefore likely to be for around 10,309 offset street trees.

4.1.3.3. Excluded locations

The identification of priority offset planting locations has excluded the following:

- › **Urban renewal areas**
Urban renewal areas in advanced stages of planning have been excluded. They are: Parramatta North, Cumberland Hospital, Camellia and Telopea – also refer to Figure 38. This is due to:
 - These projects/urban renewal areas having made their own commitments towards environmental/greening outcomes. Implementation is the responsibility of other agencies/proponents under their respective conditions of approval
 - Complexities of negotiating with additional/diverse land owners within the time available
 - The risk of damage to/removal of offset trees as part of urban renewal programs as details are still being finalised.

The exception are the links identified in *Parramatta Ways* (refer section 3.2.3) which are assumed to be integrated into respective urban renewal plans.

- › **Areas where space is considered insufficient**
This includes:

- CBD areas of with fully paved verges less than 3m wide, in accordance with the *Parramatta Public Domain Guidelines 2017*
- Outside of commercial, town centre and mixed use areas where nature strip widths are less than 1m wide. 1m is considered to be the minimum width required for tree planting to ensure longevity and prevent damage to adjoining structures and pavements

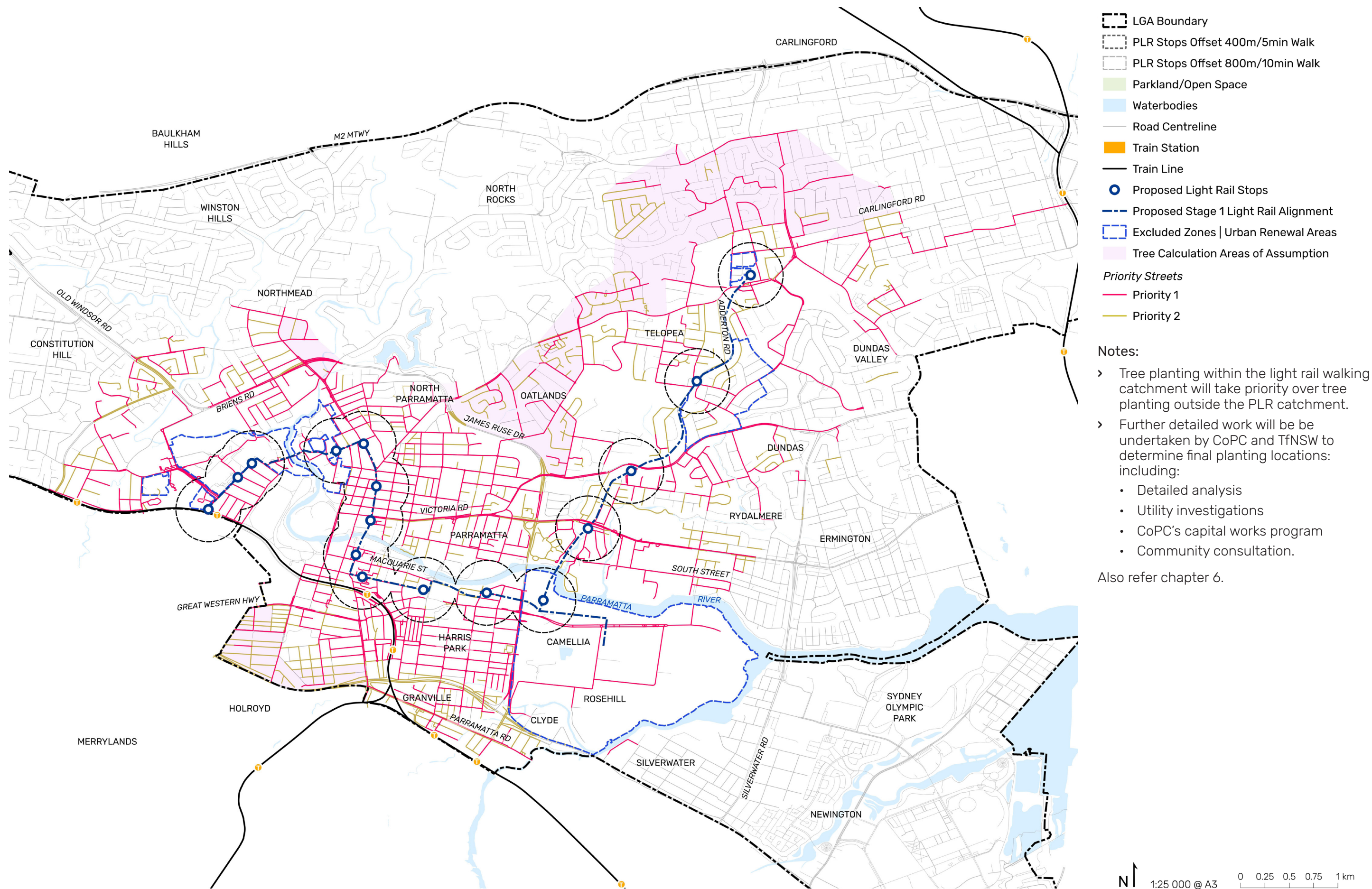


Figure 20: Priority offset planting locations for street trees

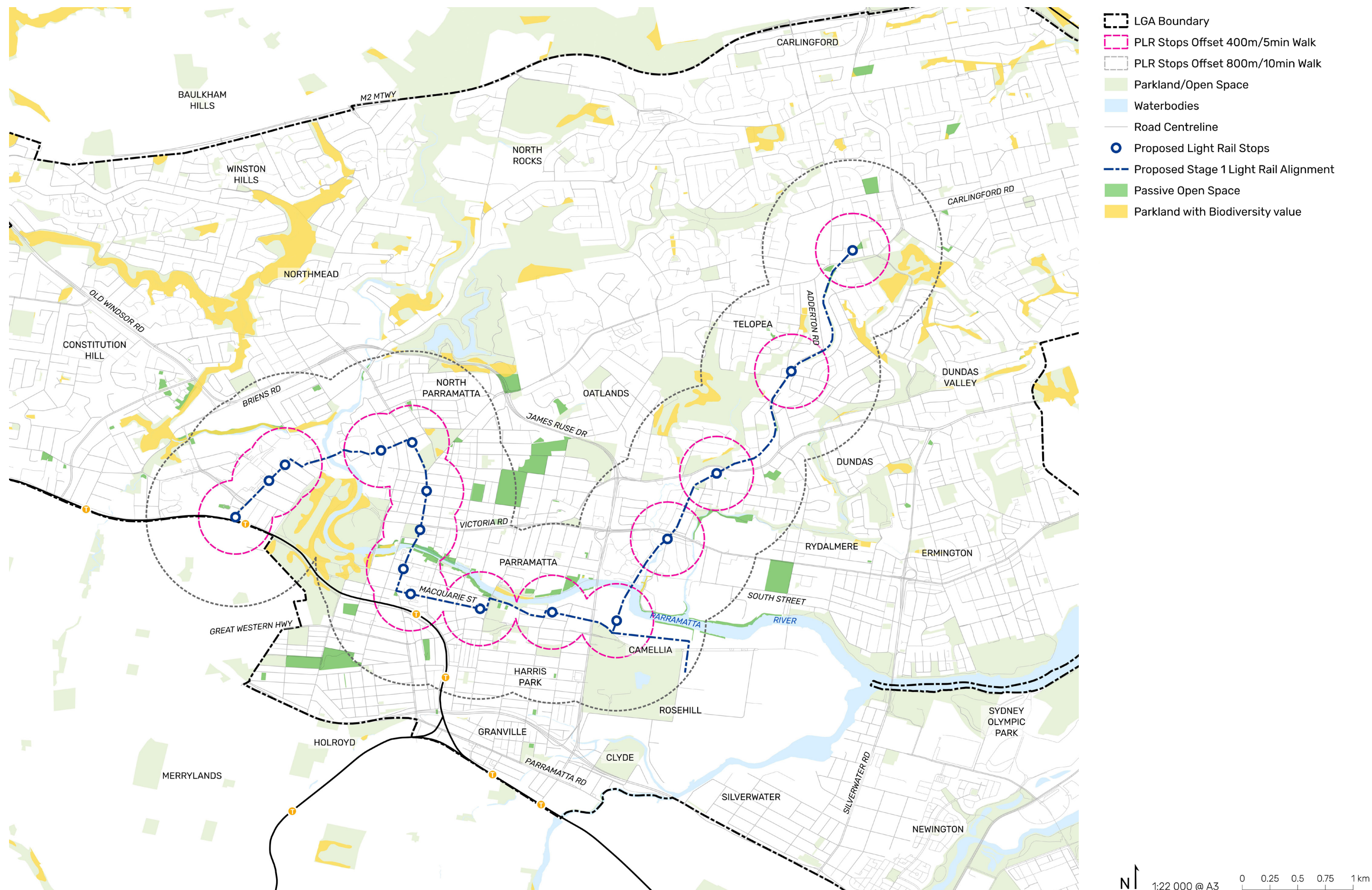


Figure 21: Priority offset planting locations for open space areas

4.2. Tree species for offset planting

Tree species for offset tree planting have been selected through a process of document review, precedent studies and consultation, including with CoPC and the Project Independent Arborist, to arrive at a list species that are compatible with

- › The objectives of the Tree Offset Strategy (Section 4.1.1)
- › Local conditions
- › Social and environmental health.

The following documents were reviewed to derive an initial long list of species that was refined through the consultation process:

- › TfNSW and CoPC guidance documents:
 - TfNSW Urban Design Requirements (Blue Book) 2018
 - Parramatta Public Domain Guidelines 2017
 - Parramatta Development Control Plan 2011
 - CoPC i-Tree data and CoPC 2019 Street Tree Audit
 - Former CoPC *Street Tree Masterplan*
 - CoPC *CBD Street Tree Investigation* (2016)
 - CoPC Biodiversity Strategy.
- › Precedent studies:
 - City of Sydney Street Tree Masterplan
 - Melbourne Urban Forest Strategy
 - Marrickville Street Tree Master Plan
 - Ashfield Street Tree Strategy
 - Newcastle Urban Forest Policy
 - Landcom *Street Tree Design Guidelines*.

4.2.1. Principles for selecting offset tree species

Based on the document review and the objectives of the Tree Offset Strategy, the following three key principles for tree selection were identified:

11. Right tree, right place
12. Species diversity
13. Availability

These principles are further explained in the following sections.

4.2.1.1. Right tree, right place

This Tree Offset Strategy is based on a tree selection approach that begins with an analysis of growing conditions, desired project outcomes and species characteristics as key considerations to determining a list of suitable species.

As highlighted in Council's Sustainability Strategy *Life in Our City*:

By selecting the right tree species and planting them in the right location, we can reduce problems like damaged footpaths and dropping branches. In doing so, we will also capture the benefits and value that trees provide – things like improved property value, improved amenity and greater spaces for children to play (CoPC 2015, p 24).

Right tree, right place in the context of this Tree Offset Strategy means finding the best trees with the greatest benefits and attributes for each location, while avoiding assets and impacts to properties – refer Figure 22. This approach delivers the maximum heat mitigation benefits while also reducing the likelihood of tree failure.

4.2.1.1. Key street selection considerations

The key consideration for tree selection is to ensure that species are suited to local conditions including:

- › Climate: tolerant of drought and heat once established:
 - Species with a low need for watering or irrigation once established, including during dry periods. Trees that are drought tolerant also tend to have fewer additional maintenance demands such as fertilising.
 - High temperatures can cause irreversible damage to plant growth and development. The most suitable species will therefore be tolerant of both short temperature spikes and extended periods of high temperatures.
- › Built context: conditions within the highly urbanised environment of buildings, roads, utility services and often highly modified soils and growing conditions. This will also consider building scale and street widths and other constraints including utilities and clear zones (i.e. need for frangible species)
- › Biophysical conditions: soils, drainage/flooding and climate (temperatures and rainfall).

Suitability to the local climate must consider both existing conditions and likely future changes. Specifically, tree cover must be primarily composed of species that are able to survive and remain healthy under the hotter conditions predicted to occur in Parramatta in the

future, as outlined in section 3.1.1. This will ensure the longevity of offset tree planting, and therefore lasting community benefits.

Due to the limited time frame for implementation of this Tree Offset Strategy, there are no opportunities to trial new species or cultivars that have not previously been used in the Australian urban context. Therefore, all species are selected on the basis of their known performance record that indicates that they are suited to the conditions found in the urban environment of the Parramatta LGA.

A final overarching preference is for trees that require minimal maintenance subsequent to establishment.

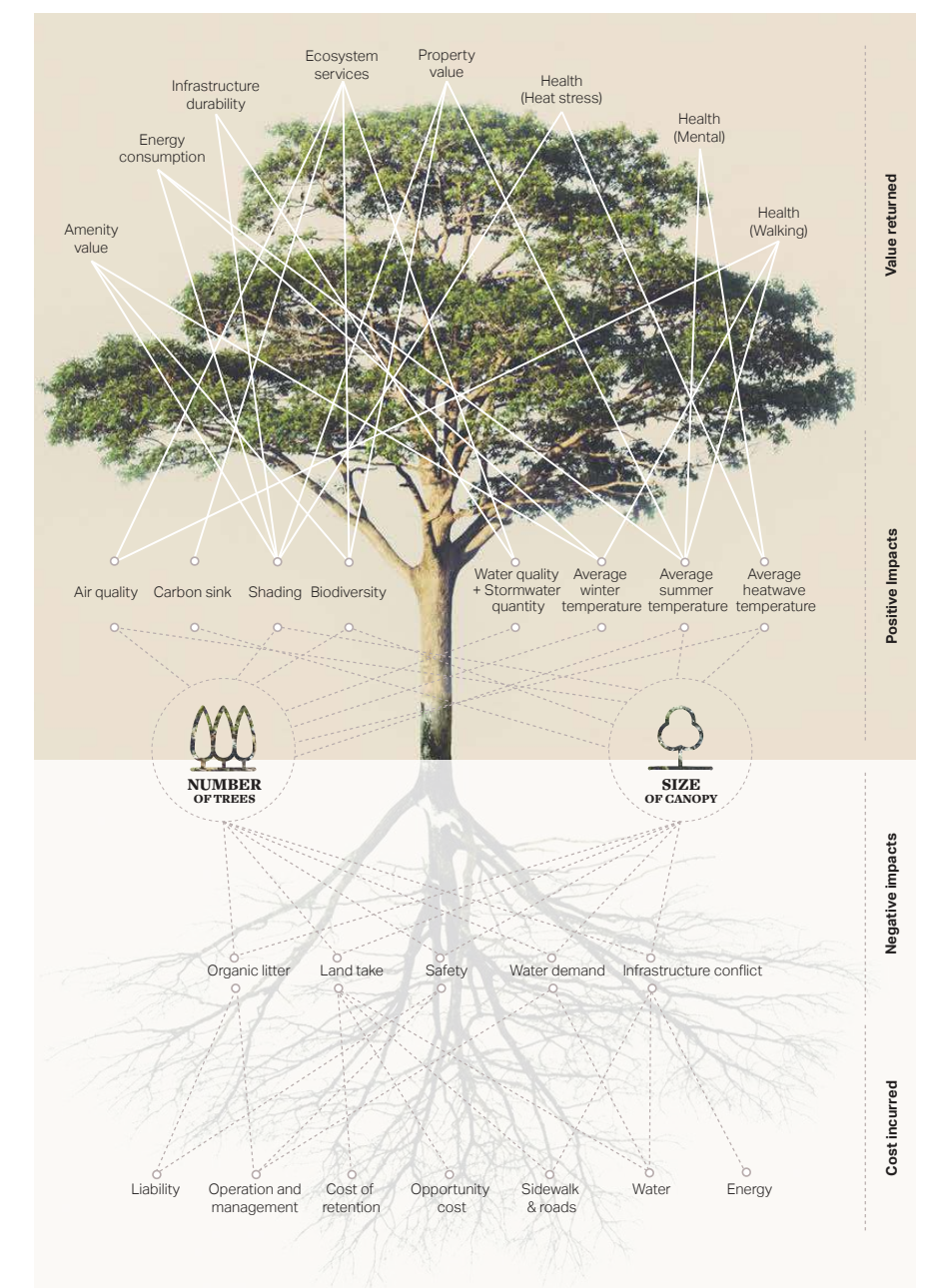


Figure 22: Potential benefits - and costs - of street trees (source: Aecom 2017, p 7)

4.2.1.1.2. Additional considerations for selecting tree species

In addition to the major performance criteria outline above, the following are a range of key attributes that have further informed species selection for the Tree Offset Strategy. They are:

14. Maximise canopy cover

Prioritise species of medium to tall height with dense and/or broad canopies as the most efficient species for heat mitigation.

15. Ensure diversity of species

A diverse range of trees is encouraged to provide variation in form and colour as-well as functional attributes such as cover, windbreaks and screening. Consideration is to be given to the planting of more diverse tree taxa in open spaces away from roads or paths to allow for windbreaks, flower colour, leaf drop and interesting crown form. Also refer to section 4.2.1.2.

16. Suitable form

Select species that have naturally clean trunks or can be pruned to:

- Maximise sight lines and passive surveillance in the public domain of streets and recreation parklands
- Ensure vehicles are able to travel freely below canopies, particularly in areas with high volumes of traffic such as in the CBD, high-rise areas and along arterial roads.

17. Low levels of tree litter

Avoid species that drop excessive litter including leaves, bark, flowers and fruit, especially in areas with high pedestrian volumes. Flowers and fruit especially can cause a trip or slip hazard. Trees that are renowned for having brittle branches and regular branch drop will be avoided for use as street trees.

18. Allergens and weeds

Avoid species that are:

- Known to be allergens. It is important to note there is a difference between an allergic reaction and an irritation
- Identified as noxious weeds.

4.2.1.2. Species diversity

Scientific research indicates that a large representation of any one particular plant family leaves urban tree populations vulnerable to pest and disease outbreaks, as a single pathogen would be able to cause significant losses to a large share of the tree population. Examples of known threats include Myrtle Rust, borers, Sycamore Lace Bug and Fusarium Wilt. Low species diversity also increase vulnerability to the kinds of extreme weather conditions the project area is expected to experience, that is: increases in heat waves and reduced rainfall/prolonged drought.

Species diversity is measured by the percentage of the tree population in particular families, genera and species. This Tree Offset Strategy will add a large number of trees to the existing urban forest in Parramatta. To ensure longevity of offset tree planting and maximise long-term benefits to both customers and the City of Parramatta, this Strategy promotes diversity in tree species and growth rates, consistent with broadly accepted best practice guidelines and recent planning for Australian urban forests. The species diversity targets are:

- › No more than 5% of any one species
- › No more than 10% of any one genus
- › No more than 30% of any one family.

Responding to diversity targets is a dynamic process whereby percentages are relative to the entire tree stock within the Parramatta Council area. Meeting the diversity criteria in the selection of offset tree planting species will therefore require ongoing liaison with CoPC, continually checking the proposed plantings against CoPC's tree database to ensure the species diversity targets above are met. This would need to be done at the time of ordering tree stock (also refer section 6.1). The tree species and families that are already over-represented (refer section 4.2.1.2.3 and Figure 23 for a snapshot indicating current high concentrations of tree families and species) should be avoided in favour of those not used or in low numbers. The large species list in section 5.4 aims to provide the respective flexibility to achieve this.

4.2.1.2.1. Cultivars, clones and intergeneric hybrids

The use of cultivars and cloned species provide a valuable contribution to the urban environment. However they are often considered less resilient and more vulnerable due to reduced genetic diversity, and therefore lower levels of adaptability. Intergeneric hybrid species, which are a cross between plants in two different genera in the same family, are however considered to have superior genetic diversity and resilience. It is therefore important to provide a balance between naturally occurring plant species, cultivars, clones and intergeneric hybrid species.

4.2.1.2.2. Native and exotic species

Locally native, non-local Australian species and exotic species make important positive contributions to the urban landscape. As summarised in *Benchmarking Heat in Parramatta* (refer section 3.3.7) and other studies, native trees such as Eucalypts are less effective in mitigating urban heat than other species characterised by dense canopies. In many instances exotic species are better adapted to the urban environment where soils, drainage and

other growing conditions are typically heavily modified and very different to the conditions in which trees would grow in their natural environment. Exotic trees can assist in enhancing the footpath micro-climate year-round realising the need for balance between providing shade in summer and solar access in winter.

The use of indigenous trees will have greater benefit in open space areas, in particular open space areas with remnant vegetation. In these locations, bushland vegetation that provides habitat for native fauna will be offset with endemic or locally native species, to reduce impacts on threatened species, populations and ecological communities. New tree planting will provide a buffer to and assist in the preservation of existing natural remnant vegetation. It also provides an opportunity to support the foraging needs of threatened wildlife impacted by the project. Specifically, there is a need to integrate winter flowering species to provide a winter food source for the Grey-headed Flying Fox.

As outlined in section 4.2.1.1, the focus needs to be for tree species that are suited to the site and with acceptable characteristics relative to the desired purpose.

4.2.1.2.3. Existing tree species diversity

In order to achieve the species diversity target, offset tree species composition needs to consider the existing mix of tree species in Parramatta. An analysis of Council's i-Tree inventory data (refer Figure 23) shows that:

- › Diversity is generally low:
 - 55% of all trees are from the Myrtaceae family
 - 26% of all trees are from the *Callistemon* genus
 - Several genera are characterised by highly concentrated species distributions
- › The vast majority of tree canopy sizes are smaller than 6m in diameter.

This highlights an existing narrow focus on relatively few species within the Parramatta LGA.

4.2.1.3. Availability

The ability to procure the identified tree species within the limited project time frame is a key need of the project in order to achieve project planning approval requirements. This Tree Offset Strategy has therefore selected commercially readily available species, to ensure stock availability to support the project need to have at least 80% of offset trees planted prior to PLR commencing operations – also refer Table 2.

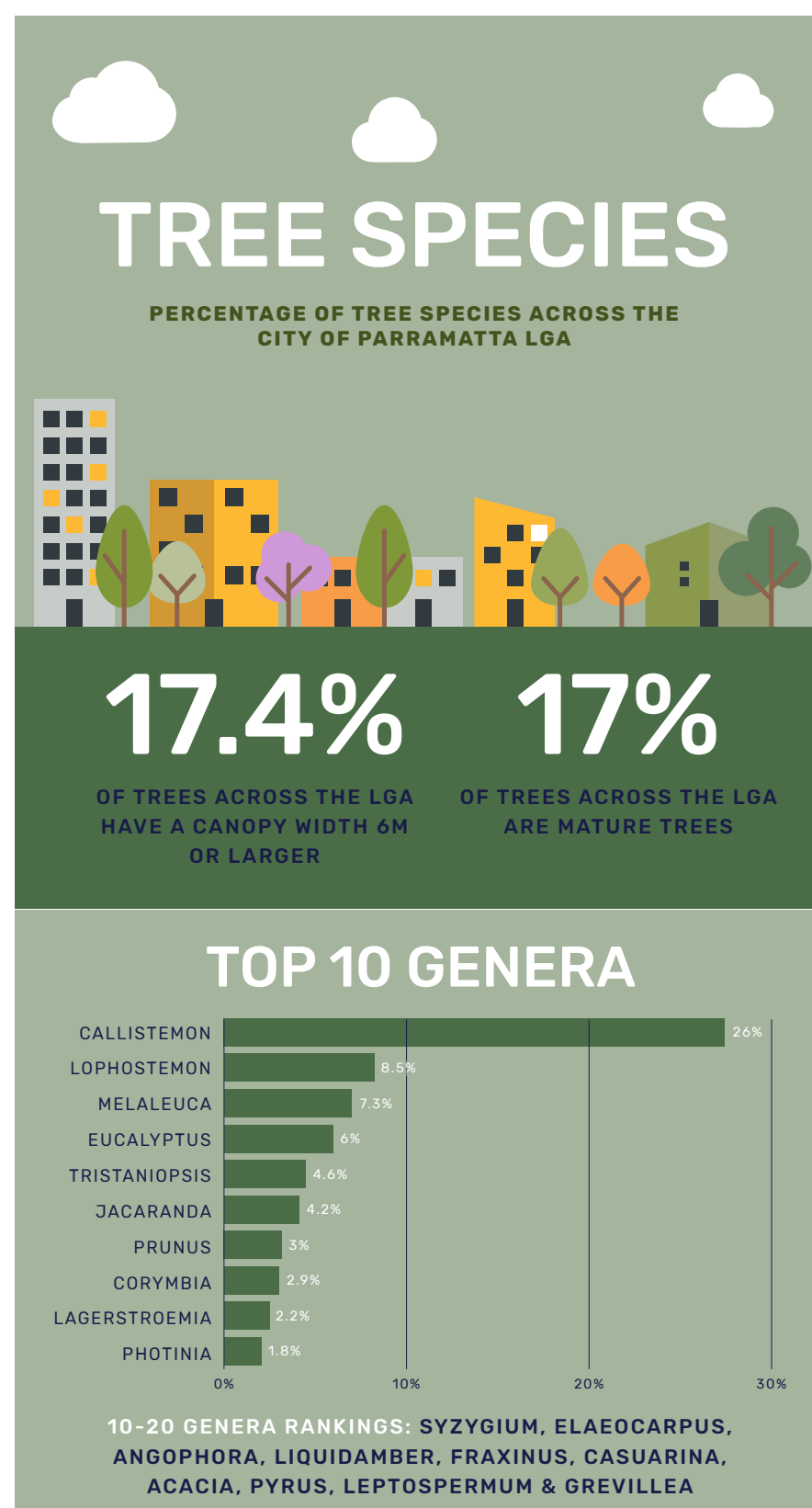


Figure 23: Existing tree diversity audit

4.2.2. Choosing the right tree for the right place

A number of street typologies have been identified within the priority planting areas. The street typologies determine which trees to plant where, in order to maximise tree size and therefore heat mitigation and other benefits while reducing potential risks such as damage to nearby buildings and infrastructure (also refer to [section 4.2.1.1](#)).

For the purposes of this Tree Offset Strategy, two major factors are considered to be the primary factors determining the suitability of tree species to their location:

- › Built form
- › Available space.

Additional considerations interacting with the above two factors include:

- › The presence of overhead powerlines
- › Planting sites located within identified heritage conservation areas.

These issues are discussed further in the following sections.

4.2.2.1. Built form context

The prevailing built form surrounding the tree planting site plays an important role as it influences growing conditions in particular in relation to solar access/the degree of shading but also other factors such as available soil volumes and drainage/access to water.

Built form also gives an indication of the likely number of people and other traffic that will be sharing the road corridor. For example in CBD areas, there will likely be larger number of pedestrians. Ensuring the free flow of people along footpaths is an important consideration for CBD functioning, as is the need to minimise the potential for trip and slip hazards.

The three built form types informing tree species distribution are:

19. CBD, mixed use and high rise areas, with buildings in excess of four storeys
20. Other urban areas, with buildings generally four storeys or less
21. Parks: parks and open space areas (including bushland), as well as street sections that adjoin open space areas.

4.2.2.2. Available space

Generally, the less space there is, the smaller or more adaptable the tree will need to be. There is a need to ensure sufficient space to sustain the tree long-term and to allow for the expansion of canopies, roots and trunks to avoid conflict with or damage to adjoining structures or services.

The need for additional maintenance such as pruning or shaping of the tree, including the availability of resources to carry out any pruning works, is also an important consideration.

In determining available space within the streetscape environment, the width of the verge and footpath is an essential consideration. A small tree in a wide verge free of obstructions is a lost opportunity as a large shade tree could be planted to mitigate heat. A tree too big for its setting can lead to costly damage to private or public infrastructure.

This Tree Offset Strategy differentiates between wide and narrow verges, to determine the largest tree size that would be able to be accommodated. Wide and narrow verges were defined as follows:

- › In CBD and mixed use areas where verges are fully paved to accommodate high pedestrian volumes and where trees will need to be planted in tree pits in the footpath:
 - Wide footpath: more than 4m wide
 - Narrow footpath: between 3m and 4m wide

Footpaths less than 3m in width have been excluded, as outlined in [section 4.1.3.3](#).

- › In urban (including suburban) areas where verges are composed of a combination of nature strip, footpath and building offset:
 - Wide: either the nature strip or the boundary offset is more than 1.5m wide
 - Narrow: either the nature strip or the boundary offset is between 1m and 1.5m wide

Streets where both nature strip and boundary offset are less than 1m wide have been excluded, as outlined in [section 4.1.3.3](#).

In situations where both nature strip and boundary offset meet the minimum width of 1m, there may be an opportunity for a double row of trees along the footpath, to maximise shading and heat mitigation outcomes.

In open space areas and in trees adjoining open space areas, there are often fewer space constraints than in the streetscape context. This provides an opportunity for large tree planting, including

biodiversity planting of indigenous trees representative of originally occurring ecological communities.

4.2.2.2.1. Data limitations

Available space was determined on existing information within CoPC's GIS database. It is noted that the data

- › Provides an average for each street verge
- › Does not cover the full extent of priority planting locations.

The following should be noted:

- › There may be local variations in verge/nature strip width that are not captured by the data. Therefore, there may be:
 - Additional planting sites not captured by the data analysis and assessment undertaken for this Tree Offset Strategy
 - Scope to increase tree size in some locations, to reflect localised widening of nature strips or boundary offsets.
- › For areas not covered by detailed data, the assessment of available space has adopted an average distribution of verge widths by suburb, based on the available data. The available data is generally concentrated around local centres. It indicates that available planting areas (nature strips and boundary offsets) are narrower in local centres than in areas further away. It is therefore likely that the available space in areas away from local centres is greater than indicated by the average width distribution. It may therefore be possible to plant larger trees in some of these areas. Areas without verge width data were also correlated to the available planting sites identified in Council's i-Tree database, to confirm that verges of a width suitable for street tree planting are available.

4.2.2.3. Power lines

Generally where overhead powerlines occur, the size and type of trees listed as suitable are limited to trees that tolerate (regular) pruning, as required to maintain safe clearances from powerlines.

They include:

- › Large trees that tolerate heavy pruning of their branch structure so that their canopies can be shaped around overhead wires while delivering significant cooling benefits to streets and footpaths below
- › Smaller growing species that either do not require pruning or tolerate pruning. The tree must be able to achieve a 2.5m

clearance above the adjoining footpath and an additional 2.0m of canopy above this, to deliver shade and effective cooling.

4.2.2.4. Heritage conservation areas

Heritage Conservation Areas are integral to the historical significance of Parramatta. The heritage value of a conservation area lies not just with the heritage significance of individual buildings, but with other factors, including the landform, subdivision pattern and the history of development.

Within the Parramatta LGA, there are eleven Heritage Conservation Areas (refer [Figure 25](#)) that demonstrate different phases of Parramatta's history. They are:

- › The colonial government town and its early residential growth:
 - North Parramatta Conservation Area: 1820s onwards
 - Sorrell Street Conservation Area: 1823 onwards
- › The coming of the railway and the development of related private residential estates:
 - South Parramatta Conservation Area: 1856 – 1960s
 - Granville Civic Conservation Area: 1870s – 1930s
 - Granville Residential Conservation Area: 1870s – 1930s
 - Eastwood/Epping Conservation Area: 1910 – 1950s
 - Wyralla Avenue, Epping: 1910 – 1930's
- › The work of the Housing Commission and the planning and building of estates:
 - Blaxcell Estate Conservation Area: 1944

More information on these areas can be found in *Parramatta Development Control Plan 2011*.

In heritage conservation areas, species selection and their final placement within the streetscape will need to consider the principles outlined in [section 3.3.1.2](#), as well as the relevant provisions of the *Parramatta Development Control Plan 2011* and the *Parramatta Public Domain Guidelines 2017*.

4.2.3. Location types

Based on the factors outlined in [section 4.2.2](#), seven different location types were identified within the priority offset planting locations. They include:

- › Five different street typologies – refer [section 4.2.4](#).
- › Two location types for open space areas – refer [section 4.2.5](#)

Each location types is associated with a range of desirable attributes. A list of suitable tree species for each location type is provided in [section 5.3](#). The location types and location-specific attributes are summarised in [Table 7](#) and [Table 9](#) for street trees and open space trees respectively.

It should be noted that location-specific attributes are in addition to the over-arching aim for the largest tree possible in every location, and the key selection principles outlined in [section 4.2.1.1](#). They ensure that the right tree is chosen for each location, as illustrated in [Figure 24](#).

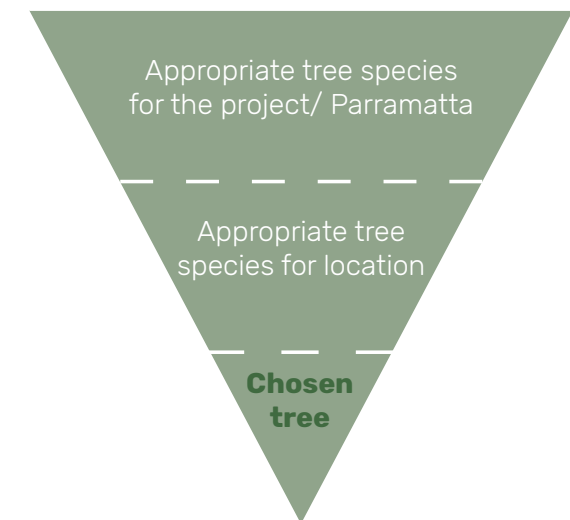


Figure 24: Choosing the right tree

4.2.3.1. Species subset

In addition to the species lists for each location type there are two species subsets to address issues of overhead powerlines and heritage:

- › Subset 1: trees suitable under powerlines. The species list identifies a subset of species suitable for planting under powerlines, as per the principles outlined in [section 4.2.2.3](#).
- › Subset 2: heritage conservation areas. The species list identifies a number of species suitable for planting in heritage conservation areas, based on the *Parramatta Development Control Plan 2011* – also refer [section 4.2.2.4](#).

4.2.4. Street tree typologies

The five different street typologies within the priority planting areas are shown in [Figure 26](#) at a whole-of-project level. More detailed

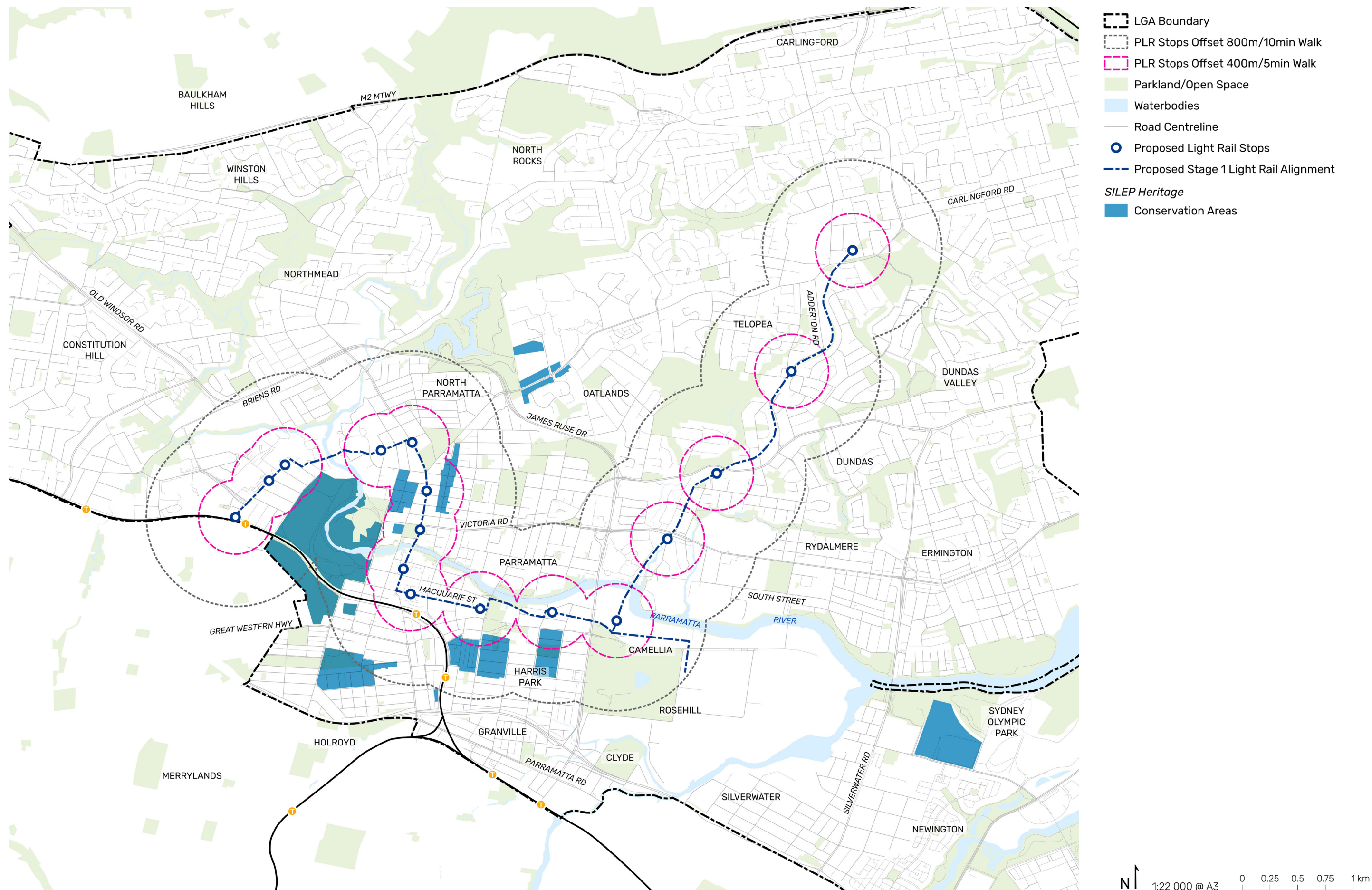


Figure 25: Heritage Conservation Areas in the Parramatta LGA

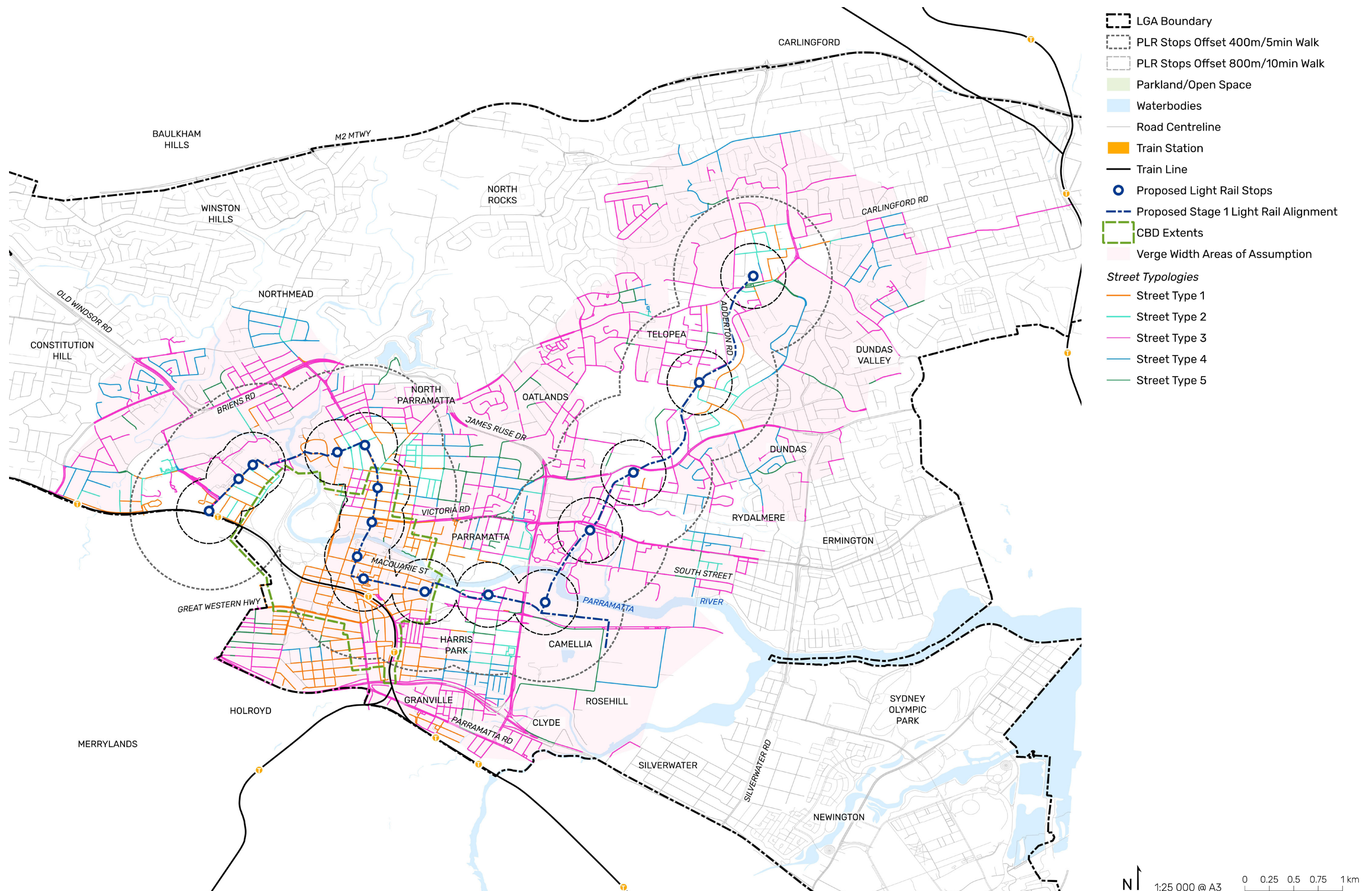


Figure 26: Location types – street typologies (to be verified at future design investigation ground-truthing)

maps are included in [section 5.2](#) and should be consulted to identify the relevant typology for individual streets. Location descriptions, location-specific attributes and the indicative number of trees able to be planted within each typology (also refer [section 4.1.3.2](#)) are summarised in [Table 7](#). The next phase of offset tree planting delivery will include verification of the typologies and associated tree species lists.

Table 7: Street typologies and location-specific tree attributes (to be verified at future design investigation ground-truthing)

Street typology, description of trees to be planted	Location-specific attributes
Type 1: Medium centre tree Location: high rise/CBD areas with fully paved narrower footpaths (3–4m)	- High canopy (>3m when mature) for uninhibited pedestrian and vehicular movement - Low litter drop, especially fruit and seeds - Tolerant of partial shade/indirect sunlight - Wind tolerant - Pollution tolerant - Minimum 6m canopy diameter when mature, unless restricted by the presence of powerlines - Able to be pruned to shape to avoid conflict with adjoining buildings - Non-invasive root system/tolerates compaction and restricted soil volumes.
Type 2: Large centre tree Location: high rise/CBD areas with fully paved wide footpaths (4m+)	- High canopy (4.5m when mature) for uninhibited pedestrian and vehicular movement - Low litter drop, especially fruit and seeds - Tolerant of partial shade/indirect sunlight - Wind tolerant - Pollution tolerant - Minimum 8m canopy diameter when mature, unless restricted by the presence of powerlines

Street typology, description of trees to be planted	Location-specific attributes
Type 3: Medium urban tree Location: urban areas beyond the commercial core including suburban residential areas with narrow planting strips (<1.5m)	- Able to be pruned to shape to avoid conflict with adjoining buildings - Non-invasive root system/tolerates compaction and restricted soil volumes. - High canopy (>3m when mature) for uninhibited pedestrian and vehicular movement - Tolerates full sun or part shade - Minimum 5m canopy diameter when mature, unless restricted by the presence of powerlines - Tolerates crown pruning if required to avoid conflict with adjoining buildings.
Type 4: Large urban tree Location: urban areas beyond the commercial core including suburban residential areas with wide planting strips (1.5m +)	- High canopy (>4m when mature) for uninhibited pedestrian and vehicular movement - Tolerates full sun - Minimum 8m canopy diameter when mature, unless restricted by the presence of powerlines - Tolerates crown pruning if required to avoid conflict with adjoining buildings.
Type 5: Park edge tree Location: along the edges of open space areas	- Indigenous/ native unless heritage - Biodiversity potential, including foraging habitat - Tolerates full sun - High canopy (>4m when mature) for uninhibited pedestrian and vehicular movement - Minimum 8m canopy diameter when mature, unless restricted by proximity to park/recreation infrastructure or presence of powerlines.

4.2.4.1. Mixed species streets

Each street type is able to support a mix of species. Planting a mix of species within each street has the following advantages. It:

- Assists in meeting the overall diversity criteria
- Maximises urban tree canopy resilience within each street
- Assists in achieving the right balance between the need for shade in summer and the need for solar access in winter through a mix of native/evergreen and exotic/deciduous trees
- Provides flexibility to respond to the often varying planting conditions within streets. One side of the street is often different to the other, particularly in relation to the presence of overhead powerlines.

4.2.4.2. Flexibility

The selection of which of the species to plant in each potential planting location within the identified priority streets will be at the discretion of the Council, dependent on:

- The existing and desired streetscape or park character
- Unique local factors such as special places warranting feature trees or the need to consider the character of adjoining heritage properties
- Findings from ground-truthing and detailed site investigations during the implementation phase
- Consultation with the community.

4.2.4.3. Street tree sizes

Consistent with the project Conditions of Approval (refer [Table 2](#)) and as indicated in [Table 7](#), the minimum installation size of offset trees will be:

- 200L in the Parramatta CBD, as defined by project planning approval
- 75L in all other streets.

As per the *Parramatta Public Domain Guidelines 2017*, it is CoPC's preference to install larger stock. The preferred minimum sizes at installation are:

- CBD areas: 400L
- Town centres, urban villages, neighbourhood and village active strips: 200L
- Other areas: 100L.

It is noted that due to the large number of trees required for this Tree Offset Strategy and the limited time frame (also refer [section 2.3.5.2](#)), it may not be possible to obtain suitable street tree species in Council’s preferred sizes. The availability of larger tree stock would need to be confirmed through further consultation with commercial growers – also refer [section 6](#).

The height, clear trunk height and trunk diameter of all trees is to conform with the requirements outlined in *Specifying Trees: a guide to assessment of tree quality* (Clark 2003) and Australian Standard 2303:2015 – *Tree Stock for Landscape Use*, unless stipulated otherwise by CoPC standard requirements.

4.2.4.4. Street tree spacing

In many areas, tree spacing will be driven by site constraints including:

- › Utilities including the locations of power poles, street light poles or substation kiosks, and the presence of underground or overhead utilities
- › Driveways
- › The need to maintain clear sightlines for traffic, including at driveways and intersections
- › Community concerns.

In areas where spacing is not dictated by the above factors or other constraints, the following typical spacings are adopted for offset tree planting. Spacings are based on the lower end of the suggested spacings outlined the *Parramatta Public Domain Guidelines 2017*, in order to achieve continuous canopy cover consistent with the heat mitigation objectives of this Tree Offset Strategy. Tree spacings are shown in [Table 8](#).

Table 8: Street tree size and spacing

Tree size	Height	Crown diameter/spread	Spacing
Small	<10m	<5m	6m
Medium	7-15m	5-12m	8m
Large	>15m	8m+	10m

4.2.5. Open space types for offset tree planting

The list of open space trees is different to the list of street trees. While most street trees can be grown in parks, the reverse is not always possible. Open space trees include species that require greater root volumes than those generally achievable in the streetscape environment, including species of large size. Due to generally reduced above and below ground constraints, open space trees are generally able to develop natural form. In addition, less stringent location-specific attributes apply to open space trees. For example, they do not include considerations such as compaction tolerance and tree litter.

There are two types of open space areas within the identified priority planting locations. The major difference lies in whether their primary use is for public recreation or biodiversity or natural area protection. The open space types and their locations are shown in [Figure 27](#). Open space types, their descriptions and location-specific attributes are summarised in [Table 9](#).

Table 9: Open space types and location-specific tree attributes

Open space type and description	Location-specific attributes
Open Space type 1: recreation park Open space areas with a majority public recreation purpose	› High canopy (>3m when mature) for uninhibited pedestrian movement › Species must not be known to be susceptible to limb drop › Tolerant of full sun › Minimum 8m canopy diameter when mature, unless restricted by proximity to park/recreation infrastructure or the presence of powerlines.

Open space type 2: biodiversity area Open space areas with a majority natural area component including bushland (remnant or re-planted), waterways and the like AND Natural area components associated with large or functionally diverse recreation parklands	› Preference for indigenous species representative of original ecological communities, otherwise native species › Range of canopy heights and widths for structural diversity and to maximise habitat opportunities › Support foraging needs of indigenous wildlife › Tolerant of full sun or partial shade.
--	---

4.2.5.1. Open space offset tree sizes

The selection of stock sizes for offset tree planting in open space areas needs to consider (also refer [Table 2](#)):

- › The location and use of the open space
- › Species and planting style: general park planting or biodiversity planting
- › Visual and amenity considerations including the time delay until potential benefits are realised
- › The requirements of relevant authorities including CoPC.

[Table 10](#) summarises the recommended pot sizes and rationale behind the sizes, based on the project objectives. It should be noted that final stock sizes may be subject to availability.

Table 10: Recommended pot sizes for open space planting

Open space type and planting location	Recommended size	Rationale
Type 1: recreation park		
Mass planted areas	Min 25L	› Less potential for conflict with recreation activities as typically removed from thoroughfares or activity zones › Less vulnerable to vandalism than individually planted trees, as typically removed from thoroughfares › Maximise value for money: many native trees adjust to their new locations better and grow faster when installed smaller. Smaller trees may potentially realise cooling benefits sooner than trees installed in larger pots. The latter require longer to adjust to the change in conditions between the nursery environment and the planting site › Quickly deliver tangible visual benefits: trees will develop quickly and will provide a display of flowers even when not yet mature.
Individual tree planting in turf	Min 75L	› Minimise potential for vandalism by installing taller trees where branches are harder to reach and to damage › Minimise potential for conflict with recreational use through greater clear trunk heights that enable walking or sitting under trees › Provide usable shade/heat mitigation sooner › Balance initial tree height with growth and establishment rates: many native trees adjust to their new locations better and grow faster when installed smaller.
Type 2: biodiversity area		
Mass planted areas adjoining streets or public areas	Min 75L	› Minimise potential for vandalism by installing taller trees where branches are harder to reach and to damage › Taller branching height to minimise potential for conflict with passing traffic including pedestrians, cyclists and vehicles › Balance initial tree height with growth and establishment rates: many native trees adjust to their new locations better and grow faster when installed smaller.
Other mass planted areas	5L	› Less vulnerable to vandalism than individually planted trees or trees adjoining streets, trails and other high activity zones › Maximise value for money: many native trees adjust to their new locations better and grow faster when installed smaller › Likely greater availability of biodiversity species and species less commonly grown commercially.

4.2.6. Maintenance of offset trees

4.2.6.1. Introduction

Urban trees require human intervention to ensure healthy growth and development and maintain them in a safe manner, according to the specific site conditions and requirements. Maintenance is key to healthy urban tree canopy, to maximise the potential benefits of urban trees and to minimise the potential risks.

The ongoing maintenance and operation costs of offset tree planting will remain the responsibility of TfNSW until satisfactory arrangements have been put in place for transfer to CoPC. Before the transfer, TfNSW must maintain offset tree planting to the design standards established by the Urban Design Requirements Report, as well as the maintenance requirements described in the following section. Offset trees are to be maintained for a minimum of 2 years from being planted.

4.2.6.2. Maintenance requirements

The following routine maintenance activities should be carried out in respect of all trees planted including streets and open space areas:

- › Formative pruning of young trees to:
 - Provide adequate clearances for pedestrians, vehicles, private property and sight lines
 - Provide clearances around services and utility lines.
- › Manage health:
 - Monitor soil moisture including regular watering during the establishment period
 - Monitoring and topping up mulch cover
 - Making health assessments including for pest and disease infestation
 - Checking tree health after unexpected events or emergencies such as severe storms.
- › Checking stakes and ties, and carrying out repair work as required
- › Weed removal
- › Replacement of lost, damaged or dead trees
- › Keep a register of all planted trees including species, location, installation size, inspection dates with health/condition

assessment for each inspection, and record of major interventions carried out including formative pruning and pest/disease control work.

All pruning work must be carried out in accordance with AS 4373–2007 Pruning of amenity trees.

Specific maintenance requirements for offset trees will be outlined in the register of planted trees.

4.2.6.3. Maintenance requirements for offset trees

Offset tree planting will be installed under the City of Parramatta Council Planting and Maintenance Contract, a standard contract developed as part of the pilot planting program (refer section 2.4.2). The contract includes a tree establishment and maintenance specification that requires the tree planting contractor to maintain the trees for a 26 week establishment period. The contract also includes provision for an extended maintenance period of an additional 78 weeks. The detailed maintenance tasks and activities required during this period are described in the specification that forms part of the contract documents.

If, for any reason the transfer of offset trees to CoPC cannot be completed during the two year maintenance and establishment period anticipated by the standard contract, an extension of the maintenance period under the contract is considered the most effective means to ensure ongoing maintenance of the trees until the transfer is completed.

[Blank Page]

5 OFFSET PLANTING STRATEGY



Chapter 5.

Offset planting strategy

This section provides the tree offset planting strategy for PLR – Stage 1, based on the objectives and principles outlined in [section 4](#). The tree offset planting strategy contains the following:

a) Detailed maps showing priority locations for street tree planting, based on the principles outlined in [4.1](#):

1. [Figure 27](#)
2. [Figure 28](#)
3. [Figure 29](#)
4. [Figure 30](#)

b) Detailed maps showing street typologies, for the purpose of identifying suitable tree species for planting in different locations (also refer [section 4.2.4](#)):

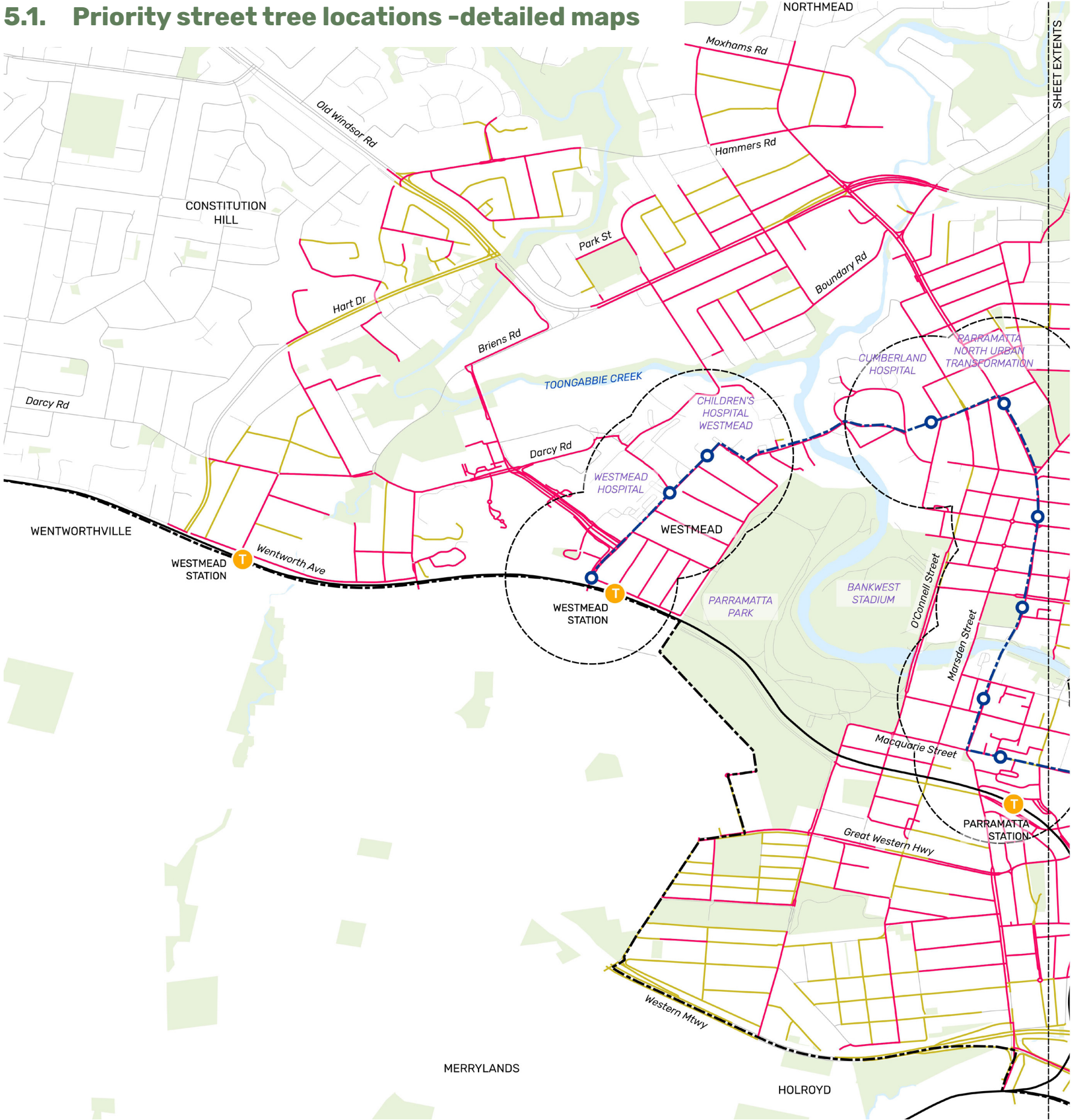
5. [Figure 31](#)
6. [Figure 32](#)
7. [Figure 33](#)
8. [Figure 34](#)

c) Detailed maps showing open space types, for the purpose of identifying suitable tree species and sizes (also refer [section 4.2.5](#))

(d) Offset tree species lists corresponding to street typologies and open space types: [section 5.3](#)

e) Master offset tree species list for the entire PLR – Stage 1 program of works: [section 5.5](#).

5.1. Priority street tree locations -detailed maps



LEGEND

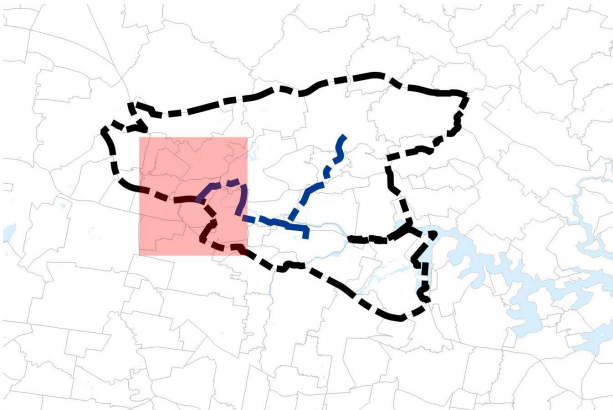
- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- Parkland/Open Space
- Priority Streets
 - Priority 1
 - Priority 2also refer to section 4.1.3.1

Notes:

- Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

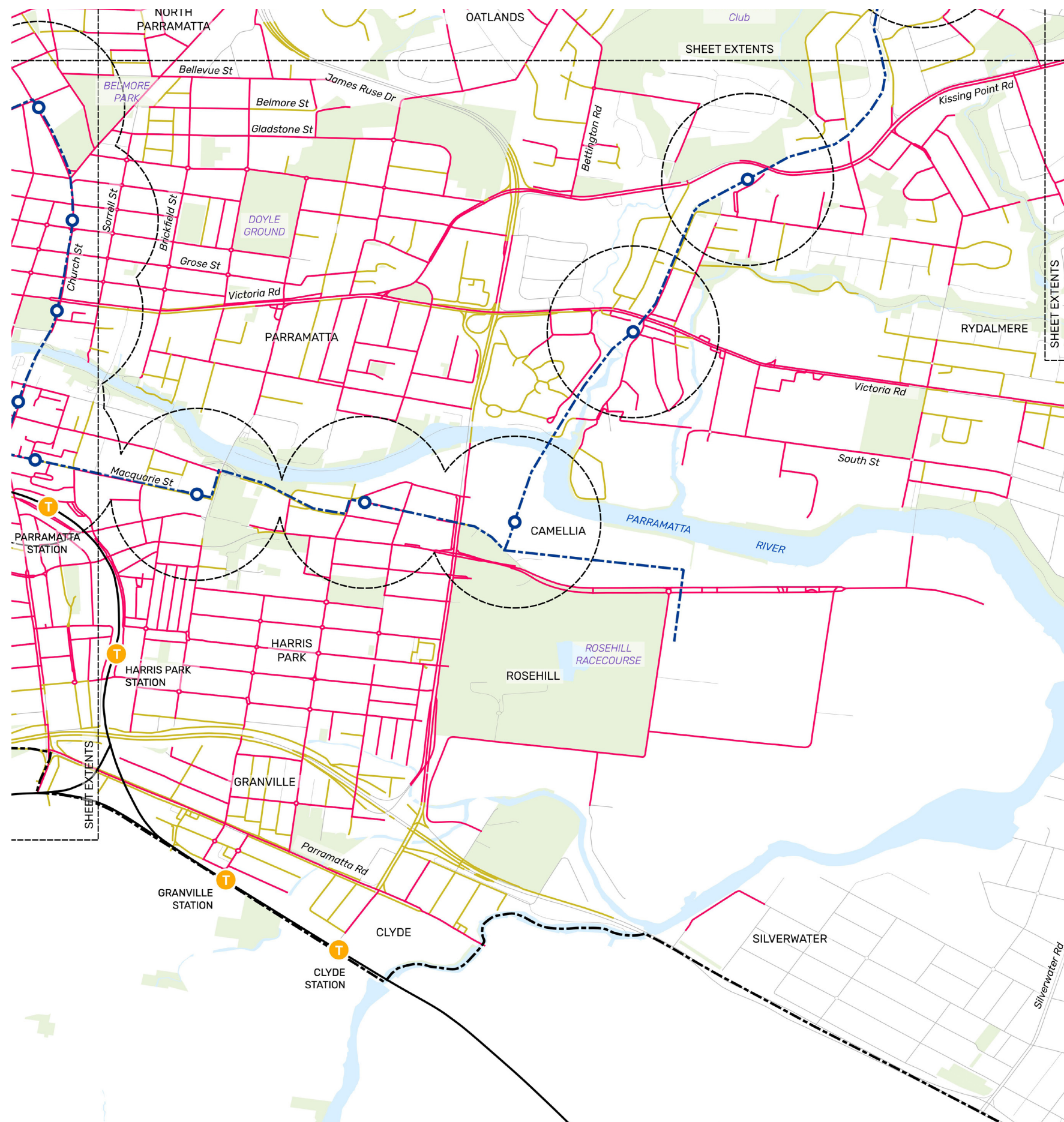
Also refer chapter 6.

KEY PLAN



N
1:12 000 @ A3
0 0.1 0.2 0.3 0.4 0.5 km

Figure 27: Priority offset planting locations for street trees. Sheet 1 of 4



LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- Parkland/Open Space

Priority Streets

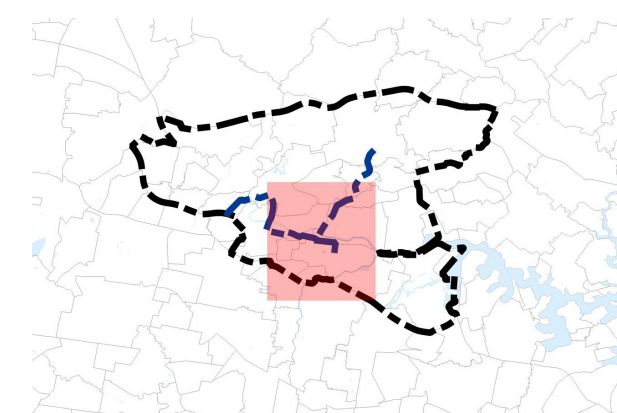
- Priority 1
 - Priority 2
- also refer to section 4.1.3.1

Notes:

- Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

Also refer chapter 6.

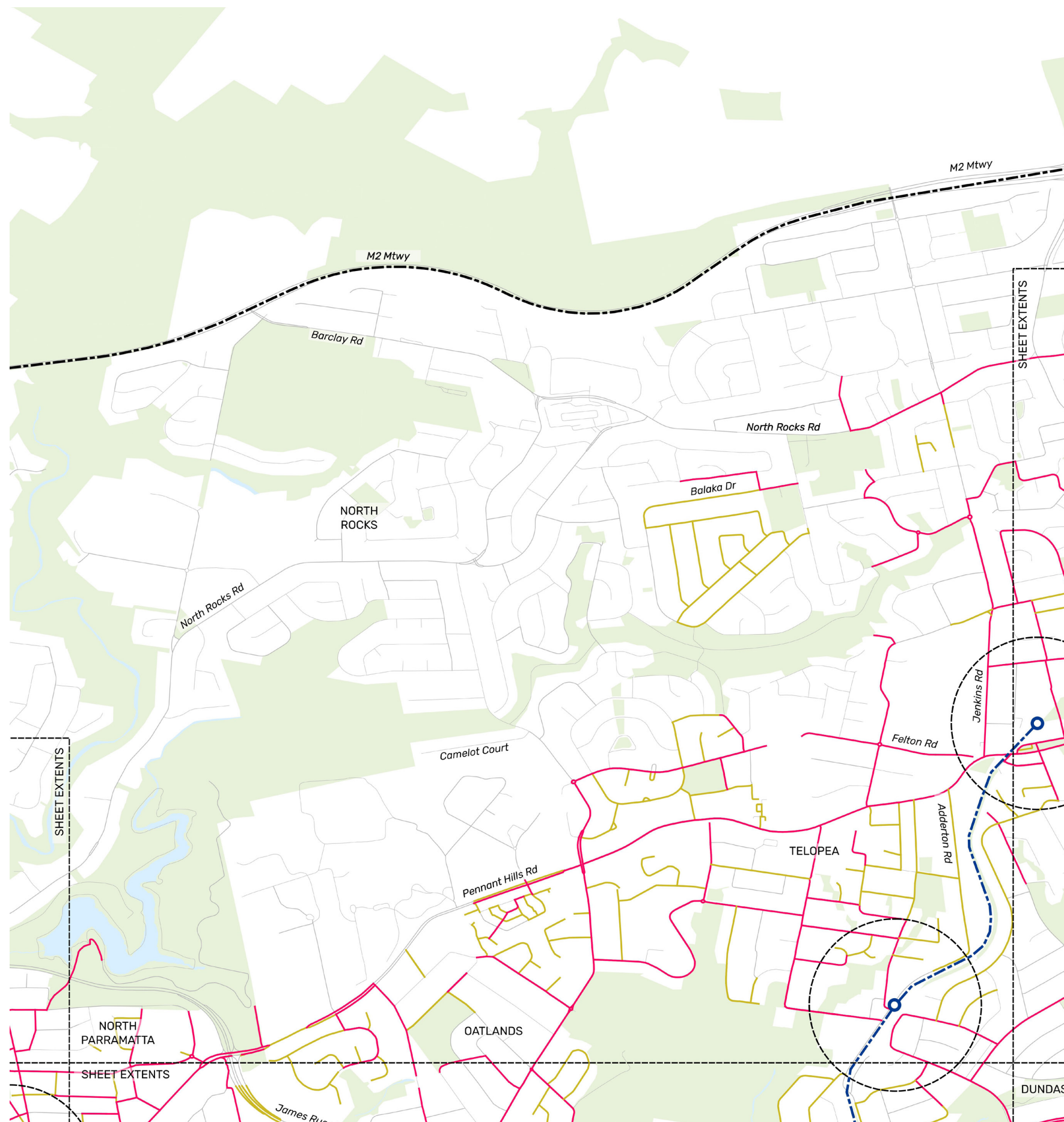
KEY PLAN



1:12 000 @ A3

0 0.1 0.2 0.3 0.4 0.5 km

Figure 28: Priority offset planting locations for street trees. Sheet 2 of 4



LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- Parkland/Open Space

Priority Streets

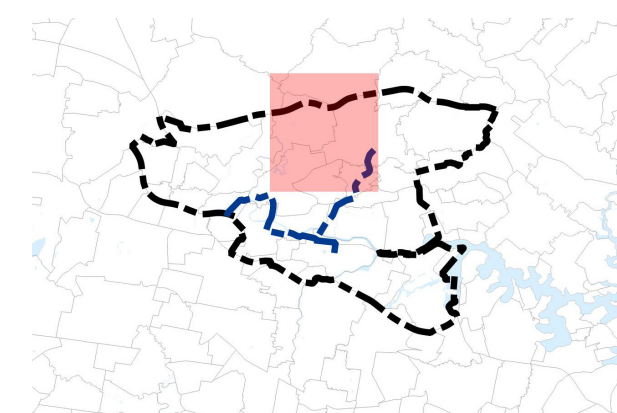
- Priority 1
 - Priority 2
- } also refer to [section 4.1.3.1](#)

Notes:

- › Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- › Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

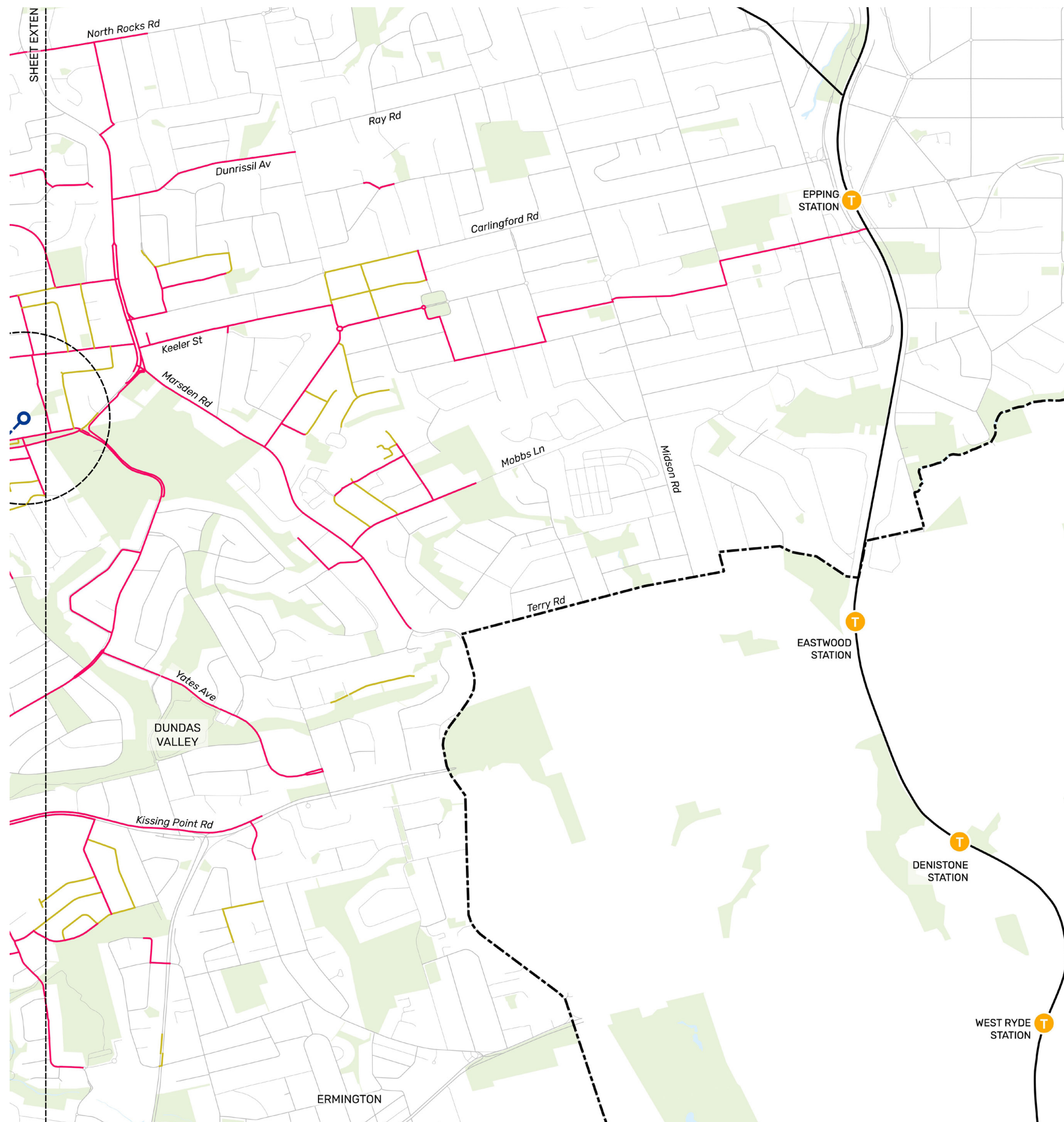
Also refer chapter 6.

KEY PLAN



N ↑
1:12 000 @ A3
0 0.1 0.2 0.3 0.4 0.5 km

Figure 29: Priority offset planting locations for street trees. Sheet 3 of 4



LEGEND

— LGA Boundary

— PLR Stops Offset 400m/5min Walk

— PLR Stops Offset 800m/10min Walk

— Road Centreline

● Proposed Light Rail Stops

— Proposed Stage 1 Light Rail Alignment

■ Parkland/Open Space

Priority Streets

— Priority 1

— Priority 2

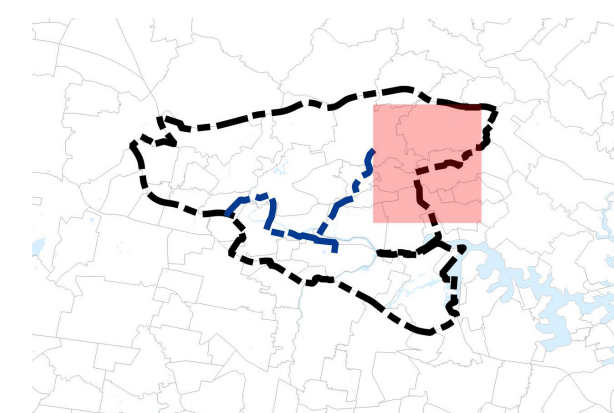
also refer to [section 4.1.3.1](#)

Notes:

- › Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- › Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

Also refer chapter 6.

KEY PLAN



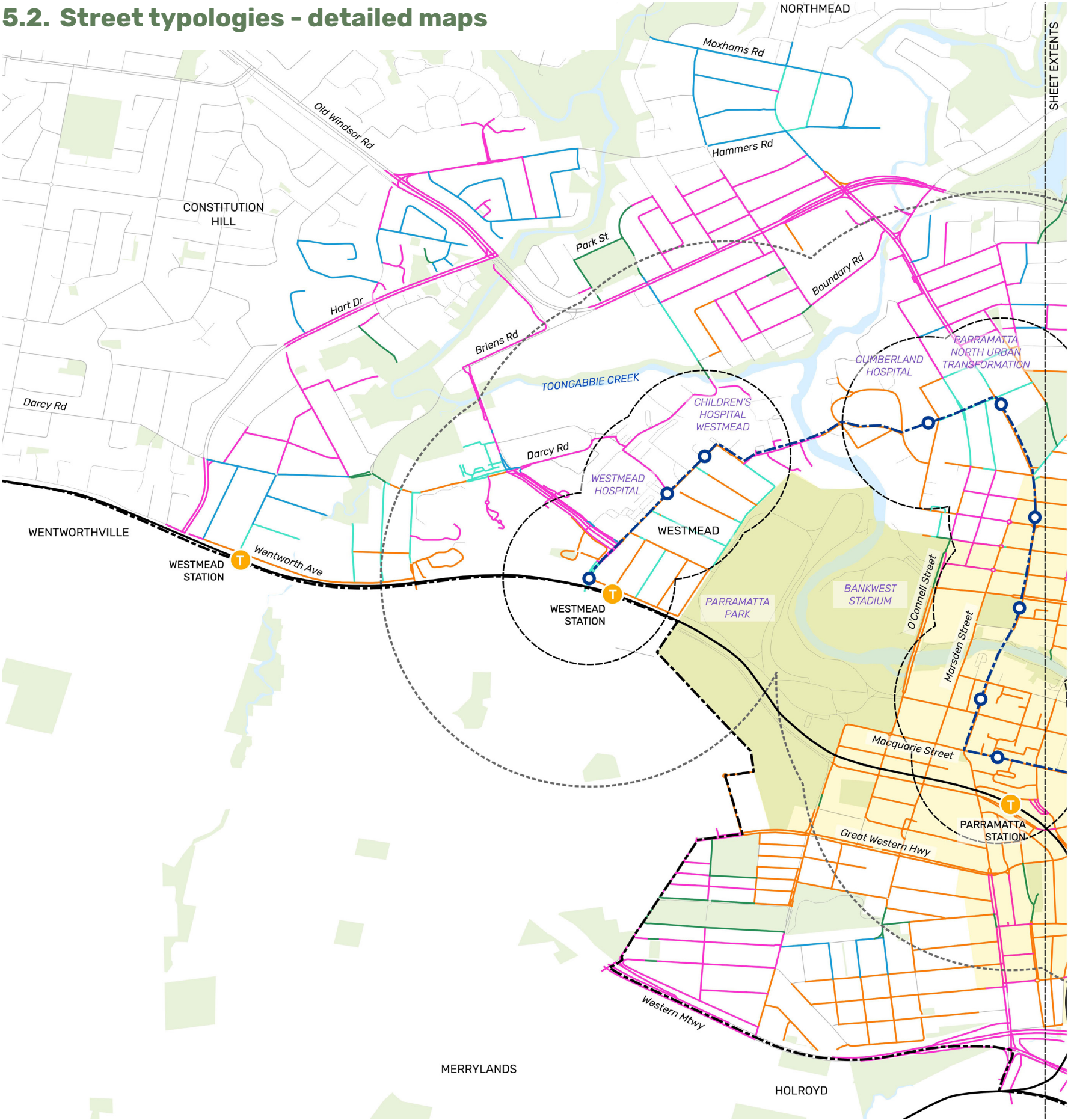
N

1:12 000 @ A3

0 0.1 0.2 0.3 0.4 0.5 km

Figure 30: Priority offset planting locations for street trees. Sheet 4 of 4

5.2. Street typologies - detailed maps



LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Parkland/Open Space
- Waterbodies
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- CBD Extents
- Street Typologies
 - Street Type 1
 - Street Type 2
 - Street Type 3
 - Street Type 4
 - Street Type 5refer to section 5.3 for species lists

Notes:

- Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

Also refer chapter 6.

KEY PLAN

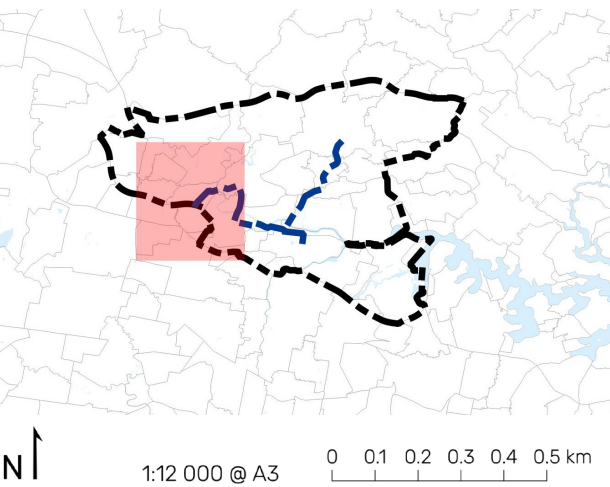
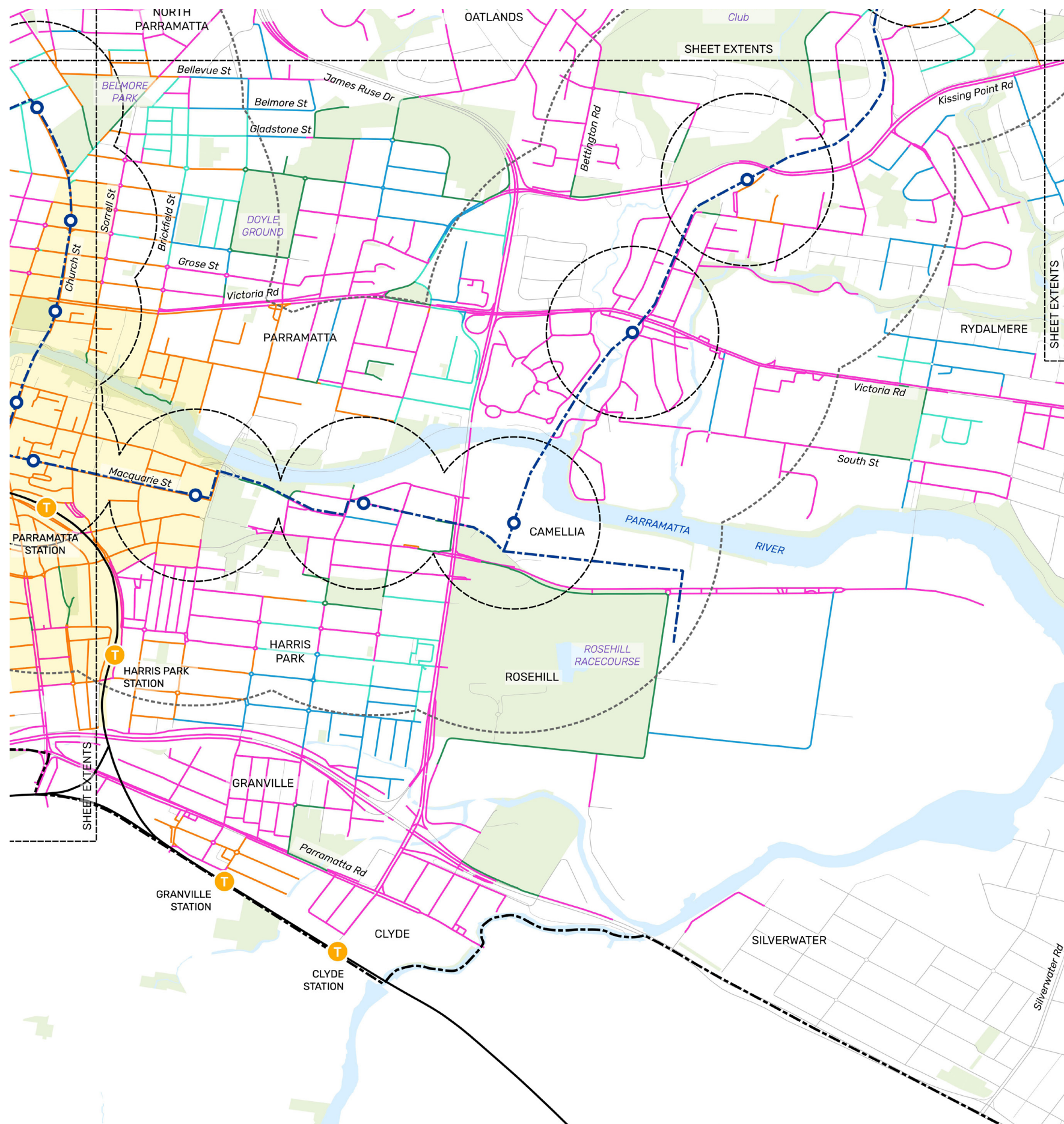


Figure 31: Street typologies. Sheet 1 of 4



LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Parkland/Open Space
- Waterbodies
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- CBD Extents

Street Typologies

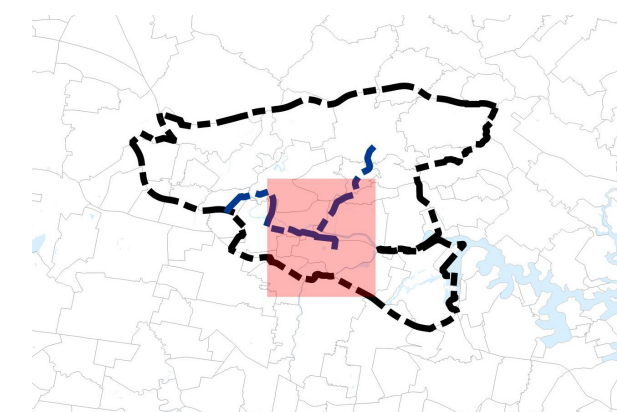
- Street Type 1
 - Street Type 2
 - Street Type 3
 - Street Type 4
 - Street Type 5
- refer to [section 5.3](#) for species lists

Notes:

- Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

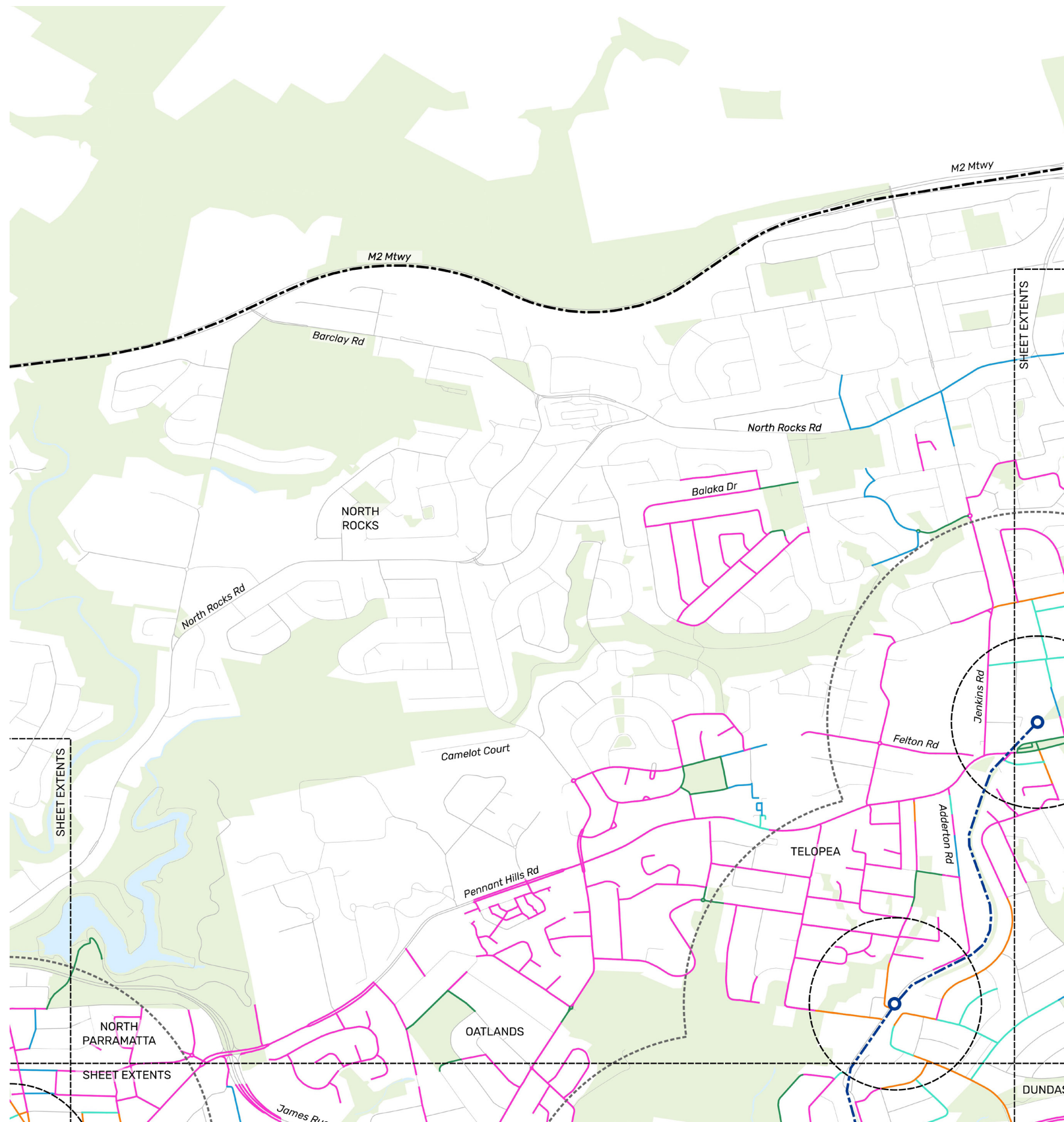
Also refer chapter 6.

KEY PLAN



N ↑
1:12 000 @ A3
0 0.1 0.2 0.3 0.4 0.5 km

Figure 32: Street typologies. Sheet 2 of 4



LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk

Parkland/Open Space

Waterbodies

Road Centreline

Proposed Light Rail Stops

Proposed Stage 1 Light Rail Alignment

CBD Extents

Street Typologies

Street Type 1

Street Type 2

Street Type 3

Street Type 4

Street Type 5

refer to [section 5.3](#)
for species lists

Notes:

- Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

Also refer chapter 6.

KEY PLAN

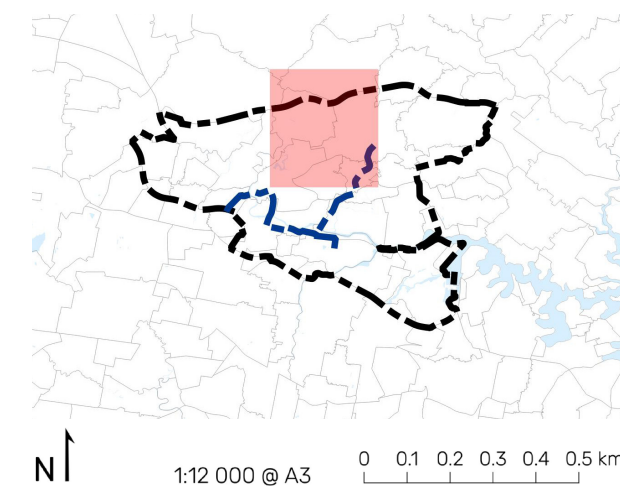


Figure 33: Street typologies. Sheet 3 of 4

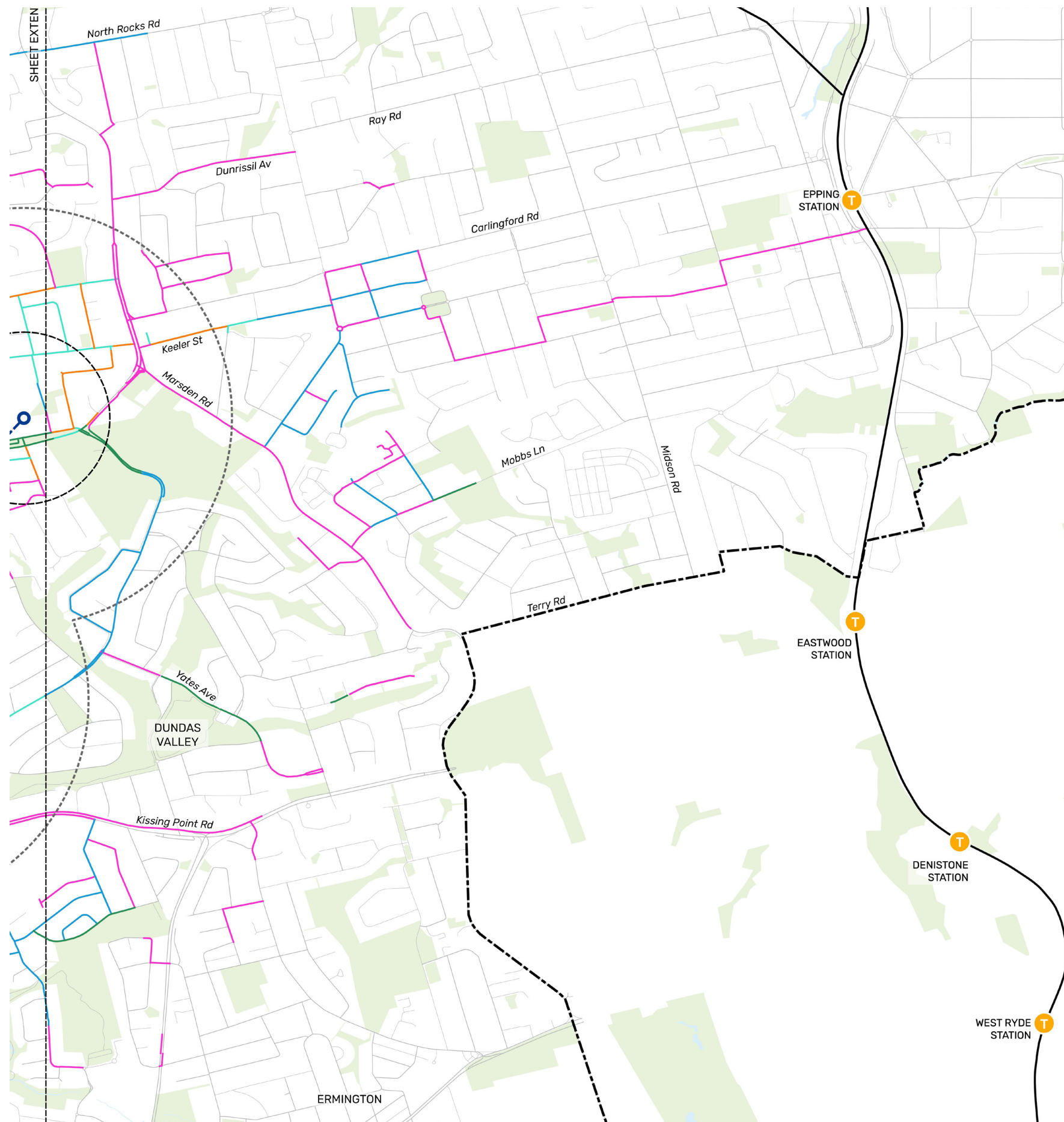


Figure 34: Street typologies. Sheet 4 of 4

LEGEND

- LGA Boundary
- PLR Stops Offset 400m/5min Walk
- PLR Stops Offset 800m/10min Walk
- Parkland/Open Space
- Waterbodies
- Road Centreline
- Proposed Light Rail Stops
- Proposed Stage 1 Light Rail Alignment
- CBD Extents

Street Typologies

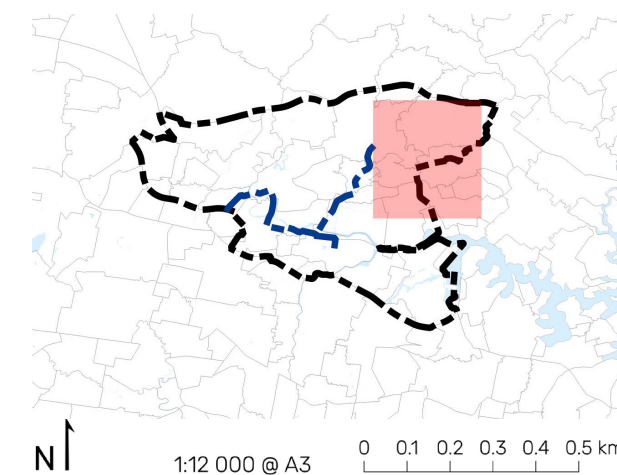
- Street Type 1
 - Street Type 2
 - Street Type 3
 - Street Type 4
 - Street Type 5
- refer to [section 5.3](#) for species lists

Notes:

- › Tree planting within the light rail walking catchment will take priority over tree planting outside the PLR catchment.
- › Further detailed work will be undertaken by CoPC and TfNSW to determine final planting locations: including:
 - Detailed analysis
 - Utility investigations
 - CoPC's capital works program
 - Community consultation.

Also refer chapter 6.

KEY PLAN



5.3. Offset trees species list

The selection of which offset tree species to plant in each priority location follows the steps in Figure 36 to determine the appropriate species for that location, in accordance with the principles outlined in section 4.2.2. For a master list of all tree species to be used as part of the PLR – Stage 1 tree offset planting program refer to

SELECTING WHICH TREE TO PLANT WHERE

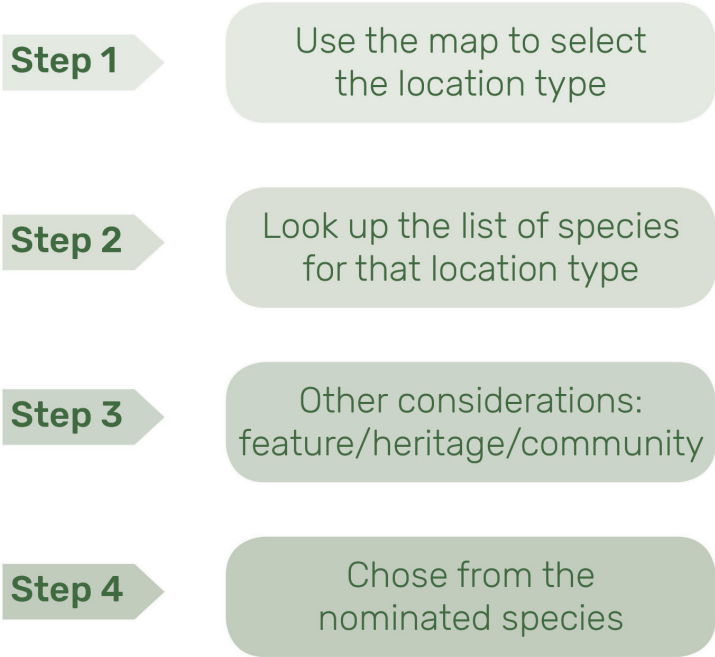


Figure 35: Species selection process

section 5.5.

5.3.1. Street tree planting species lists

The tree species for street tree planting in the various location types are listed in Table 11 to Table 15. The origin of each species (native, endemic, exotic) is detailed in Table 20.

Please note: The final selection of tree species will be consistent with this strategy and the Planning Approval but subject to detailed design and site investigations such as utilities, availability of tree stock, community consultation and Council’s capital works program.

Table 11: Street Type 1: medium centre trees – species list

STREET TYPE 1 - MEDIUM CENTRE TREES	
Botanical name	Common name
<i>Acer campestre</i> ‘Elsrijk’	Filed Maple ‘Elsrijk’
<i>Acer truncatum</i> x <i>Acer plata-noides</i> ‘Keithsform’	Norwegian Sunset Maple
<i>Acer truncatum</i> x <i>platanooides</i> ‘WARRENRED’ Pacific Sunset	Pacific Sunset Maple
<i>Backhousia citriodora</i>	Lemon Scented Myrtle
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Cercis siliquastrum</i>	Judas Tree
<i>Fraxinus excelsior</i> ‘Aurea’	Golden Ash
<i>Fraxinus griffithii</i>	Evergreen Ash
<i>Fraxinus ornus</i>	Flowering Ash
<i>Fraxinus ornus</i> ‘Meczek’	Meczek Designer Flowering Ash
<i>Fraxinus oxycarpa</i> ‘Raywoodii’	Claret Ash
<i>Fraxinus pennsylvanica</i> ‘Aerial’	Aerial Green Ash
<i>Fraxinus velutina</i>	Arizona Ash
<i>Gleditsia triacanthos</i> var. <i>inermis</i>	Thornless Honey Locust vari-eties
<i>Koelreuteria paniculata</i>	Golden Rain Tree
<i>Lagerstroemia indica</i> ‘Indian Summer’ Biloxi’	Biloxi’ Crepe Myrtle
<i>Lagerstroemia indica</i> ‘Natchez’	Natchez’ White Crepe Myrtle
<i>Libidibia ferrea</i>	Leopardwood Tree
<i>Liriodendron tulipifera</i> ‘Fastigiata’	Tulip Tree Fastigiate
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Magnolia grandiflora</i> ‘Exmouth’	Bull-bay Magnolia
<i>Melaleuca linariifolia</i>	Snow-in-Summer
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark
<i>Melia azedarach</i> ‘Elite’	Pink Euodia
<i>Michelia</i> x <i>alba</i>	White Sandalwood
<i>Nyssa sylvatica</i>	Tupelo
<i>Populus deltoides</i>	Cottonwood
<i>Pyrus calleryana</i> ‘Bradford’	Callery Pear
<i>Pyrus calleryana</i> ‘Chanticleer’	Chanticleer’ Pear

STREET TYPE 1 - MEDIUM CENTRE TREES	
Botanical name	Common name
<i>Quercus robur</i> ‘Fastigiata’	Cypress Oak
<i>Robinia pseudoacacia</i> ‘Frisia’	Golden Robinia
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree
<i>Sophora japonica</i> ‘Princeton Upright’	Princeton Upright Sophora
<i>Tilia cordata</i> ‘Greenspire’	Small-leaved Lime
<i>Tristaniopsis laurina</i> ‘Luscious’	Lucious’ Water Gum
<i>Waterhousia floribunda</i> ‘Green Avenue’	Weeping Lily Pilly

Table 12: Street Type 2: large centre trees – species list

STREET TYPE 2 - LARGE CENTRE TREES	
Botanical name	Common name
<i>Acer campestre</i> ‘Elsrijk’	Filed Maple ‘Elsrijk’
<i>Acer freemanii</i> ‘maple’	Autumn Blaze Maple
<i>Acer</i> x <i>freemanii</i> ‘Jeffersred’ Autumn Blaze	Autumn Blaze Lipstick Maple
<i>Acer rubrum</i> ‘October Glory’	October Glory Maple
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Corymbia citriodora</i>	Lemon-Scented Gum
<i>Corymbia maculata</i>	Spotted Gum
<i>Ficus benjamina</i>	Weeping Fig
<i>Ficus microcarpa</i> var. “Hillii”	Hill’s Weeping Fig
<i>Ficus obliqua</i>	Small-leaved Fig
<i>Ficus rubiginosa</i>	Port Jackson Fig
<i>Flindersia australis</i>	Australian Teak
<i>Fraxinus ornus</i>	Flowering Ash
<i>Fraxinus oxycarpa</i> ‘Raywoodii’	Claret Ash
<i>Fraxinus pennsylvanica</i> ‘Cimmaron’	‘Cimmzam’ Cimmaron

STREET TYPE 2 - LARGE CENTRE TREES	
Botanical name	Common name
<i>Fraxinus pennsylvanica</i> 'Urbdell'	Urbanite Ash
<i>Fraxinus velutina</i>	Arizona Ash
<i>Glochidion ferdinandi</i>	Cheese Tree
<i>Grevillea robusta</i>	Silky Oak
<i>Koelreuteria bipinnata</i>	Chinese Rain Tree
<i>Liriodendron tulipifera</i>	Tulip Tree
<i>Liriodendron tulipifera</i> 'Fastigiata'	Tulip Tree Fastigate
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Lophostemon confertus</i>	Brush Box
<i>Magnolia grandiflora</i>	Southern Magnolia
<i>Magnolia grandiflora</i> 'Exmouth'	Bull-bay Magnolia
<i>Melia azedarach</i> 'Elite'	Pink Euodia
<i>Nyssa sylvatica</i>	Tupelo
<i>Platanus orientalis</i>	London Plane Tree
<i>Platanus orientalis</i> 'Digitata'	Oriental Plane
<i>Quercus ilex</i>	Holly Oak
<i>Quercus palustris</i>	Pin Oak
<i>Robinia pseudoacacia</i> 'Frisia'	Golden Robinia
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree
<i>Toona ciliata</i>	Australian Red Cedar
<i>Ulmus glabra</i> 'Lutescens'	Golden Elm
<i>Ulmus parvifolia</i> 'Todd'	Chinese Elm 'Todd'
<i>Ulmus procera</i>	English Elm
<i>Zelkova serrata</i> 'Green Vase'	Japanese Zelkova

Table 13: Street Type 3: medium urban trees - species list

STREET TYPE 3 - MEDIUM URBAN TREES	
Botanical name	Common name
<i>Acacia binervia</i>	Coast Myall
<i>Acacia floribunda</i>	White Sallow Wattle
<i>Acacia parramattensis</i>	Parramatta Wattle

STREET TYPE 3 - MEDIUM URBAN TREES	
Botanical name	Common name
<i>Acer campestre</i> 'Elsrijk'	Filed Maple 'Elsrijk'
<i>Acer campestre</i> – 'Evelyn'	Queen Elizabeth Maple
<i>Acer truncatum</i> x <i>Acer platanoides</i> 'Keithsform'	Norwegian Sunset Maple
<i>Acer truncatum</i> x <i>platanoides</i> 'WARRENRED' Pacific Sunset	Pacific Sunset Maple
<i>Acmena smithii</i>	Lillypilly
<i>Agonis flexuosa</i>	Willow Myrtle
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Alphitonia excelsa</i>	Red Ash
<i>Angophora hispida</i>	Dwarf Apple Gum
<i>Auranticarpa rhombifolia</i> (syn <i>Pittosporum rhombifolia</i>)	Australian Laurel
<i>Backhousia citriodora</i>	Lemon Scented Myrtle
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Brachychiton populneus</i>	Kurrajong
<i>Buckinghamia celsissima</i>	Ivory Curl Tree
<i>Callistemon</i> 'Kings Park Special'	Callistemon 'Kingspark Special'
<i>Celtis occidentalis</i>	Common Hackberry
<i>Corymbia ficifolia</i>	Red Flowering Gum
<i>Cupaniopsis anacardioides</i>	Tuckeroo
<i>Elaeocarpus eumundi</i>	Quondong
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Eucalyptus cosmophylla</i>	Cup Gum
<i>Eucalyptus leucoxylon</i> ssp. <i>megalocarpa</i>	Large-fruited Blue Gum
<i>Eucalyptus ovata</i>	Swamp Gum
<i>Eucalyptus platypus</i>	Round-leaved Moort
<i>Eucalyptus sideroxylon</i> "Rosea"	Pink-flowering Ironbark
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Fraxinus excelsior</i> 'Aurea'	Golden Ash
<i>Fraxinus griffithii</i>	Evergreen Ash
<i>Fraxinus angustifolia</i> subsp. <i>oxycarpa</i> 'Raywoodi'	Claret Ash
<i>Fraxinus pennsylvanica</i> 'Aerial'	Aerial Green Ash

STREET TYPE 3 - MEDIUM URBAN TREES	
Botanical name	Common name
<i>Fraxinus velutina</i>	Arizona Ash
<i>Geijera parviflora</i>	Wilga
<i>Gleditsia triacanthos</i> var. <i>inermis</i>	Thornless Honey Locust varieties
<i>Glochidion ferdinandi</i>	Cheese Tree
<i>Hibiscus tiliaceus</i> 'Rubra'	Native Hibiscus
<i>Hymenosporum flavum</i>	Native Frangipani
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Koelreuteria paniculata</i>	Golden Rain Tree
<i>Lagerstroemia indica</i> 'Indian Summer' Biloxi'	Biloxi' Crepe Myrtle
<i>Leptospermum petersonii</i>	Lemon Scented Tea Tree
<i>Libidibia ferrea</i>	Leopardwood Tree
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Liriodendron tulipifera</i> 'Fastigiata'	Tulip Tree Fastigate
<i>Magnolia grandiflora</i> 'Exmouth'	Bull-bay Magnolia
<i>Malus adams</i> 'crab apple'	Crab Apple
<i>Melaleuca decora</i>	White Feather Honeymyrtle
<i>Melaleuca linariifolia</i>	Snow-in-Summer
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Melia azedarach</i> 'Elite'	Pink Euodia
<i>Melia azederach</i>	White Cedar
<i>Metrosideros excelsa</i>	New Zealand Christmas Bush
<i>Michelia</i> x <i>alba</i>	White Sandalwood
<i>Nyssa sylvatica</i>	Tupelo
<i>Photinia robusta</i>	Red Leafed Photinia
<i>Pistacia chinensis</i>	Chinese Pistachio
<i>Populus deltoides</i>	Cottonwood
<i>Prunus campanulata</i>	Bell Flower Cherry
<i>Prunus cerasifera</i>	Black Cherry Plum
<i>Pyrus calleryana</i> 'Bradford'	Callery Pear
<i>Pyrus calleryana</i> 'Chanticleer'	Chanticleer' Pear
<i>Quercus robur</i> 'Fastigiata'	Cypress Oak

STREET TYPE 3 - MEDIUM URBAN TREES	
Botanical name	Common name
<i>Robinia pseudoacacia</i> ‘Frisia’	Golden Robinia
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree
<i>Sophora japonica</i> ‘Princeton Upright’	Princeton Upright Sophora
<i>Stenocarpus salignus</i>	Red Silky Oak
<i>Stenocarpus sinuatus</i>	Firewheel Tree
<i>Syzygium luehmannii</i>	Riberry
<i>Tibouchina lepidota</i> ‘Alstoneville’	Alstonville Tibouchina
<i>Tilia cordata</i> ‘Greenspire’	Small-leaved Lime
<i>Tristaniopsis laurina</i>	Water Gum
<i>Tristaniopsis laurina</i> ‘Luscious’	Lucious’ Water Gum
<i>Waterhousia floribunda</i> ‘Green Avenue’	Weeping Lily Pilly
<i>Xanthostemon chrysanthus</i>	Golden Penda

Table 14: Street Type 4: large urban trees – species list

STREET TYPE 4 - LARGE URBAN TREES	
Botanical name	Common name
<i>Acer freemanii</i> ‘maple’	Autumn Blaze Maple
<i>Acer x freemanii</i> ‘Jeffersred’ <i>Autumn Blaze</i>	Autumn Blaze Lipstick Maple
<i>Acer rubrum</i> ‘October Glory’	October Glory Maple
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree
<i>Brachychiton populneus</i>	Kurrajong
<i>Celtis occidentalis</i>	Common Hackberry
<i>Ceratopetalum apetalum</i>	Coachwood
<i>Corymbia citriodora</i>	Lemon-Scented Gum
<i>Corymbia gummifera</i>	Red Bloodwood
<i>Corymbia maculata</i>	Spotted Gum

STREET TYPE 4 - LARGE URBAN TREES	
Botanical name	Common name
<i>Eucalyptus botryoides</i>	Bangalay
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus globoidea</i>	White Stringybark
<i>Eucalyptus longifolia</i>	Woollybutt
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus ovata</i>	Swamp Gum
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus sideroxylon</i>	Red-flowering Ironbark
<i>Eucalyptus sideroxylon</i> “Rosea”	Pink-flowering Ironbark
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Ficus benjamina</i>	Weeping Fig
<i>Ficus microcarpa</i> var. “Hillii”	Hill’s Weeping Fig
<i>Ficus obliqua</i>	Small-leaved Fig
<i>Ficus rubiginosa</i>	Port Jackson Fig
<i>Flindersia australis</i>	Australian Teak
<i>Fraxinus excelsior</i> ‘Aurea’	Golden Ash
<i>Fraxinus angustifolia</i> subsp. <i>oxycarpa</i> ‘Raywoodi’	Claret Ash
<i>Fraxinus pennsylvanica</i> ‘Cimmaron’	‘Cimmzam’ Cimmaron
<i>Fraxinus pennsylvanica</i> ‘Urbdell’	Urbanite Ash
<i>Fraxinus velutina</i>	Arizona Ash
<i>Grevillea robusta</i>	Silky Oak
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Koelreuteria bipinnata</i>	Chinese Rain Tree
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Liriodendron tulipifera</i>	Tulip Tree
<i>Lophostemon confertus</i>	Brush Box
<i>Magnolia grandiflora</i>	Southern Magnolia
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Melia azedarach</i> ‘Elite’	Pink Euodia
<i>Melia azederach</i>	White Cedar
<i>Paulownia tomentosa</i>	Empress Tree
<i>Pistacia chinensis</i>	Chinese Pistachio

STREET TYPE 4 - LARGE URBAN TREES	
Botanical name	Common name
<i>Platanus orientalis</i>	London Plane Tree
<i>Platanus orientalis</i> ‘Digitata’	Oriental Plane
<i>Podocarpus elatus</i>	Plum Pine
<i>Quercus ilex</i>	Holly Oak
<i>Quercus palustris</i>	Pin Oak
<i>Quercus suber</i>	Cork Oak
<i>Robinia pseudoacacia</i> ‘Frisia’	Golden Robinia
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree
<i>Schinus molle</i> var. <i>areira</i>	Peppercorn Tree
<i>Stenocarpus salignus</i>	Red Silky Oak
<i>Stenocarpus sinuatus</i>	Firewheel Tree
<i>Syncarpia glomulifera</i>	Turpentine
<i>Syzygium luehmannii</i>	Riberry
<i>Syzygium paniculatum</i>	Magenta Cherry
<i>Toona ciliata</i>	Australian Red Cedar
<i>Ulmus glabra</i> ‘Lutescens’	Golden Elm
<i>Ulmus parvifolia</i> ‘Todd’	Chinese Elm ‘Todd’
<i>Ulmus procera</i>	English Elm
<i>Waterhousia floribunda</i> ‘Green Avenue’	Weeping Lily Pilly
<i>Zelkova serrata</i> ‘Green Vase’	Japanese Zelkova

Table 15: Street Type 5: park edge trees – species list

STREET TYPE 5 - PARK EDGE TREES	
Botanical name	Common name
<i>Acer freemanii</i> ‘maple’	Autumn Blaze Maple
<i>Acer x freemanii</i> ‘Jeffersred’ Autumn Blaze	Autumn Blaze Lipstick Maple
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Brachychiton populneus</i>	Kurrajong
<i>Castanospermum australe</i>	Black Bean

STREET TYPE 5 - PARK EDGE TREES	
Botanical name	Common name
<i>Celtis occidentalis</i>	Common Hackberry
<i>Ceratopetalum apetalum</i>	Coachwood
<i>Corymbia gummifera</i>	Red Bloodwood
<i>Corymbia maculata</i>	Spotted Gum
<i>Eucalyptus botryoides</i>	Bangalay
<i>Eucalyptus elata</i>	River Peppermint
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus globoidea</i>	White Stringybark
<i>Eucalyptus longifolia</i>	Woollybutt
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Eucalyptus sideroxylon</i>	Red-flowering Ironbark
<i>Eucalyptus sideroxylon "Rosea"</i>	Pink-flowering Ironbark
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Ficus benjamina</i>	Weeping Fig
<i>Ficus macrophylla</i>	Moreton Bay Fig
<i>Ficus microcarpa</i> var. "Hillii"	Hill's Weeping Fig
<i>Ficus obliqua</i>	Small-leaved Fig
<i>Ficus rubiginosa</i>	Port Jackson Fig
<i>Flindersia australis</i>	Australian Teak
<i>Fraxinus angustifolia</i> subsp. <i>oxycarpa</i> 'Raywoodi'	Claret Ash
<i>Fraxinus pennsylvanica</i> 'Cimmaron'	'Cimmzam' Cimmaron
<i>Fraxinus pennsylvanica</i> 'Urbdell'	Urbanite Ash
<i>Fraxinus velutina</i>	Arizona Ash
<i>Grevillea robusta</i>	Silky Oak
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Koelreuteria bipinnata</i>	Chinese Rain Tree
<i>Liriodendron tulipifera</i>	Tulip Tree
<i>Lophostemon confertus</i>	Brush Box
<i>Magnolia grandiflora</i>	Southern Magnolia

STREET TYPE 5 - PARK EDGE TREES	
Botanical name	Common name
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Paulownia tomentosa</i>	Empress Tree
<i>Pistacia chinensis</i>	Chinese Pistachio
<i>Platanus orientalis</i>	London Plane Tree
<i>Platanus orientalis</i> 'Digitata'	Oriental Plane
<i>Podocarpus elatus</i>	Plum Pine
<i>Quercus palustris</i>	Pin Oak
<i>Quercus suber</i>	Cork Oak
<i>Schinus molle</i> var. <i>areira</i>	Peppercorn Tree
<i>Stenocarpus salignus</i>	Red Silky Oak
<i>Stenocarpus sinuatus</i>	Firewheel Tree
<i>Syncarpia glomulifera</i>	Turpentine
<i>Syzygium paniculatum</i>	Magenta Cherry
<i>Toona ciliata</i>	Australian Red Cedar
<i>Ulmus glabra</i> 'Lutescens'	Golden Elm
<i>Ulmus parvifolia</i> 'Todd'	Chinese Elm 'Todd'

5.3.2. Open space tree planting species list

The tree species for street tree planting in the various location types are listed in [Table 16](#) to [Table 17](#).

Table 16: Open Space type 1: recreation park trees - species list

OPEN SPACE TYPE 1 - RECREATION PARK TREES	
Botanical names	Common name
<i>Acacia binervia</i>	Coast Myall
<i>Acer freemanii</i> 'maple'	Autumn Blaze Maple
<i>Acer x freemanii</i> 'Jeffersred'	Autumn Blaze Lipstick Maple
<i>Autumn Blaze</i>	
<i>Acer rubrum</i> 'October Glory'	October Glory Maple
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Brachychiton populneus</i>	Kurrajong
<i>Castanospermum australe</i>	Black Bean
<i>Casuarina cunninghamiana</i>	She-Oak

OPEN SPACE TYPE 1 - RECREATION PARK TREES	
Botanical names	Common name
<i>Ceratopetalum apetalum</i>	Coachwood
<i>Corymbia citriodora</i>	Lemon-Scented Gum
<i>Corymbia gummifera</i>	Red Bloodwood
<i>Eucalyptus botryoides</i>	Bangalay
<i>Eucalyptus elata</i>	River Peppermint
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus globoidea</i>	White Stringybark
<i>Eucalyptus longifolia</i>	Woollybutt
<i>Eucalyptus microcorys</i>	Tallowwood
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Eucalyptus sideroxylon</i>	Red-flowering Ironbark
<i>Eucalyptus sideroxylon "Rosea"</i>	Pink-flowering Ironbark
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Ficus benjamina</i>	Weeping Fig
<i>Ficus macrophylla</i>	Moreton Bay Fig
<i>Ficus microcarpa</i> var. "Hillii"	Hill's Weeping Fig
<i>Ficus obliqua</i>	Small-leaved Fig
<i>Ficus rubiginosa</i>	Port Jackson Fig
<i>Flindersia australis</i>	Australian Teak
<i>Fraxinus ornus</i>	Flowering Ash
<i>Fraxinus velutina</i>	Arizona Ash
<i>Grevillea robusta</i>	Silky Oak
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Koelreuteria bipinnata</i>	Chinese Rain Tree
<i>Liriodendron tulipifera</i>	Tulip Tree
<i>Lophostemon confertus</i>	Brush Box
<i>Magnolia grandiflora</i>	Southern Magnolia
<i>Melia azedarach</i> 'Elite'	Pink Euodia
<i>Metrosideros excelsa</i>	New Zealand Christmas Bush
<i>Paulownia tomentosa</i>	Empress Tree
<i>Pistacia chinensis</i>	Chinese Pistachio
<i>Podocarpus elatus</i>	Plum Pine

OPEN SPACE TYPE 1 - RECREATION PARK TREES	
Botanical names	Common name
<i>Quercus ilex</i>	Holly Oak
<i>Quercus palustris</i>	Pin Oak
<i>Quercus suber</i>	Cork Oak
<i>Schinus molle</i> var. <i>areira</i>	Peppercorn Tree
<i>Stenocarpus salignus</i>	Red Silky Oak
<i>Stenocarpus sinuatus</i>	Firewheel Tree
<i>Syzygium paniculatum</i>	Magenta Cherry
<i>Toona ciliata</i>	Australian Red Cedar
<i>Ulmus glabra</i> ‘Lutescens’	Golden Elm
<i>Ulmus parvifolia</i> ‘Todd’	Chinese Elm ‘Todd’
<i>Ulmus procera</i>	English Elm
<i>Zelkova serrata</i> ‘Green Vase’	Japanese Zelkova

5.3.2.1. Biodiversity planting

Biodiversity planting will occur in locations connected to bushland and native vegetation remnants or fauna hotspots, generally within proximity to the Carlingford corridor. Offset tree planting species for biodiversity planting must be chosen to be consistent with indigenous ecological communities in the locations where they are to be planted - also refer to **Figure 44** in **Chapter 8. Appendix 1**.

Refer to **Figure 43** and **Table 26** in **Chapter 9. Appendix 1**, to determine the ecological community to represent.

Table 17: Open space type 2: biodiversity area trees – species list

OPEN SPACE TYPE 1 - BIODIVERSITY AREA TREES	
Botanical name	Common name
<i>Acacia binervia</i>	Coast Myall
<i>Acacia floribunda</i>	White Sallow Wattle
<i>Acacia parramattensis</i>	Parramatta Wattle
<i>Acmena smithii</i>	Lillypilly
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Alphitonia excelsa</i>	Red Ash
<i>Angophora costata</i>	Smooth-barked Apple

OPEN SPACE TYPE 1 - BIODIVERSITY AREA TREES	
Botanical name	Common name
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Argiceras corniculatum</i>	River Mangrove
<i>Avicennia marina</i>	Grey Mangrove
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Callistemon salignus</i>	Willow Bottlebrush
<i>Casuarina cunninghamiana</i>	She-Oak
<i>Casuarina glauca</i>	Swamp Oak
<i>Corymbia citriodora</i>	Lemon-Scented Gum
<i>Corymbia maculata</i>	Spotted Gum
<i>Cupaniopsis anacardioides</i>	Tuckeroo
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Eucalyptus amplifolia</i>	Cabbage Gum
<i>Eucalyptus botryoides</i>	Bangalay
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark
<i>Eucalyptus curtisii</i>	Plunkett Mallee
<i>Eucalyptus elata</i>	River Peppermint
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus fibrosa</i>	Red Ironbark
<i>Eucalyptus globoidea</i>	White Stringybark
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus ovata</i>	Swamp Gum
<i>Eucalyptus paniculata</i>	Grey Ironbark
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Eucalyptus punctata</i>	Grey Gum
<i>Eucalyptus resinifera</i>	Red Mahogany
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Glochidion ferdinandi</i>	Cheese Tree
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Melaleuca decora</i>	White Feather Honeymyrtle
<i>Melaleuca ericifolia</i>	Swamp Paperbark

OPEN SPACE TYPE 1 - BIODIVERSITY AREA TREES	
Botanical name	Common name
<i>Melaleuca linariifolia</i>	Snow-in-Summer
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Syncarpia glomulifera</i>	Turpentine
<i>Tristaniopsis laurina</i>	Water Gum

Table 18: Trees suitable for use under overhead power line

TREES SUITABLE UNDER POWERLINES	
Botanical name	Common name
<i>Acacia floribunda</i>	White Sallow Wattle
<i>Acacia parramattensis</i>	Parramatta Wattle
<i>Acer truncatum</i> x <i>Acer platanoides</i> ‘Keithsform’	Norwegian Sunset Maple
<i>Acmena smithii</i> ‘Minor’	Dwarf Lillypilly
<i>Agonis flexuosa</i>	Willow Myrtle
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora costata</i> ‘Little Gum-ball’	Angophora ‘Little Gumball’
<i>Angophora hispida</i>	Dwarf Apple Gum
<i>Backhousia citriodora</i>	Lemon Scented Myrtle
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Buckinghamia celsissima</i>	Ivory Curl Tree
<i>Callicoma serratifolia</i>	Black Wattle
<i>Callistemon ‘Kings Park Special’</i>	Callistemon ‘Kingspark Special’
<i>Callistemon salignus</i>	Willow Bottlebrush
<i>Callistemon viminalis</i> ‘Hannah Ray’	Red Bottlebrush
<i>Catalpa bignonioides</i> ‘Nana’	Dwarf Indian Bean Tree
<i>Ceratopetalum gummiferum</i>	New South Wales Christmas Bush
<i>Corymbia citriodora</i>	Lemon-Scented Gum
<i>Corymbia maculata</i>	Spotted Gum
<i>Cupaniopsis anacardioides</i>	Tuckeroo

TREES SUITABLE UNDER POWERLINES	
Botanical name	Common name
<i>Elaeocarpus eumundi</i>	Quondong
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Eucalyptus cosmophylla</i>	Cup Gum
<i>Eucalyptus leucoxylon</i> ‘Euky Dwarf’	Yellow Gum
<i>Eucalyptus leucoxylon</i> ‘Rosea’	Red-flowering Yellow Gum
<i>Eucalyptus leucoxylon</i> ssp. <i>Megalocarpa</i>	Large-fruited Blue Gum
<i>Eucalyptus platypus</i>	Round-leaved Moort
<i>Fraxinus excelsior</i> ‘Aurea’	Golden Ash
<i>Fraxinus griffithii</i>	Evergreen Ash
<i>Geijera parviflora</i>	Wilga
<i>Gordonia axillaris</i> (syn. <i>Poly-spora axillaris</i>)	Fried Egg Plant
<i>Hibiscus tiliaceus</i> ‘Rubra’	Native Hibiscus
<i>Jacaranda mimosifolia</i>	Jacaranda
<i>Koelreuteria paniculata</i>	Golden Rain Tree
<i>Lagerstroemia indica</i>	Crepe Myrtle
<i>Lagerstroemia indica</i> ‘Indian Summer’ ‘Tuscarora’	Tuscarora’ Crepe Myrtle
<i>Lagerstroemia indica</i> ‘Indian Summer’ Biloxi’	Biloxi’ Crepe Myrtle
<i>Leptospermum petersonii</i>	Lemon Scented Tea Tree
<i>Libidibia ferrea</i>	Leopardwood Tree
<i>Liquidambar styraciflua</i>	Liquidambar
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Lophostemon confertus</i>	Brush Box
<i>Malus adams</i> ‘crab apple’	Crab Apple
<i>Melaleuca decora</i>	White Feather Honey myrtle
<i>Melaleuca ericifolia</i>	Swamp Paperbark
<i>Melaleuca linariifolia</i>	Snow-in-Summer
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Melia azedarach</i> ‘Elite’	Pink Euodia
<i>Melia azederach</i>	White Cedar

TREES SUITABLE UNDER POWERLINES	
Botanical name	Common name
<i>Olea europaea</i>	European Olive Tree
<i>Photinia glabra</i>	Japanese Photinia
<i>Photinia glabra</i> ‘Rubens’	Dwarf Photinia
<i>Pistacia chinensis</i>	Chinese Pistachio
<i>Populus deltoides</i>	Cottonwood
<i>Prunus armeniaca</i> ‘Moorpark’	Moorpark Apricot
<i>Prunus campanulata</i>	Bell Flower Cherry
<i>Prunus cerasifera</i> ‘Nigra’	Black Cherry Plum
<i>Prunus cerasifera</i> ‘Oakville Crimson Spire’	Crimson Spire
<i>Quercus suber</i>	Cork Oak
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree
<i>Tibouchina lepidota</i> ‘Alstoneville’	Alstonville Tibouchina
<i>Tibouchina urvilleana</i>	Princess Flower
<i>Tristaniopsis laurina</i>	Water Gum
<i>Xanthostemon chrysanthus</i>	Golden Penda
<i>Zelkova serrata</i> ‘Green Vase’	Japanese Zelkova

Table 19: Trees suitable for heritage planting

* based on Parramatta DCP and Public Domain Guidelines 2017

TREES SUITABLE FOR HERITAGE PLANTING	
Botanical name	Common name
<i>Fraxinus griffithii</i>	Evergreen Ash
<i>Fraxinus pennsylvanica</i> ‘Urbanite’	Urbanite Ash
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Lophostemon confertus</i> *	Brush Box
<i>Zelkova serrata</i> ‘Green Vase’	Japanese Zelkova

5.4. PLR tree offset master species

Table 20 presents the full list of tree species that will be used for offset tree planting within the PLR - Stage 1 program of works, including:

- › Infrastructure contract
- › Hawkesbury Road Widening Works (Enabling Works)
- › Robin Thomas Reserve
- › Pilot Offset Tree Planting
- › Supply, Operate and Maintain Contract (SOM)

Please note: The final selection of tree species will be consistent with this Strategy and the Planning Approval but subject to detailed design and site investigations such as utilities, availability of tree stock, community consultation and Council’s capital works program.

Table 20: Master list of offset tree species for PLR

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Acacia binervia</i>	Coast Myall	Fabaceae	Endemic	Low	6 x 8m	N	N	Y	N	N	Y	Y	N	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Acacia floribunda</i>	White Sallow Wattle	Fabaceae	Endemic	Low	6 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Acacia longifolia</i>	Sydney Golden Wattle	Fabaceae	Native	Low	6 x 4m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Acacia parramattensis</i>	Parramatta Wattle	Fabaceae	Endemic	Low	10 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	Y	Y	N	N
<i>Acer campestre</i> 'Elsrijk'	Filed Maple 'Elsrijk'	Aceraceae	Exotic	Dense	7 x 6m	Y	Y	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Acer campestre</i> – 'Evelyn'	Queen Elizabeth Maple	Aceraceae	Exotic	Dense	8 x 6m	N	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Acer freemanii</i>	Autumn Blaze Maple	Aceraceae	Exotic	Dense	13 x 10m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Acer x freemanii</i> 'Jeffersred' Autumn Blaze	Autumn Blaze Lipstick Maple	Aceraceae	Exotic	Dense	14 x 10m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Acer rubrum</i> 'October Glory'	October Glory Maple	Aceraceae	Exotic	Dense	12 x 9m	N	Y	N	Y	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Acer truncatum x Acer platanoides</i> 'Keithsform'	Norwegian Sunset Maple	Aceraceae	Exotic	Medium	10 x 6m	Y	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Acer truncatum x platanoides</i> 'WARRENRED' Pacific Sunset	Pacific Sunset Maple	Aceraceae	Exotic	Medium	10 x 6m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Acmena smithii</i>	Lillypilly	Myrtaceae	Endemic	Dense	10 x 7m	N	N	Y	N	N	N	Y	N	N	> Off alignment > Infrastructure Contract (To be confirmed)	N	N	Y	Y	N
<i>Acmena smithii</i> 'Minor'	Dwarf Lillypilly	Myrtaceae	Native	Dense	4 x 3m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Agonis flexuosa</i>	Willow Myrtle	Myrtaceae	Native	Medium	10 x 5m	N	N	Y	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Allocasuarina torulosa</i>	Forest Oak	Casuarinaceae	Endemic	Medium	12 x 8m	N	N	Y	Y	N	Y	Y	Y	N	> Off alignment	Y	N	N	N	N
<i>Alphitonia excelsa</i>	Red Ash	Rhamnaceae	Endemic	Medium	10 x 6m	N	N	Y	N	N	N	Y	N	N	> Off alignment	N	N	N	Y	N
<i>Angophora costata</i>	Smooth-barked Apple	Myrtaceae	Endemic	Medium	20 x 12m	N	Y	N	Y	Y	N	Y	Y	N	> Off alignment > Infrastructure Contract	Y	N	N	N	Y
<i>Angophora costata</i> 'Little Gumball'	Angophora 'Little Gum-ball'	Myrtaceae	Native	Medium	5 x 4m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Angophora floribunda</i>	Rough Barked Apple	Myrtaceae	Endemic	Medium	15 x 12m	N	Y	N	Y	Y	N	Y	N	N	> Off alignment > Infrastructure Contract	Y	Y	Y	Y	Y
<i>Angophora hispida</i>	Dwarf Apple Gum	Myrtaceae	Native	Medium	6x 5m	N	N	Y	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Angophora subvelutina</i>	Broad-leaved Apple	Myrtaceae	Endemic	Low	>20m	N	Y	N	Y	Y	Y	Y	N	N	> Off alignment	N	Y	Y	Y	N
<i>Aegiceras corniculatum</i>	River Mangrove	Primulaceae	Endemic	Dense	6 x 7m	N	N	N	N	N	N	Y	N	N	> Off alignment > Infrastructure Contract	N	N	N	N	N
<i>Auranticarpa rhombifolia</i> (syn <i>Pittosporum rhombifolia</i>)	Australian Laurel	Pittosporaceae	Native	Dense	10 x 8m	N	N	Y	N	N	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Avicennia marina</i>	Grey Mangrove	Acanthaceae	Endemic	Dense	6 x 6m	N	N	N	N	N	N	Y	N	N	> Off alignment > Infrastructure Contract	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Backhousia citriodora</i>	Lemon Scented Myrtle	Myrtaceae	Native	Dense	8 x 5m	Y	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Backhousia myrtifolia</i>	Grey Myrtle	Myrtaceae	Endemic	Medium	10 x 6m	Y	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Banksia integrifolia</i>	Coast Banksia	Proteaceae	Native	Low	8 x 4m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Brachychiton acerifolius</i>	Illawarra Flame Tree	Moraceae	Native	Medium	12 x 6m	N	N	Y	Y	N	N	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Brachychiton acerifolius</i> x <i>B. populneus</i>	Jerilderie Red	Moraceae	Native	Dense	8 x 7m	N	N	Y	Y	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Brachychiton populneus</i>	Kurrajong	Moraceae	Native	Dense	12 x 10m	N	N	Y	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Buckinghamia celsissima</i>	Ivory Curl Tree	Proteaceae	Native	Dense	8 x 5m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Callicoma serratifolia</i>	Black Wattle	Cunoniaceae	Endemic	Low	6 x 4m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Callistemon 'Harkness'</i>	Callistemon 'Harkness'	Myrtaceae	Native	Low	4 x 2m	N	N	N	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Callistemon 'Kings Park Special'</i>	Callistemon 'Kingspark Special'	Myrtaceae	Native	Low	4 x 5m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Callistemon citrinus</i>	Bottlebrush	Myrtaceae	Native	Low	2 x 2m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Callistemon citrinus 'Endeavour'</i>	Bottlebrush	Myrtaceae	Native	Low	2 x 2m	N	N	N	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Callistemon salignus</i>	Willow Bottlebrush	Myrtaceae	Endemic	Medium	9 x 4m	N	N	N	N	N	N	Y	Y	N	› Off alignment	N	N	N	Y	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Callistemon viminalis</i>	Red Bottlebrush	Myrtaceae	Native	Low	6 x 4m	N	N	N	N	N	N	N	N	N	> Off alignment > Infrastructure Contract	N	N	N	N	N
<i>Callistemon viminalis</i>	‘Dawson River Weeper’	Myrtaceae	Native	Low	6 x 4m	N	N	N	N	N	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Callistemon viminalis</i> ‘Hannah Ray’	Red Bottlebrush	Myrtaceae	Native	Low	6 x 4m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Calodendron capense</i>	Cape Chestnut	Rutaceae	Exotic	Dense	20 x 10	N	N	N	N	N	Y	N	N	Y	> Off alignment	N	N	N	N	N
<i>Castanospermum australe</i>	Black Bean	Fabaceae	Native	Dense	12 x 8m	N	N	N	N	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Casuarina cunninghamiana</i>	She-Oak	Casuarinaceae	Endemic	Medium	>35m	N	N	N	N	N	Y	Y	N	N	> Off alignment > Infrastructure Contract	N	N	Y	N	N
<i>Casuarina glauca</i>	Swamp Oak	Casuarinaceae	Endemic	Medium	10 x 4m	N	N	N	N	N	N	Y	N	N	> Off alignment > Infrastructure Contract	N	N	Y	Y	N
<i>Catalpa bignonioides</i> ‘Nana’	Dwarf Indian Bean Tree	Bignoniaceae	Exotic	Medium	1.8 x 1.8m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Cedrus libani</i>	Lebanese Cedar	Cupressaceae	Exotic	Dense	20 x 20m	N	N	N	N	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Celtis occidentalis</i>	Common Hackberry	Cannabaceae	Exotic	Medium	9 x 7m	N	N	Y	Y	Y	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Ceratonia siliqua</i>	Carob Tree	Fabaceae	Exotic	Dense	6 x 6m	N	N	N	N	Y	Y	N	N	Y	> Off alignment	N	N	N	N	N
<i>Ceratopetalum apetalum</i>	Coachwood	Cunoniaceae	Native	Medium	12 x 10m	N	N	N	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Ceratopetalum gummiferum</i>	New South Wales Christmas Bush	Cunoniaceae	Native	Medium	5 x 3m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Cercis siliquastrum</i>	Judas Tree	Fabaceae	Exotic	Low	8 x 2m	Y	N	N	N	N	N	N	N	N	> Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Citrus sinensis</i> 'Valencia'	Valencia orange	Rutaceae	Exotic	Medium	4 x 3m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Corymbia citriodora</i>	Lemon-Scented Gum	Myrtaceae	Endemic	Low	25 x 15m	N	Y	N	Y	N	Y	Y	Y	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Corymbia ficifolia</i>	Red Flowering Gum	Myrtaceae	Native	Dense	7 x 5m	N	N	Y	N	N	N	N	N	N	› Off alignment › Infrastructure Contract; › Robin Thomas Reserve	N	N	N	N	N
<i>Corymbia gummiifera</i>	Red Bloodwood	Myrtaceae	Native	Medium	15 x 10m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Corymbia maculata</i>	Spotted Gum	Myrtaceae	Endemic	Low	20 x 12m	N	Y	N	Y	Y	N	Y	Y	N	› Off alignment › Infrastructure Contract › Robin Thomas Reserve › Enabling Works › PLR Pilot Program	N	Y	N	N	N
<i>Cupaniopsis anacardioides</i>	Tuckeroo	Sapindaceae	Endemic	Dense	8 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	N	N	Y	N
<i>Cupressus arizonica</i> var. <i>glabra</i>	Smooth Arizona Cypress	Cupressaceae	Exotic	Medium	20 x 15m	N	N	N	N	N	Y	Y	N	N	› Off alignment	N	N	N	N	N
<i>Cupressus sempervirens</i>	Mediterranean Cypress	Cupressaceae	Exotic	Low	30 x 10m	N	N	N	N	N	Y	Y	N	N	› Off alignment	N	N	N	N	N
<i>Cupressus torulosa</i>	Bhutan Cypress	Cupressaceae	Exotic	Low	25 x 6m	N	N	N	N	N	Y	Y	N	N	› Off alignment	N	N	N	N	N
<i>X Cupressocyparis leylandii</i>	Leyland Cypress	Cupressaceae	Exotic	Dense	25 x 10m	N	N	N	N	N	Y	Y	N	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>X Cupressocyparis leylandii</i>	Leighton Green Cypres	Cupressaceae	Exotic	Dense	25 x 10m	N	N	N	N	N	Y	Y	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus amplifolia</i>	Cabbage Gum	Myrtaceae	Endemic	Low	20 x 10m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	Y	Y	N	N
<i>Eucalyptus botryoides</i>	Bangalay	Myrtaceae	Endemic	Medium	25 x 15m	N	N	N	Y	Y	Y	Y	N	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Elaeocarpus eumundi</i>	Quondong	Elaeocarpaceae	Native	Dense	12 x 5m	N	N	Y	N	N	N	N	Y	N	› Infrastructure Contract › PLR Pilot Program	N	N	N	N	N
<i>Elaeocarpus reticulatus</i>	Blueberry Ash	Elaeocarpaceae	Endemic	Medium	9 x 4m	N	N	Y	N	N	N	Y	Y	N	› Off alignment › Robin Thomas Reserve › Infrastructure Contract (To be confirmed)	Y	N	N	N	N
<i>Eucalyptus cosmophylla</i>	Cup Gum	Myrtaceae	Native	Low	5 x 5m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark	Myrtaceae	Endemic	Low	25 x 10m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	Y	N	N	N
<i>Eucalyptus curtisii</i>	Plunkett Mallee	Myrtaceae	Endemic	Low	6 x 4m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Eucalyptus elata</i>	River Peppermint	Myrtaceae	Endemic	Medium	20 x 15m	N	N	N	N	Y	Y	Y	N	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark	Myrtaceae	Endemic	Low	12 x 8m	N	N	N	Y	Y	Y	Y	N	N	› Off alignment	N	Y	N	N	Y
<i>Eucalyptus fibrosa</i>	Red Ironbark	Myrtaceae	Endemic	Low	20 x 8m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	Y	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Eucalyptus globoidea</i>	White Stringybark	Myrtaceae	Endemic	Medium	20 x 10m	N	N	N	Y	Y	Y	Y	N	N	› Off alignment	N	N	N	N	Y
<i>Eucalyptus leucoxylon</i> ‘Euky Dwarf’	Yellow Gum	Myrtaceae	Native	Low	7 x 3m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus leucoxylon</i> ‘Rosea’	Red-flowering Yellow Gum	Myrtaceae	Native	Medium	6 x 3m	N	N	N	N	N	N	N	Y	N	› Off alignment › PLR Pilot Program	N	N	N	N	N
<i>Eucalyptus leucoxylon</i> ssp. <i>Megalocarpa</i>	Large-fruited Blue Gum	Myrtaceae	Native	Medium	12 x 5	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus longifolia</i>	Woollybutt	Myrtaceae	Endemic	Medium	20 x 10m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus microcorys</i>	Tallowwood	Myrtaceae	Native	Medium	30 x 12m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus melliodora</i>	Yellow Box	Myrtaceae	Endemic	Medium	30 x 15m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus moluccana</i>	Grey Box	Myrtaceae	Endemic	Medium	25 x 12m	N	N	N	N	Y	Y	Y	N	N	› Off alignment › Infrastructure Contract	N	Y	N	Y	N
<i>Eucalyptus ovata</i>	Swamp Gum	Myrtaceae	Endemic	Medium	12 x 8m	N	N	Y	Y	N	N	Y	N	N	› Off alignment	N	N	Y	N	N
<i>Eucalyptus paniculata</i>	Grey Ironbark	Myrtaceae	Endemic	Low	22 x 12m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	Y	N	N	N	Y
<i>Eucalyptus pilularis</i>	Blackbutt	Myrtaceae	Endemic	Low	25 X 12m	N	N	N	N	N	N	Y	N	N	› Off alignment	Y	N	Y	N	Y
<i>Eucalyptus platypus</i>	Round-leaved Moort	Myrtaceae	Native	Medium	7 x 5m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus punctata</i>	Grey Gum	Myrtaceae	Endemic	Low	22 X 12m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	Y
<i>Eucalyptus resinifera</i>	Red Mahogany	Myrtaceae	Endemic	Low	20 x 12m	N	N	N	N	N	N	Y	N	N	› Off alignment	N	N	N	N	Y

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Eucalyptus robusta</i>	Swamp Mahogany	Myrtaceae	Endemic	Medium	20 x 10m	N	N	N	Y	Y	Y	Y	N	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Eucalyptus saligna</i>	Sydney Blue Gum	Myrtaceae	Endemic	Medium	25 x 15m	N	N	N	N	Y	Y	Y	N	N	› Off alignment › Infrastructure Contract	Y	N	Y	N	Y
<i>Eucalyptus sideroxylon</i>	Red-flowering Ironbark	Myrtaceae	Endemic	Medium	22 x 12m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus sideroxylon</i> "Rosea"	Pink-flowering Ironbark	Myrtaceae	Native	Medium	15 x 8m	N	N	Y	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Eucalyptus tereticornis</i>	Forest Red Gum	Myrtaceae	Endemic	Low	20 x 12m	N	N	N	N	N	N	Y	N	N	› Off alignment › Infrastructure Contract	N	Y	Y	Y	N
<i>Eucalyptus viminalis</i>	Ribbon Gum	Myrtaceae	Endemic	Medium	20 x 12m	N	N	Y	Y	Y	Y	Y	N	N	› Off alignment	N	N	Y	N	N
<i>Ficus benjamina</i>	Weeping Fig	Moraceae	Native	Dense	15 x 15m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ficus macrophylla</i>	Moreton Bay Fig	Moraceae	Native	Dense	15 x 30m	N	N	N	N	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ficus microcarpa</i> var. "Hillii"	Hill's Weeping Fig	Moraceae	Native	Dense	15 x 30m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ficus obliqua</i>	Small-leaved Fig	Moraceae	Native	Dense	25 x 35m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ficus rubiginosa</i>	Port Jackson Fig	Moraceae	Native	Dense	20 x 20m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Flindersia australis</i>	Australian Teak	Rutaceae	Native	Dense	15 x 10m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Fraxinus excelsior</i> 'Aurea'	Golden Ash	Oleaceae	Exotic	Medium	8 x 7m	Y	N	Y	Y	N	N	N	Y	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Fraxinus griffithii</i>	Evergreen Ash	Oleaceae	Exotic	Dense	8 x 6m	Y	N	Y	N	N	N	N	Y	Y	› Off alignment	N	N	N	N	N
<i>Fraxinus ornus</i>	Flowering Ash	Oleaceae	Exotic	Dense	12 x 8m	Y	Y	N	N	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Fraxinus ornus</i> 'Meczek'	Meczek Designer Flowering Ash	Oleaceae	Exotic	Dense	6 x 3m	Y	N	N	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Fraxinus angustifolia</i> subsp. <i>oxycarpa</i> 'Raywoodi'	Claret Ash	Oleaceae	Exotic	Dense	12 x 7m	Y	Y	Y	Y	Y	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Fraxinus pennsylvanica</i> 'Aerial'	Aerial Green Ash	Oleaceae	Exotic	Medium	10 x 5m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Fraxinus pennsylvanica</i> 'Cimmaron'	'Cimmzam' Cimmaron	Oleaceae	Exotic	Medium	13 x 8m	N	Y	N	Y	Y	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Fraxinus pennsylvanica</i> 'Urdbell'	Urbanite Ash	Oleaceae	Exotic	Dense	15 x 8m	N	Y	N	Y	Y	N	N	N	Y	› Off alignment › Robin Thomas Reserve › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Fraxinus velutina</i>	Arizona Ash	Oleaceae	Exotic	Dense	12 x 10m	Y	Y	Y	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Geijera parviflora</i>	Wilga	Rutaceae	Native	Dense	8 x 8m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Gleditsia triacanthos</i> var. <i>inermis</i>	Thornless Honey Locust varieties	Fabaceae	Exotic	Medium	12 x 5m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Glochidion ferdinandi</i>	Cheese Tree	Phyllanthaceae	Endemic	Dense	10 x 5m	N	Y	Y	N	N	N	Y	N	N	› Off alignment	N	N	N	Y	N
<i>Gordonia axillaris</i> (syn. <i>Polyspora axillaris</i>)	Fried Egg Plant	Theaceae	Exotic	Dense	5 x 4m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Grevillea olivacea</i>	Olive Grevillea	Proteaceae	Native	Low	4 x 4m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Grevillea robusta</i>	Silky Oak	Proteaceae	Native	Medium	12 x 10m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Hibiscus tiliaceus</i> 'Rubra'	Native Hibiscus	Malvaceae	Native	Dense	7 x 5m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Hymenosporum flavum</i>	Native Frangipani	Pittosporaceae	Native	Low	10 x 5m	N	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Jacaranda mimosifolia</i>	Jacaranda	Bignoniaceae	Exotic	Medium	10 x 12m	N	N	Y	Y	Y	Y	N	Y	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Koelreuteria bipinnata</i>	Chinese Rain Tree	Sapindaceae	Exotic	Medium	10 x 8m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Koelreuteria paniculata</i>	Golden Rain Tree	Sapindaceae	Exotic	Dense	6 x 4m	Y	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Lagerstroemia indica</i>	Crepe Myrtle	Lythraceae	Exotic	Medium	6 x 4m	N	N	N	N	N	N	N	Y	N	› Off alignment › Hawkesbury Road Widening › PLR Pilot Program › Infrastructure Contract	N	N	N	N	N
<i>Lagerstroemia indica</i> 'Indian Summer' 'Tuscarora'	Tuscarora' Crepe Myrtle	Lythraceae	Exotic	Medium	6 x 5m	N	N	N	N	N	N	N	Y	N	› Off alignment › PLR Pilot Program	N	N	N	N	N
<i>Lagerstroemia indica</i> 'Indian Summer' Biloxi'	Biloxi' Crepe Myrtle	Lythraceae	Exotic	Medium	7 x 5m	Y	N	Y	N	N	N	N	Y	N	› Off alignment › PLR Pilot Program	N	N	N	N	N
<i>Lagerstroemia indica</i> 'Natchez'	Natchez' White Crepe Myrtle	Lythraceae	Exotic	Medium	8 x 4m	Y	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure contract › Robin Thomas Reserve	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Leptospermum petersonii</i>	Lemon Scented Tea Tree	Myrtaceae	Native	Low	5 x 4m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Libidibia ferrea</i>	Leopard-wood Tree	Caesalpinia	Exotic	Medium	8 x 5m	Y	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Liquidambar formosa</i>	Chinese Sweet Gum	Altingiaceae	Exotic	Medium	15 x 7m	N	N	Y	Y	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Liquidambar styraciflua</i>	Liquidambar	Altingiaceae	Exotic	Medium	15 x 7m	N	N	Y	Y	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Liriodendron tulipifera</i>	Tulip Tree	Magnoliaceae	Exotic	Dense	20 x 8m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Liriodendron tulipifera</i> 'Fastigiata'	Tulip Tree Fastigate	Magnoliaceae	Exotic	Medium	20 x 4m	Y	Y	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Livistona australis</i>	Cabbage Tree Palm	Arecaceae	Endemic	Low	30 x 1m	Y	Y	N	N	N	N	Y	Y	Y	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Lophostemon confertus</i>	Brush Box	Myrtaceae	Native	Dense	20 x 12m	N	Y	N	Y	Y	Y	N	Y	Y	› Off alignment › Infrastructure contract › Robin Thomas Reserve › Enabling Works › PLR Pilot Program	N	N	N	N	N
<i>Lophostemon suaveolens</i> (syn <i>Tristania suaveolens</i>)	Swamp Box	Myrtaceae	Native	Medium	20 x 12m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Magnolia grandiflora</i>	Southern Magnolia	Magnoliaceae	Exotic	Dense	12 x 15m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Magnolia grandiflora</i> 'Exmouth'	Bull-bay Magnolia	Magnoliaceae	Exotic	Medium	12 x 5m	Y	Y	Y	N	N	N	N	N	N	› Off alignment › PLR Pilot Program	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Magnolia grandiflora</i> var. "Little Gem"	'Little Gem' Dwarf Magnolia	Magnoliaceae	Exotic	Medium	6 x 3m	N	N	N	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Malus adams</i>	Crab Apple	Rosaceae	Exotic	Low	4 x 6m	N	N	Y	N	N	N	N	Y	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Malus domestica</i> 'Pinkabelle'	'Pinkabelle' Dwarf Apple	Rosaceae	Exotic	Medium	2 x 1m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Melaleuca bracteata</i>	River Tea Tree	Myrtaceae	Endemic	Medium	6 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment	N	N	N	N	N
<i>Melaleuca bracteata</i>	'Revolution Gold'	Myrtaceae	Endemic	Medium	6 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment	N	N	N	N	N
<i>Melaleuca decora</i>	White Feather Honey-myrtle	Myrtaceae	Endemic	Medium	8 x 6m	N	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	N	Y	N	N
<i>Melaleuca ericifolia</i>	Swamp Paperbark	Myrtaceae	Endemic	Dense	7 x 4m	N	N	N	N	N	N	Y	Y	N	› Off alignment	N	N	N	Y	N
<i>Melaleuca linariifolia</i>	Snow-in-Summer	Myrtaceae	Endemic	Medium	10 x 4m	Y	N	Y	N	N	N	Y	Y	N	› Off alignment › Robin Thomas Reserve	N	N	Y	N	N
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	Myrtaceae	Endemic	Medium	15 x 5m	Y	N	Y	N	N	N	Y	Y	N	› Off alignment › Infrastructure Contract	N	N	N	N	N
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree	Myrtaceae	Endemic	Dense	10 x 8m	N	N	Y	Y	Y	N	Y	Y	N	› Off alignment	N	N	Y	Y	N
<i>Melia azedarach</i> 'Elite'	Pink Euodia	Meliaceae	Native	Dense	10 x 8m	Y	Y	Y	Y	N	Y	N	Y	N	› Off alignment	N	N	N	N	N
<i>Melia azederach</i>	White Cedar	Meliaceae	Native	Dense	10 x 8m	N	N	Y	Y	N	N	N	Y	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Metrosideros excelsa</i>	New Zealand Christmas Bush	Myrtaceae	Native	Dense	7 x 9m	N	N	Y	N	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Michelia x alba</i>	White Sandalwood	Magnoliales	Exotic	Medium	8 x 4m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Nyssa sylvatica</i>	Tupelo	Nyssaceae	Exotic	Medium	12 x 6m	Y	Y	Y	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Olea europaea</i>	European Olive Tree	Oleaceae	Exotic	Medium	4 x 8m	N	N	N	N	Y	Y	N	Y	N	› Off alignment	N	N	N	N	N
<i>Olea europaea</i> ‘Swan Hill’	Swan Hill Sterile Olive	Oleaceae	Exotic	Medium	6 x 7m	N	N	N	N	Y	Y	N	Y	N	› Off alignment	N	N	N	N	N
<i>Olea europaea</i> ‘Tolley’s Upright’	Tolley’s Upright Olive	Oleaceae	Exotic	Medium	7 x 3m	N	N	N	N	Y	Y	N	Y	N	› Off alignment	N	N	N	N	N
<i>Paulownia tomentosa</i>	Empress Tree	Scrophulariaceae	Exotic	Dense	12 x 12m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Photinia glabra</i>	Japanese Photinia	Rosaceae	Exotic	Medium	4 x 2m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Photinia glabra</i> ‘Rubens’	Dwarf Photinia	Rosaceae	Exotic	Medium	4 x 2m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Photinia robusta</i>	Red Leafed Photinia	Rosaceae	Exotic	Medium	8 x 8m	N	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Pinus patula</i>	Mexican Weeping Pine	Cupressaceae	Exotic	Medium	25 x 15	N	N	N	N	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Pistacia chinensis</i>	Chinese Pistachio	Anacardiaceae	Exotic	Dense	8 x 8m	N	N	Y	Y	Y	Y	N	Y	N	› Off alignment › Robin Thomas Reserve › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Platanus orientalis</i>	London Plane Tree	Platanaceae	Exotic	Dense	20 x 10m	N	Y	N	Y	Y	N	N	N	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Platanus orientalis</i> 'Digitata'	Oriental Plane	Platanaceae	Exotic	Medium	15 x 10m	N	Y	N	Y	Y	N	N	N	N	› Off alignment › Enabling Works	N	N	N	N	N
<i>Podocarpus elatus</i>	Plum Pine	Podocarpaceae	Native	Dense	16 x 10m	N	N	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Populus deltoides</i>	Cottonwood	Salicaceae	Exotic	Medium	20 x 5m	Y	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Prunus armeniaca</i> 'Moorpark'	Moorpark Apricot	Rosaceae	Exotic	Medium	4 x 3m	N	N	N	N	N	N	N	Y	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Prunus campanulata</i>	Bell Flower Cherry	Roseaceae	Exotic	Medium	5 x 6m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Prunus cerasifera</i>	Black Cherry Plum	Rosaceae	Exotic	Medium	8 x 6m	N	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Prunus cerasifera</i> 'Nigra'	Black Cherry Plum	Rosaceae	Exotic	Medium	5 x 4m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Prunus cerasifera</i> 'Oakville Crimson Spire'	Crimson Spire	Rosaceae	Exotic	Medium	6 x 2m	N	N	N	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Prunus dulcis</i>	Almond	Rosaceae	Exotic	Medium	5 x 3m	N	N	N	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Pyrus calleryana</i> 'Bradford'	Callery Pear	Rosaceae	Exotic	Medium	8 x 6m	Y	N	Y	N	N	N	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Pyrus calleryana</i> 'Chanticleer'	Chanticleer' Pear	Rosaceae	Exotic	Medium	10 x 6m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Quercus ilex</i>	Holly Oak	Fagaceae	Exotic	Dense	20 x 12m	N	Y	N	Y	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Quercus palustris</i>	Pin Oak	Fagaceae	Exotic	Medium	12 x 8m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Quercus robur</i> 'Fastigiata'	Cypress Oak	Fagaceae	Exotic	Medium	13 x 4m	Y	N	Y	N	N	N	N	N	N	› Off alignment	N	N	N	N	N
<i>Quercus suber</i>	Cork Oak	Fagaceae	Exotic	Medium	12 x 10m	N	N	N	Y	Y	Y	N	Y	N	› Off alignment	N	N	N	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Robinia pseudoacacia</i> 'Frisia'	Golden Robinia	Leguminosae	Exotic	Medium	10 x 6m	Y	Y	Y	Y	N	N	N	N	N	> Off alignment > Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Sapium sebiferum</i> (syn <i>Triadica sebifera</i>)	Chinese Tallow Tree	Euphorbiaceae	Exotic	Medium	8 x 7m	Y	Y	Y	Y	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Schinus molle</i> var. <i>areira</i>	Peppercorn Tree	Anacardiaceae	Exotic	Medium	12 x 10m	N	N	N	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Sophora japonica</i> 'Princeton Upright'	Princeton Upright Sophora	Fabaceae	Exotic	Medium	12 x 6m	Y	N	Y	N	N	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Stenocarpus salignus</i>	Red Silky Oak	Proteaceae	Native	Dense	10 x 10m	N	N	Y	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Stenocarpus sinuatus</i>	Firewheel Tree	Proteaceae	Native	Medium	12 x 8m	N	N	Y	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Syncarpia glomulifera</i>	Turpentine	Myrtaceae	Endemic	Dense	20 x 6m	N	N	N	Y	Y	N	Y	N	N	> Off alignment > Infrastructure Contract	Y	N	N	N	Y
<i>Syzygium luehmannii</i>	Riberry	Myrtaceae	Native	Medium	12 x 6m	N	N	Y	Y	N	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Syzygium paniculatum</i>	Magenta Cherry	Myrtaceae	Native	Medium	15 x 10m	N	N	N	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Tibouchina lepidota</i> 'Alstonville'	Alstonville Tibouchina	Melastomataceae	Exotic	Dense	6 x 5m	N	N	Y	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Tibouchina urvilleana</i>	Princess Flower	Melastomataceae	Exotic	Medium	4 x 3m	N	N	N	N	N	N	N	Y	N	> Off alignment	N	N	N	N	N
<i>Tilia cordata</i> 'Greenspire'	Small-leaved Lime	Tiliaceae	Exotic	Medium	8 x 6m	Y	N	Y	N	N	N	N	N	N	> Off alignment	N	N	N	N	N
<i>Toona ciliata</i>	Australian Red Cedar	Meliaceae	Native	Medium	12 x 10m	N	Y	N	Y	Y	Y	N	N	N	> Off alignment	N	N	N	N	N
<i>Tristaniopsis laurina</i>	Water Gum	Myrtaceae	Endemic	Medium	10 x 6m	N	N	Y	N	N	N	Y	Y	N	> Off alignment > Infrastructure Contract (To be confirmed)	N	N	Y	N	N

BOTANICAL NAME	COMMON NAME	FAMILY	ORIGIN	SHADE	MATURE SIZE (H x W)	Street Type					Open Space Type		POWER LINES	HERITAGE	INTENDED USE	ECOLOGY				
						1	2	3	4	5	1	2				Blue Gum High Forest	Cumberland Shale Plains Woodland	River-flat Forest	Swamp Oak Floodplain Forest	Turpentine Ironbark Forest
<i>Tristaniopsis laurina</i> 'Luscious'	Lucious' Water Gum	Myrtaceae	Native	Medium	9 x 7m	Y	N	Y	N	N	N	N	N	N	› Off alignment › Infrastructure contract; › Enabling Works	N	N	N	N	N
<i>Ulmus glabra</i> 'Lutescens'	Golden Elm	Ulmaceae	Exotic	Medium	10 x 12m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ulmus parvifolia</i>	Chinese Elm	Ulmaceae	Exotic	Medium	10 x 15m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment › Infrastructure Contract (To be confirmed)	N	N	N	N	N
<i>Ulmus parvifolia</i> 'Todd'	Chinese Elm 'Todd'	Ulmaceae	Exotic	Medium	10 x 8m	N	Y	N	Y	Y	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Ulmus procera</i>	English Elm	Ulmaceae	Exotic	Medium	16 x 11m	N	Y	N	Y	N	Y	N	N	N	› Off alignment	N	N	N	N	N
<i>Waterhousia floribunda</i> 'Green Avenue'	Weeping Lily Pilly	Myrtaceae	Native	Dense	8 x 5m	Y	N	Y	Y	N	N	N	N	N	› Off alignment › Robin Thomas Reserve	N	N	N	N	N
<i>Xanthostemon chrysanthus</i>	Golden Penda	Myrtaceae	Native	Medium	10 x 6m	N	N	Y	N	N	N	N	Y	N	› Off alignment	N	N	N	N	N
<i>Zelkova serrata</i> 'Green Vase'	Japanese Zelkova	Ulmaceae	Exotic	Dense	12 x 10m	N	Y	N	Y	N	Y	N	Y	Y	› Off alignment › Infrastructure Contract	N	N	N	N	N

6 NEXT STEPS TO IMPLEMENTATION



Chapter 6.

Next steps to implementation

This section outlines a series of next steps that are tasks that must be undertaken in order to ensure implementation of this Tree Offset Strategy. Implementation involves five key planning steps:

1. Initiating tree procurement and determining supply timeframes
2. Investigating additional offset planting opportunities within the PLR corridor
3. Determining installation capacity and planning for an orderly roll-out
4. Identify and planning for timely community consultation
5. Monitoring and tracking progress.

They are discussed further in the following sections.

6.1. Tree procurement and supply

6.1.1. Initial tree supply quantities

As outlined in [section 2.3.5](#), securing trees for planting under this offset strategy is a key priority for immediate implementation.

While the final number of offset trees required will continue to be refined through the detailed design and construction stage and outlined in the IA Tree Register (refer [section 2.3.4.2](#)), their number is likely to be substantial. As outlined in [Table 3](#), a minimum of 5,679 offset trees remain to be planted. Of these, a minimum of 80%, or at least 4,544 trees, will need to be planted by mid 2023 to achieve project planning approval requirements.

Given that the upper estimate for required offset trees remaining to be planted is 8,679, this Strategy recommends a pre-cautionary approach to ensuring the timely availability of tree species for planting. This approach is to plan to secure 80% of the mean between the lower and upper estimates of required offset trees in time for planting by mid 2023. It is further recommended to allow for a loss factor of 5% to cover any tree losses as a result of tree failure, vandalism or for other reasons.

The process for calculating the number of trees to be ordered as a priority is summarised in [Table 21](#).

Table 21: Priority tree procurement quantities

Lower EIS estimate	5,679
Upper EIS estimate	8,679
Mean quantity estimate	7,179
80% of mean	5,744
5% loss factor	288
Quantity of trees to be procured as a priority	6,032

Depending on the capacity to mobilise resources and roll out tree planting this means that a substantial number of trees may be required earlier prior to 2023 – also refer [section 6.3](#).

6.1.1.1. Quantities of advanced tree stock

Based on the identified priority planting locations, an estimated 472 offset trees will be planted within the Parramatta CBD, as defined by Project Planning Approval. Consistent with the Conditions of Approval, a minimum stock size of 200L is required in the CBD (also refer [Table 2](#) and [section 4.2.4.3](#)).

6.1.2. Tendering and commercial availability – initial tree supply

The initial tree supply contract will need to target street tree planting as this will require advanced stock sizes. Procurement lead times for subsequent tree supply contracts may be insufficient to secure trees at the required minimum 75L and 200L sizes.

Based on the initial supply quantities outlined in [Table 21](#), [Table 22](#) outlines the tree quantities and respective sizes that will need to be procured as a priority. Due to the longer lead time, this includes all trees that need to be planted in a minimum 200L container, i.e. all trees in the Parramatta CBD – refer [section 6.1.1.1](#):

Table 22: Priority tree procurement by container size

Container size	Quantity
200L trees for the Parramatta CBD	456
75L trees for other streets	5,576

Given the quantities, the final composition of species to be planted will be informed by the ability to obtain trees within the required time frame and to the required size. This is likely to include species:

- › Grown on from existing stock available in commercial nurseries
- › Grown specifically for the project “from scratch”.

The best process to determine tree availability and finalise the species composition is through a tree supply tender process, leading to a tree supply contract. The tender process should target commercial tree growers with the capability and track record to deliver quality landscape trees in large quantities.

Key contract requirements will need to include:

- › The tree species supplied must reflect the location types and associated species identified in [section 4.2.3](#), [section 5.2](#) and [section 5.3](#)
- › Tree supply quality specifications to TfNSW and CoPC standards
- › Species diversity criteria as outlined in [section 4.2.1.2](#) must be applied to both the total quantity supplied and to each species list in [section 5.3](#).
This must factor in Council data in relation to the existing species diversity within the Parramatta LGA (also refer [section 4.2.1.2.3](#)), with the aim of balancing out the existing concentrations and over-representations of species, genera and families
- › Provision of a program for staged tree delivery/supply to enable scheduling of tree planting activities
- › Delivering the required quantities of 200L trees
- › Potential for holding/in-nursery maintenance of tree stock until planting site/s are ready for delivery and installation
- › Contingency measures and insurance against losses. For example nurseries could be affected by extreme weather events with the potential to decimate tree supply.

6.1.2.1. Tree procurement

Tree procurement would need to follow accepted TfNSW and specific Local Government area if required (ie. CoPC) processes and guidelines. Generally, two types of procurement models would be available:

- › Open tender
- › Expression of interest (EOI) followed by selective/invited tender.

The preferred procurement model should also consider the appropriate risk profile to the project associated with letting a single supply contract or multiple supply contracts.

6.1.3 Final IA Tree Register and residual tree supply

An update of the IA Tree Register based on the final detailed design and construction drawings will be prepared by the Independent Arborist. The final IA Tree Register will inform to the final number of additional offset trees (if any) to be procured and planted, both before commencement of PLR operations and after.

Subsequent tree supply contract/s should include the same requirements as the initial tree supply contract (refer section 6.1.2). There is also a need to consider the potential demand for contingency trees to ensure sufficient trees are available for planting, in the event of:

- › Any additional tree removal during the construction phase that was not anticipated in the detailed design and construction drawings
- › Any losses due to tree failure, vandalism or the like – allow for a 5% loss factor.

Due to the shorter procurement time frame, and the need for 80% of offset trees to be installed before commencement of PLR operations, second and/or subsequent tree supply contracts may only be able to deliver smaller stock sizes, suitable for planting in open space areas.

Consistent with the project’s objectives and offset tree planting principles (refer [section 4.1.2](#)), the final 20% of offset trees that are able to planted once the project is operational should:

- › Be planted as street trees in the identified priority planting locations
- › Maximise stock sizes to meet the minimum requirements for street trees, that is 200L in CBD areas and 75L in all other streets.

6.1.3. Summary of tree procurement actions

Table 23 summarises the key actions required to secure tree stock to be used for offset planting, including the corresponding responsibilities.

Table 23: Key actions to secure tree supply and responsibilities

#	Tree supply action	Responsibility
1	Agree procurement model and establish tender process for initial tree supply contract(s)	TfNSW in consultation with land/property owner or asset manager for offset locations.
2	Confirm final species list, quantities and availability time frame/s for installation, integrating the species diversity requirements	Successful tender(s)/ preferred tree supplier(s)
3	Finalise detailed design and construction drawings	PLR contractors and respective design teams
4	Update IA Tree Register based on construction drawings	Independent Arborist
5	Determine final number of offset trees required to meet project CoAs. Calculate additional tree quantities (if any) that need to be procured	TfNSW in consultation with the Independent Arborist
6	Quantify how many trees are to be delivered by the PLR Contractors	TfNSW in conjunction with PLR contractors and respective design teams
7	Agree procurement model and establish tender process for subsequent tree supply contract(s)	TfNSW in consultation with land/property owner or asset manager for offset locations.
8	Confirm final species list, sizes and quantities for: Open space planting of smaller stock sizes to meet the requirement for 80% of offset trees to be planted prior to commencement of PLR operations The final 20% of offset trees to be planted in streets, including availability time frame/s for installation.	Successful tender(s)/ preferred tree supplier(s)

6.2. Corridor planting opportunities

As shown in Table 3, the various PLR contractors collectively are committed to planting 1,801 trees that will count towards the total number of offset trees that need to be planted to secure project approval. The majority of these trees will be planted within the PLR corridor.

While detailed design plans are still being finalised, it appears likely, from consultation with the detailed design teams during the preparation of this Tree Offset Strategy, that the PLR corridor may be able to accommodate more trees than the quantity that needs to be provided under the construction contracts.

There is therefore an opportunity for further design investigations in consultation with the PLR contractors in order to determine locations within the PLR corridor where additional trees may be able to be planted, as well as the potential quantity and type of trees.

CoA E107(b) (refer Table 2) requires offset trees to be located near the site of impact, that is close to where trees need to be removed for the project, in order to mitigate project impacts. Any additional planting sites identified within the PLR corridor should therefore be prioritised for additional offset tree planting.

6.2.1 Summary of actions

The actions identified in Table 24 should be initiated as a priority:

Table 24: Corridor planting opportunity investigation actions

#	Tree installation action	Responsibility
1	Work with PLR contractors and their detailed design teams to identify potential additional locations for offset tree planting within the PLR corridor (including areas surrounding PLR stops).	TfNSW in partnership with PLR contractors and CoPC
2	Determine appropriate tree species and potential quantities for additional corridor planting.	TfNSW in partnership with PLR contractors and CoPC
3	Develop detailed planting layouts and tree schedules	TfNSW (or professional services contractor)
4	Work with PLR contractors to determine the most appropriate process and timing for procurement and installation of additional corridor trees.	TfNSW
5	Adjust tree supply contract or initiate separate contract - also refer section 6.1.2.	TfNSW in partnership with CoPC
6	Agree on maintenance responsibilities for additional corridor trees.	TfNSW in partnership with PLR contractors and CoPC
7	Planting by PLR contractor or separate contractor, as agreed in step 5.	To be decided

6.3. Roll-out and installation

A critical implementation planning step is the determination of the likely time frames required for planting activities, including the letting of any tree installation contracts. Based on the experience with the pilot planting program (refer section 2.4.2), TfNSW and CoPC will need to determine the joint capacity, including speed, for tree installation.

For example, assuming that some tree species may be available for planting from mid 2020 and using the mid-level quantity estimate as per Table 21, an average of 168 trees would need to be planted every month in the 36 months until mid 2023 to meet the project CoAs.

While the timing of tree availability and respective quantities would be confirmed through the initial tree supply contract (refer section 6.1.2), the example indicates that a significant amount of coordination and of mobilisation of resources is required in order to plant 80% of offset trees prior to the project commencing operations. A critical step for TfNSW, in partnership with CoPC, is therefore to review its existing capacity and processes to commission this program of works. The following may need to be considered:

- › Capacity of in-house CoPC resources to contribute to tree roll-out and ongoing maintenance, including whether or not this would be a desirable approach
- › Potential to augment existing CoPC in-house resources with temporary staff to assist in tree roll-out and maintenance, including whether or not this would be a desirable approach
- › Is there an existing panel of pre-approved/pre-registered landscape contractors with the proven track record to be able to install and maintain trees?
 - If yes: what is the upper limit capital value for panel contracts before tendering is required? Therefore how many contracts would need to be let?
 - If no: is there a need to establish a panel and what would be the appropriate process?
- › What other steps/processes may need to be put in place in order to facilitate timely and orderly roll-out?
- › What ground-truthing and detailed design investigations can be brought forward (now), in order to speed up the installation process/roll-out? Also refer section 6.3.1
- › What consultation activities need to happen and when, in order to ensure consultation does not delay tree planting or lead to failure to meet planting targets? Also refer section 6.3.

6.3.1. Ground-truthing

Priority planting locations have been determined through high level data analysis and assessment. Prior to tree installation there is a need to undertake ground-truthing to verify the availability and suitability of the identified planting sites and the size of the proposed species as determined by the location types.

6.3.1.1. Ground-truthing activities

Ground-truthing activities would include a combination of site assessments, consultation and detailed design work to firm up planting locations and assign the most suitable tree species from the location type list. These activities include:

- › Additional site audits to confirm capacity within priority locations. This is especially important in areas with limited existing data coverage, including areas outside the Parramatta LGA boundaries pre Council amalgamations. Locations closest to the PLR alignment should be prioritised
- › On-site assessment of verge widths and adjoining built form to confirm/maximise tree size and corresponding suitable species (from the location type lists – refer Table 11 to Table 15)
- › ‘Dial Before You Dig’ investigation/authority enquiries
- › On-site assessment of services and utilities to determine the need for adjustments in tree planting locations relative to mapped i-Tree data locations
- › Review of existing environmental information to determine the risk of latent conditions such as the presence of contamination material
- › Check for heritage/conservation area requirements
- › On-site review of planting sites for other constraints such as driveways, road-side furniture, sight lines, clear zones, heritage etc, consistent with relevant Australian and CoPC design standards and guidelines
- › Determine the species types and their distribution within streets of each typology, as well as within each street, once the species and quantities that will be available have been confirmed through the initial tree supply contract. This would also need to consider community consultation feedback.

6.3.1.2. Timing for ground-truthing and tree installation contract

Ground-truthing and site auditing could follow the methodology adopted by the CoPC operations team for its 2019 Street Tree Audit, or adopt a tailored approach to suit the needs and timing of this Tree Offset Strategy. The level of detail and methodology used for additional site investigations would be largely determined by when ground-truthing would be undertaken, relative to the availability of tree stock for planting:

- › If there is a significant lag in time until the first trees can be supplied: undertake more detailed site investigations while plants are being grown to size to provide a high level of design confidence. This would speed up the planting process by removing the need for site investigations and design development as part of the installation contract (construct only contract)
- › If plants are available for immediate planting (say within 2020):
 - Require detailed site investigations as part of the tree installation contract (design and construct contract)
 - Work with CoPC to complete the 2019 Street Tree Audit for remaining priority tree locations to verify for remaining areas that offset tree planting can be accommodated.

The most appropriate way forward would be able to be determined based on the proposed tree delivery program that would be provided by the initial tree supply contract (refer section 6.1.2).

6.3.2. Summary of tree installation actions

Table 25 summarises the key actions required to ensure timely and orderly tree installation, including the corresponding responsibilities.

Table 25: Key actions to ensure timely tree installation and responsibilities

#	Tree installation action	Responsibility
1	Review procurement processes and guidelines to determine, and if necessary establish, appropriate procurement pathways for tree installation contracts	TfNSW in partnership with CoPC
2	Develop high-level roll-out program, based on tree supply availability schedule	TfNSW in partnership with CoPC
3	Identify consultation strategy including consultation program of activities and respective timing to support timely installation of offset trees	CoPC, supported by TfNSW
4	Determine the timing and method for ground-truthing and tree installation design development, based on tree supply availability schedule. Prioritise locations closest to the PLR alignment.	TfNSW in partnership with CoPC
5	Complete Street Tree Audit for priority planting locations to verify capacity assumptions	CoPC
6	Check for heritage considerations (sites, relationships etc.)	TfNSW in partnership with CoPC
7	Procure detailed design investigation services through either › Design and construct tree procurement contract(s) › Design only contract(s)	TfNSW in partnership with CoPC
8	Develop detailed planting layouts and tree distribution schedules, suitable for consultation	TfNSW/ CoPC service contractor
9	Refine layouts/species if required based on consultation outcomes	TfNSW/ CoPC service contractor
10	Incremental planting by approved contractors	TfNSW/ CoPC service contractor

6.4. Consultation

Accompanying the pilot tree planting program (refer section 2.4.2), CoPC hosted a website to provide information on offset tree planting. The availability of an existing media channel provides an opportunity to disseminate updates to the community regarding the progress and next steps in the delivery of the tree offset program, consistent with this Tree Offset Strategy.

In addition, more targeted consultation activities may be appropriate to advise residents in priority planting areas of the likely timing, locations and species to be planted in their neighbourhoods and streets.

The most appropriate suite of consultation activities and the corresponding level of engagement as per the International Association for Public Participation (IAP2) spectrum of public participation should be determined in consultation with CoPC, and drawing on Council’s experience with similar consultation processes, including that for the pilot tree planting program. Given the time constraints for delivery of the Offset Tree Package, it is suggested that the most appropriate level of participation may be within the “inform” to “involve” range of activities – refer Figure 37.

6.4.1. Opportunities for community partnerships

While this Strategy has been developed with the primary focus of enabling the implementation of the offset tree planting to meet project requirements, there are other opportunities to provide additional benefits to the community.

As the project will have a significant community interface, there are opportunities beyond delivery of the core Tree Offset Strategy to partner with the community and to supplement offset tree planting with additional measures. These might include including a broader range of activities with potential to expand the spectrum of public participation activities to the “collaborate” or “empower” level of the IAP2 spectrum (refer Figure 36), as appropriate:

- Tree give-away programs:
 - To encourage additional planting in private property and/or to ameliorate amenity losses within private property as a result of streetscape tree removal
 - To community groups or institutions such as schools to support greening of community infrastructure, with associated cooling, educational and other benefits.

- Partnership initiatives:
 - Joint community planting events to foster community involvement, ownership and appreciation of what is being achieved through the Tree Offset Package
 - With local environment/conservation groups such as bushland restoration groups to support biodiversity protection and enhancement activities including planting, weeding and education programs.

6.5. Tracking progress and reporting

Tracking of tree planting will be critical to demonstrate compliance with the project CoA.

During the pilot tree planting program (refer section 2.4.2), each tree planted was provided with an identification tag to help track its health and development. Tags or survey tags will be used where appropriate to identify offset trees to assist with maintenance.

Maintenance requirements for tree offsets are outlined in Section 4.2.6. Trees are to be maintained for a minimum of two years from being planted.

TfNSW will maintain a Register of Planted Trees that will be a live document that is continually updated as new offset trees are planted. This will enable the progress of the Tree Offset Package to be tracked. Progress will be monitored against the timing obligations provided in Condition E107(f) where 80% of tree offsets are required prior to operation of the Light Rail.

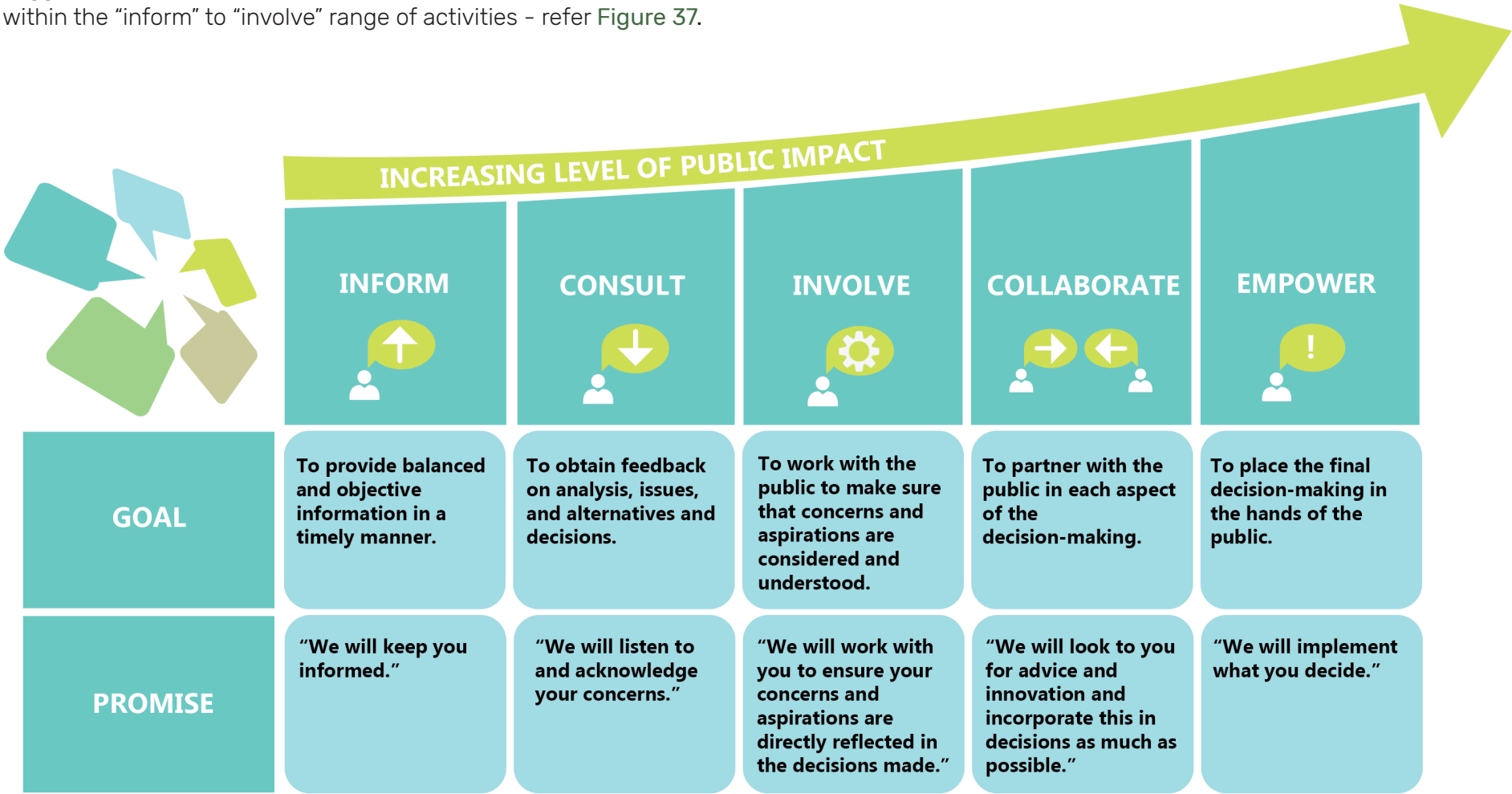


Figure 36: IAP2 spectrum of public participation (source: Town of Cochrane 2018)

7 REFERENCES AND FURTHER READING



Chapter 7.

References /

Further reading

7.1. References/image sources

AECOM 2017, *Green Infrastructure. A vital step to Brilliant Australian cities*, an AECOM Brilliant Cities report, published by Aecom Australia

Architectus and Arup 2018, *Parramatta Light Rail. Urban Design Requirements*, prepared for Transport for NSW, State of New South Wales

Arterra Design 2016, *Parramatta CBD - Street Tree Investigation Issues and Options Report*, Rev B, June 2016, prepared for Parramatta City Council

ASPECT Studios and Tree Logic 2011, *Urban Forest Diversity Guidelines. 2011 Tree Species Selection Strategy for the City of Melbourne*, prepared for the City of Melbourne

ASPECT Studios, Earthscape Horticultural Services and EcoLogical Australia 2013, *City of Ryde Street Tree Master Plan. To inform and direct all street tree planting in the City of Ryde*, adopted 16 April 2013, prepared for the City of Ryde, NSW

Cardno 2019, *Parramatta Light Rail. Selected pedestrian network audit*, 80018104, prepared for the City of Parramatta, 20 June 2019

City of Melbourne 2012, *Urban Forest Strategy. Making a Great City Greener 2012-2032*, the Council, Melbourne

City of Parramatta Council 2011, *Parramatta Development Control Plan 2011*, published by the Council, Parramatta, NSW

City of Parramatta Council 2016, *Heatwaves are a silent killer, published by the Council*, http://coolparramatta.com.au/about_us, accessed 01.11.2019

City of Parramatta Council 2017, *City of Parramatta Environmental Sustainability Strategy 2017. A great city grows better every day. Our plan to create a nature inspired, efficient and resilient City*, published by the Council, Parramatta, NSW

City of Parramatta Council 2017, *Parramatta Ways. Implementing Sydney's Green Grid*, Draft, published by the Council, Parramatta, NSW

City of Parramatta Council 2017, *Public Domain Guidelines*, published by the Council, Parramatta, NSW

City of Parramatta Council 2019, *Parramatta Light Rail Tree Planting Neighbourhood Improvement Program*, <https://www.cityofparramatta.nsw.gov.au/council/parramatta-light-rail/tree-planting>, accessed 05.11.2019

Devereux D and Caccetta PA 2017, *Estimation of Land Surface Temperature and Urban Heat Island effect for Australian urban centres*. Report CSIRO Data61, Australia.

E2designlab Blog 2017: *City Cooling - Mitigation of the Urban Heat Island (UHI) Effect*, https://e2designlab.com.au/blog/i_2017-11-17-city-cooling-mitigation-of-the-urban-heat-island-uhi-effect, accessed 01.11.2019

Gallagher L 2014, *Cooling Parramatta City. Scoping Paper*, prepared by Gallagherstudio for Parramatta City Council, 07.02.2014

Government Architect NSW 2017, *Greener Places. Establishing an urban Green Infrastructure policy for New South Wales* Draft for discussion, published by the NSW Department of Planning + Environment, Sydney

Government Architect NSW 2018, *Greener Places Urban tree canopy guide. Green infrastructure for climate adaptation and resilience*, Draft for discussion, published by the NSW Department of Planning + Environment, Sydney

Greater Sydney Commission 2017, *Greater Sydney Region Plan. A Metropolis of Three Cities - connecting people*, State of New South Wales

Landcom 2008, *Street tree design guidelines for Landcom projects*, published by Landcom, Parramatta, NSW 2150

National University of Singapore 2016, *An Insight into the Urban Heat Island Effect...*, published 16 September 2016, in "Natural urban crisis. Are we really beyond the point of redemption?", blog by the Centre for Instructional Technology, National University of Singapore, <http://blog.nus.edu.sg/e0014690/2016/09/16/an-insight-into-the-urban-heat-island-effect/#>, accessed 01.11.2019

Marrickville Council 2014, *Marrickville Street Tree Masterplan 2014*, adopted September 2014, the Council, Marrickville, NSW

Newcastle City Council 2016, *Street Tree Selection Manual*, March 2016, published by the Council, Newcastle, NSW

Parramatta City Council 2011, *Parramatta Street Tree Plan*, published by the Council, Parramatta, NSW

Parramatta City Council 2015, *'Life in Our City' Parramatta City Council's Biodiversity Strategy 2015 – 2025*, published by the Council, Parramatta, NSW

Pfautsch S and Rouillard S 2019, *Benchmarking heat in Parramatta, Sydney's Central River City*, published by Western Sydney University, August 2019

PricewaterhouseCoopers Australia 2011, *Protecting human health and safety during severe and extreme heat events. A national framework*, prepared for the Commonwealth Department of Climate Change and Energy and Efficiency, November 2011

The Nature Conservancy and Resilient Melbourne 2019, *Living Melbourne: Our Metropolitan Urban Forest Technical Report*, The Nature Conservancy and Resilient Melbourne, Melbourne

Town of Cochrane 2018, *About. Find out what Let's Talk Cochrane is all about*, Let's talk Cochrane, <https://www.letstalkcochrane.ca/about-2/>, accessed 27.11.2019

Transport for NSW Planning and Environment Services 2017, *Vegetation Offset Guide, 9TP-SD-087/1.0. Supporting document – Applicable to Infrastructure and Services*, Version 1, 1 August 2017, Transport for NSW

TyrrellStudio in association with the Office of the Government Architect 2017, *West Central District. Sydney Green Grid. Spatial Framework and Project Opportunities*, prepared for the Department of Planning and Environment, the Department, NSW

WSP Australia and Jacobs Group 2017, *Parramatta Light Rail (Stage 1). Westmead to Carlingford via Parramatta CBD and Camellia. Environmental Impact Statement*, prepared for Transport for NSW, State of New South Wales

WSP Australia and Jacobs Group 2018, *Parramatta Light Rail (Stage 1). Westmead to Carlingford via Parramatta CBD and Camellia. Submissions Report (incorporating Preferred Infrastructure Report)*, prepared for Transport for NSW, State of New South Wales

WSP Parsons Brinckerhoff 2017, *Biodiversity Assessment Report. Parramatta Light Rail*, prepared for Transport for NSW

7.2. Further reading/resources

ABC Radio National 2017, *On the street where you live – money does grow on trees*, broadcast 31.08.2017 on "The Money" with Richard Eady, available at: <https://www.abc.net.au/radionational/programs/themoney/turning-a-new-leaf:-the-value-of-green-investment/8858984>, published by the Australian Broadcasting Corporation 2017, Sydney

Ball, Matt 2013: *Satellite Images Reveal London's Heat Island Effect*, published by Informed Infrastructure. The magazine for civil & structural engineers, <https://informedinfrastructure.com/5503/satellite-images-reveal-londons-heat-island-effect/>, accessed 01.11.2019

City of Melbourne 2019, *Quantifying the benefits of green infrastructure in Melbourne. Literature review and gap analysis*, the Council, Melbourne

City of Sydney 2013, *Urban Forest Strategy 2013*, the City, Sydney, NSW

Clark R 2003, *Specifying Trees: a guide to assessment of tree quality*, published by NATSPEC//Construction Information, 61 Lavender Street, Milsons Point, New South Wales 2061

Commonwealth of Australia 2015, *National Climate Resilience and Adaptation Strategy*, published by the Department of the Environment, Commonwealth of Australia

Government Architect's Office 2015, *Urban Green Cover in NSW. Technical Guidelines*, prepared for the NSW Office of Environment and Heritage, State of NSW

The Age and Sydney Morning Herald 2016, *The urban heat island effect*, video, <https://www.youtube.com/watch?v=4SihdPRRMPI>, accessed 01.11.2019

Green and Growing 2018, *Urban Heat Islands: What Are They and Can We Cool them?*, <https://www.greenandgrowing.org/urban-heat-islands-cool/>, accessed 01.11.2019

Horticulture Innovation Australia Ltd 2019, *Greener Spaces Better Places*, <https://www.greenerspacesbetterplaces.com.au>, accessed 25.11.2019

Peters A 2018, *A simple solution to help cities fight overheating: more trees*, published by Fast Company, <https://www.fastcompany.com/90204411/a-simple-solution-to-help-cities-fight-overheating-more-trees>, accessed 01.11.2019

Peters A 2019, *Cities are getting hotter, but we can redesign them to keep us cool*, published by Fast Company, <https://www.fastcompany.com/90379081/cities-are-getting-hotter-but-we-can-redesign-them-to-keep-us-cool>, accessed 01.11.2019

[Blank Page]

8 APPENDICES



Appendix 1

Based on the principles outlined in [section 4.1.2](#), the following pages present a series of maps and accompanying information to explain the individual layers of information that have been considered and overlaid to identify the priority street tree planting locations for this Tree Offset Strategy.

Consistent with the overarching aim for multiple benefits from offset tree planting, the streets that realise benefits against multiple criteria constitute the preferred planting locations, as shown in [Figure 20](#).

8.1. CBD and connected urban streets

As outlined in [section 3.3.6](#), the “selected pedestrian network” is the primary network that will support pedestrian access to light rail stops. It consists of about 57 kilometres of road that are likely to have the highest pedestrian activity within walking catchments of light rail stops. In determining areas of likely highest pedestrian activity, destinations and points of interest including community infrastructure such as schools, centres and open spaces were considered.

For the purposes of determining priority offset planting locations, the following streets were filtered out from the network – refer [section 4.1.3.3](#):

- › Streets in the Parramatta CBD (as defined by Project Planning Approval) that are less than 3m wide
- › Streets outside of the CBD with a planting strip less than 1m wide
- › Streets in urban renewal areas.

In addition, streets with high-pressure gas mains in the verge are considered unsuitable for tree planting and have also been excluded.

The priority streets for offset tree planting within the selected pedestrian network are shown in [Figure 38](#).

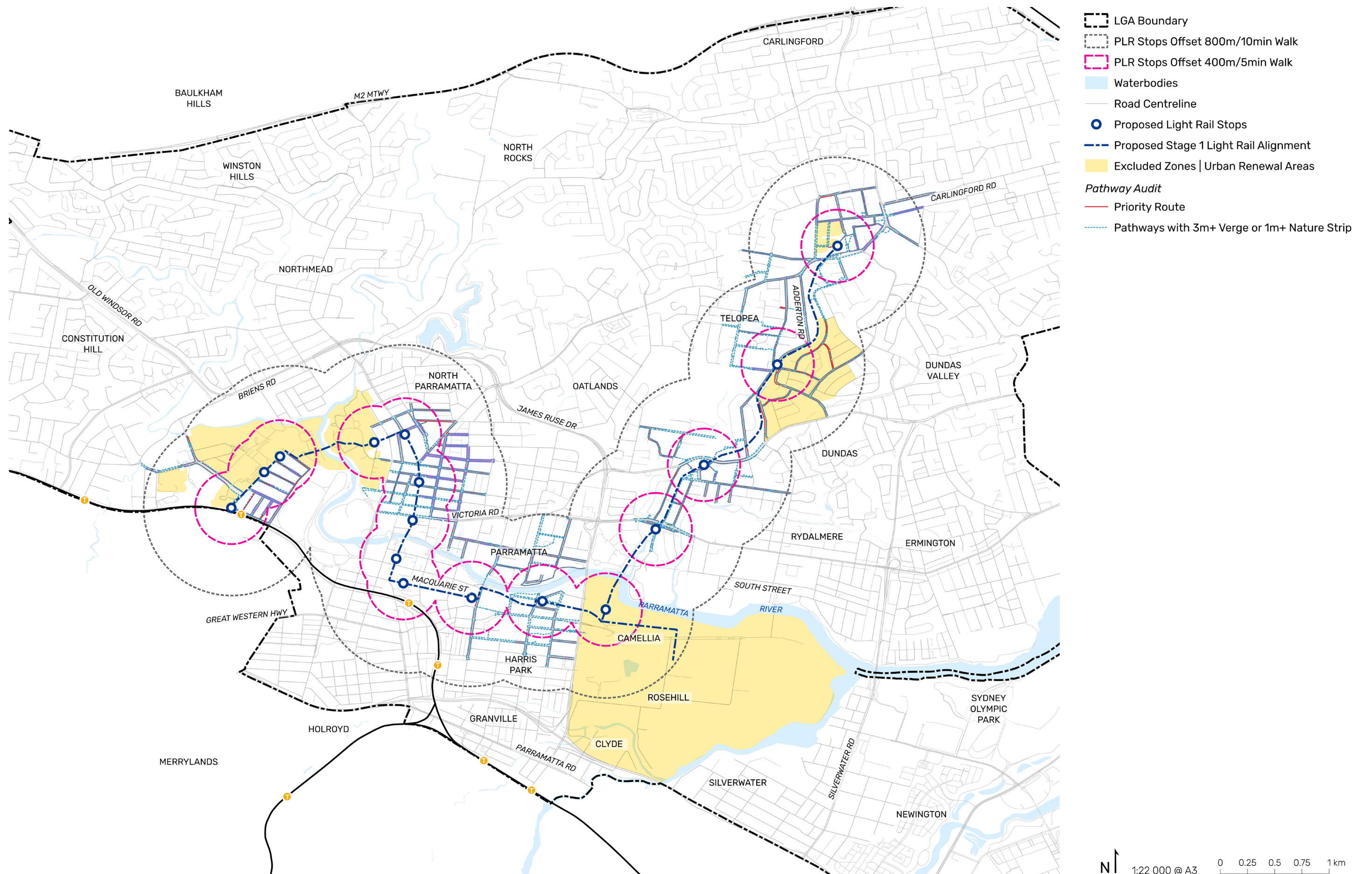


Figure 37: The selected pedestrian network, modified to suit PLR offset planting constraints

8.2. Urban heat streets

Consistent with the objective enhancing customer comfort, this map identifies the hottest streets in proximity of PLR. These streets would benefit most from tree planting to mitigate urban heat. Two priorities were identified:

Streets more than 9°C hotter than the baseline temperature

Streets between 7 and 9°C hotter than the baseline temperature.

Devereux and Caccetta (2017) define the baseline temperature as follows:

The UHI is a measure of the deviation of urban temperatures relative to a non-urban baseline.

Native vegetated sites were used to establish the baseline. This was achieved by estimating a first-order fit to the temperature of native vegetation within and around each urban centre. This fit captures any broad-scale temperature trend that is likely independent of urbanisation, such as cooling with increased latitude or proximity to the coast.

The temperature above the baseline is calculated by subtracting these broad-scale trends from the measured temperature trends. The remaining temperature difference indicates deviations that can be attributed to urban development of the area.

Figure 39 shows the streets in Parramatta that are consistently the hottest streets and should be targeted with tree planting to mitigate urban heat.

The same streets as per **Figure 38** have been excluded from the map.

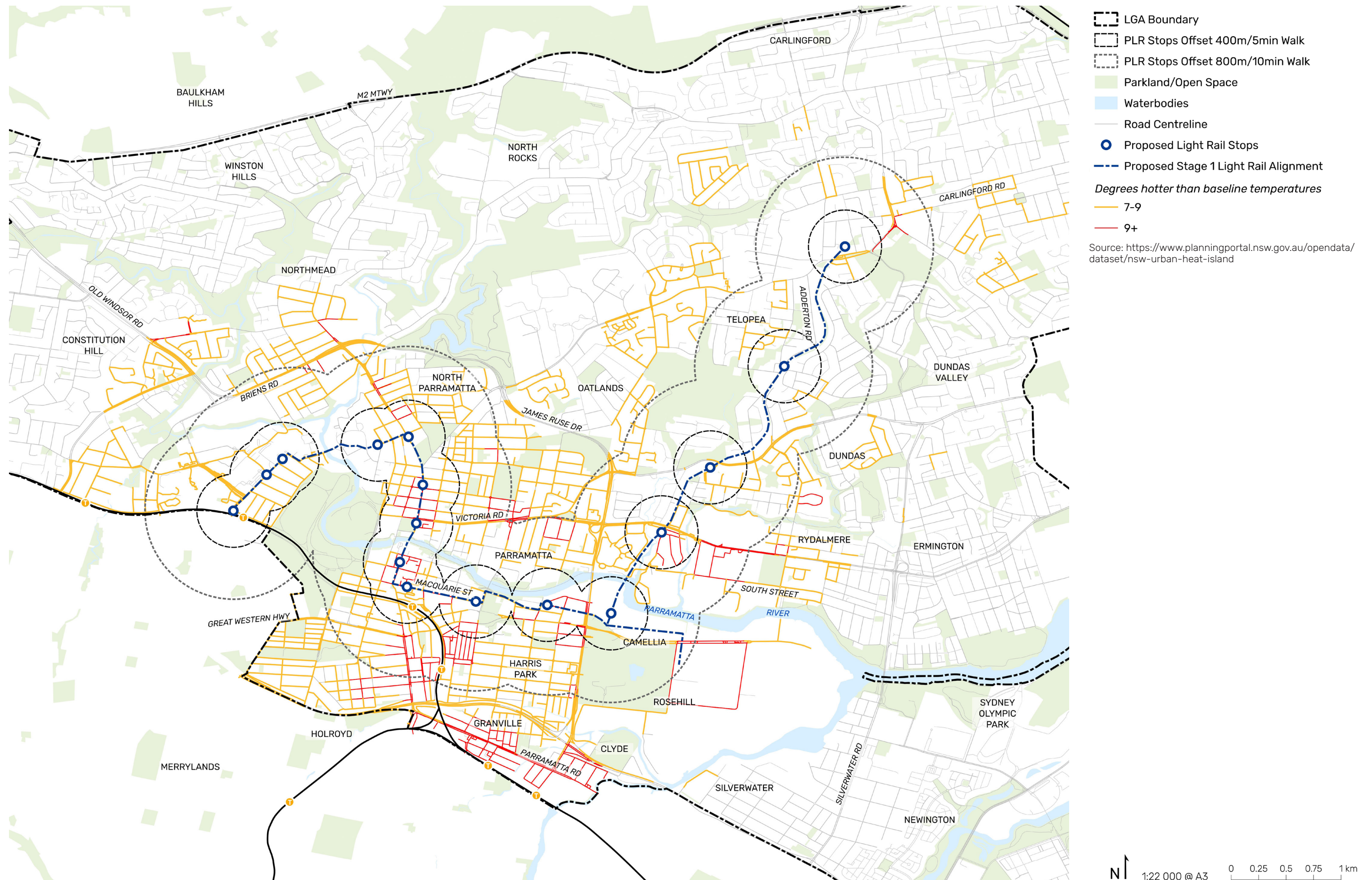


Figure 38: Parramatta streets with highest temperatures due to the urban heat island effect

8.3. Parramatta Ways

Parramatta Ways implements the Sydney Green Grid at the Parramatta LGA level. **Figure 40** shows the following, as identified by the study:

- › Major routes
- › Intermediate routes
- › Local routes.

Prioritising offset tree planting along these routes would help assist implement existing published policy documents, while serving to enhance customer comfort within the PLR walking catchment. Planting along these routes would therefore realise multiple benefits, consistent with the principles for offset tree planting.

Installation of trees in locations along *Parramatta Ways* routes beyond the PLR – Stage walking catchment would be possible, if there is a need to accommodate offset trees beyond the walking catchment, due to the large number of trees required to be planted.

Due to the level of planning and investigation undertaken as part of the development of *Parramatta Ways*, routes within urban renewal areas were retained as appropriate locations for offset tree planting under this strategy. This is based on an assumption that, due to inclusion of these routes in the planning framework, the risk of offset tree losses due to urban renewal is reduced as planning protections would be put in place to ensure protection of the green grid links.

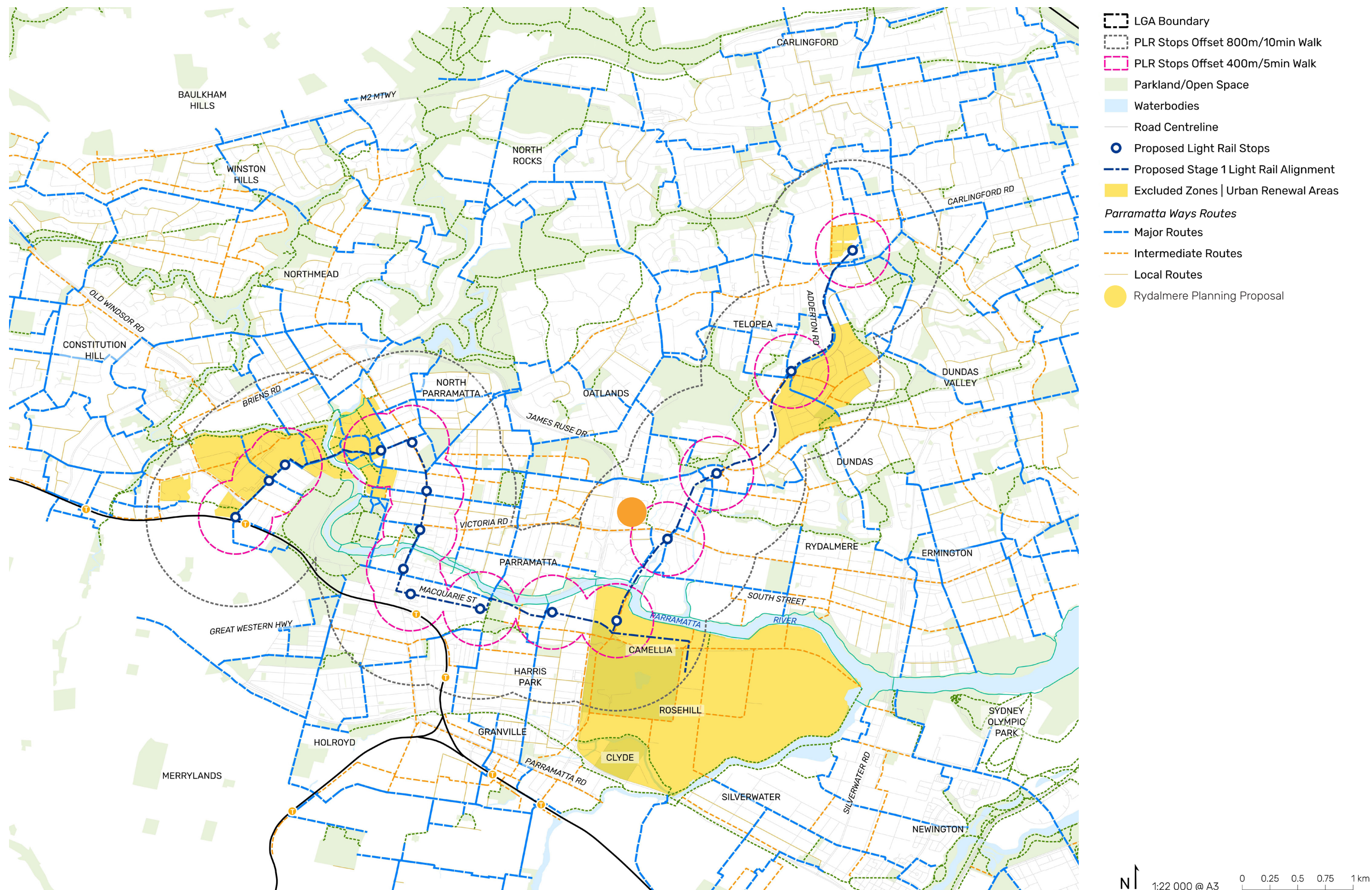


Figure 39: Parramatta Ways routes relative to the PLR walking catchment and urban renewal areas

8.4. Parramatta cycle network

Figure 41 shows the existing Parramatta cycle network including planned extensions. There are opportunities to provide tree canopy cover along:

- › Existing on-and off-road routes
- › Routes delivered by PLR: along Bridge Road Westmead, Tramway Avenue and the Carlingford Corridor
- › Planned on-road routes, or other routes where future implementation does not pose a risk to trees.

Tree planting along these cycle routes has the potential to:

- › Enhance customer comfort
- › Encourage greater participation in cycling
- › Grow the PLR customer catchment by making cycling to light rail stops more attractive.

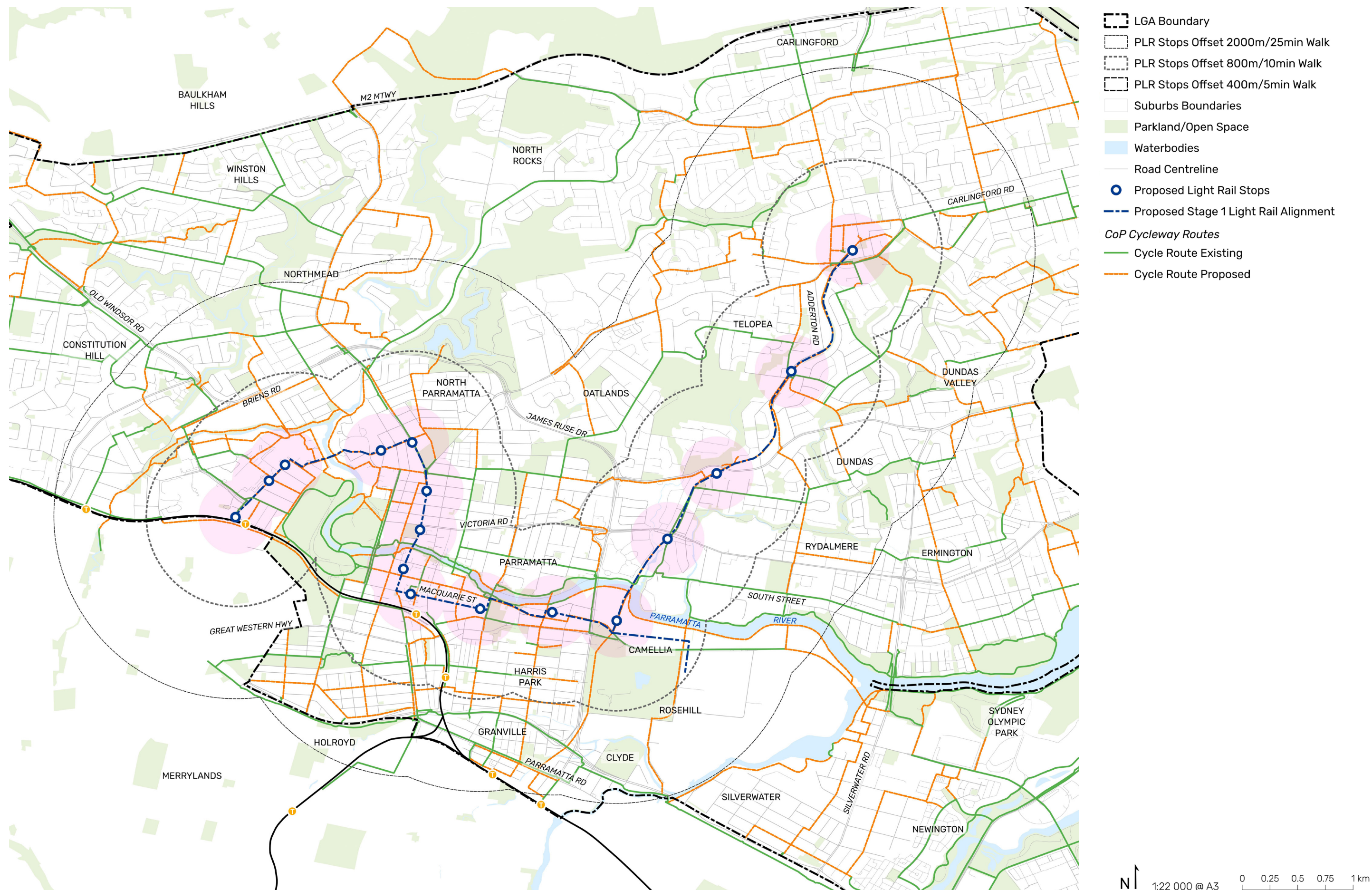


Figure 40: The Parramatta cycle network

8.5. Land use

To determine location types for the purpose of identifying appropriate tree species, the built form of the Parramatta LGA was analysed. Street were divided into three broad categories - refer **Figure 42**:

- › Commercial centres, mixed use precincts and other areas with existing buildings more than four storeys tall, or planned for future uplift
- › Other urban areas including residential, employment/commercial areas or local town centres with buildings up to four storeys in height
- › Streets or sections of streets along parks and other open space areas such as bushland.

It should be noted that some streets may have different conditions on both sides of the street.

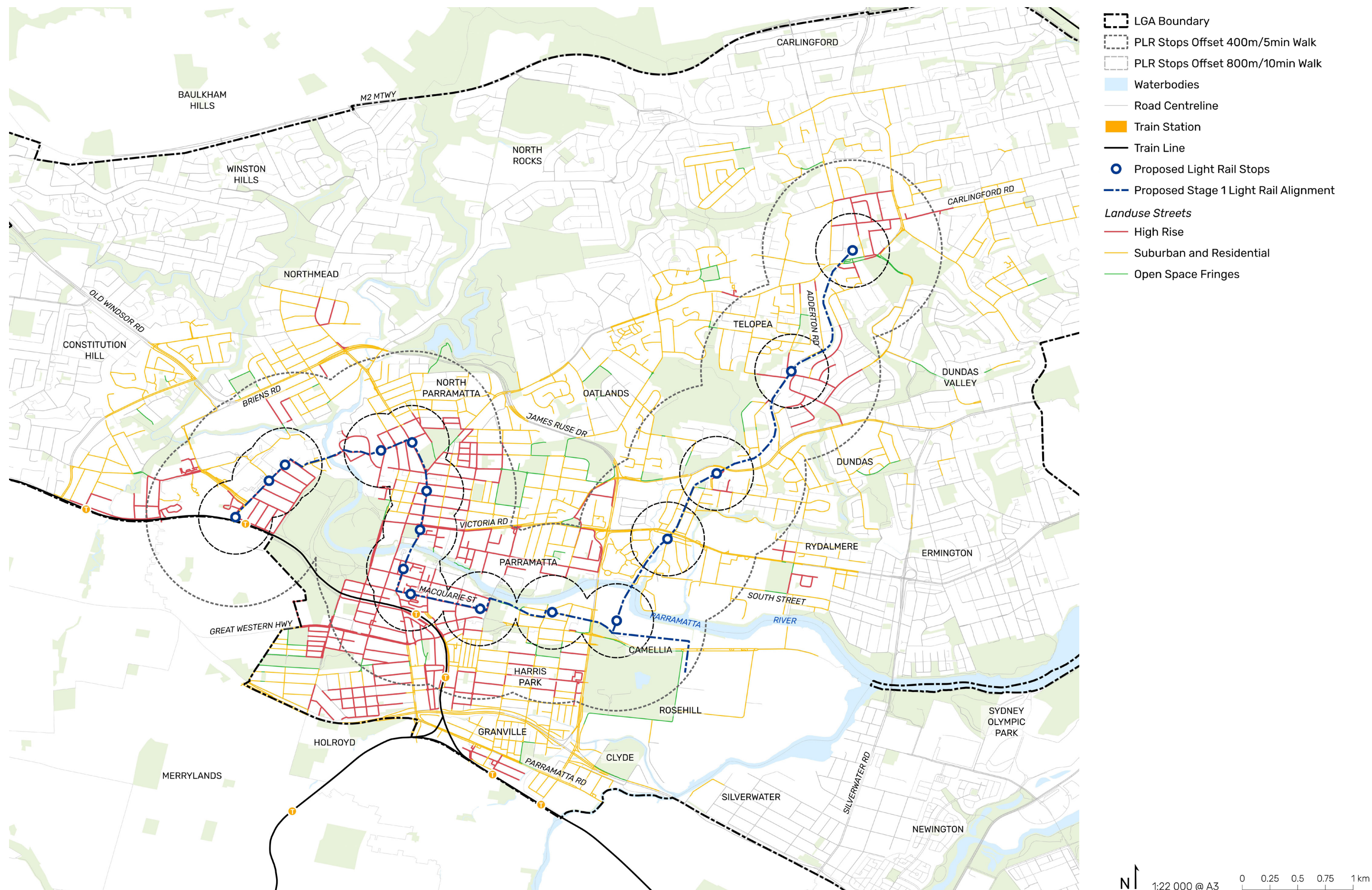


Figure 41: Built form analysis to inform street typologies

8.6. Verge widths

Figure 43 shows areas of wide and narrow verge widths, as defined in section 4.2.2.2. The combination of built form and verge widths gives a good indication of the space likely to be available for street tree planting, providing the basis for selecting tree species. This will ensure that the largest possible tree is planted in every location, while minimise the risk of damage to other infrastructure.

Areas with a pink fill indicate areas data on verge widths was unavailable and where assumptions have been made based on available data and through correlation with locations identified as suitable tree planting locations in Council’s i-Tree database.

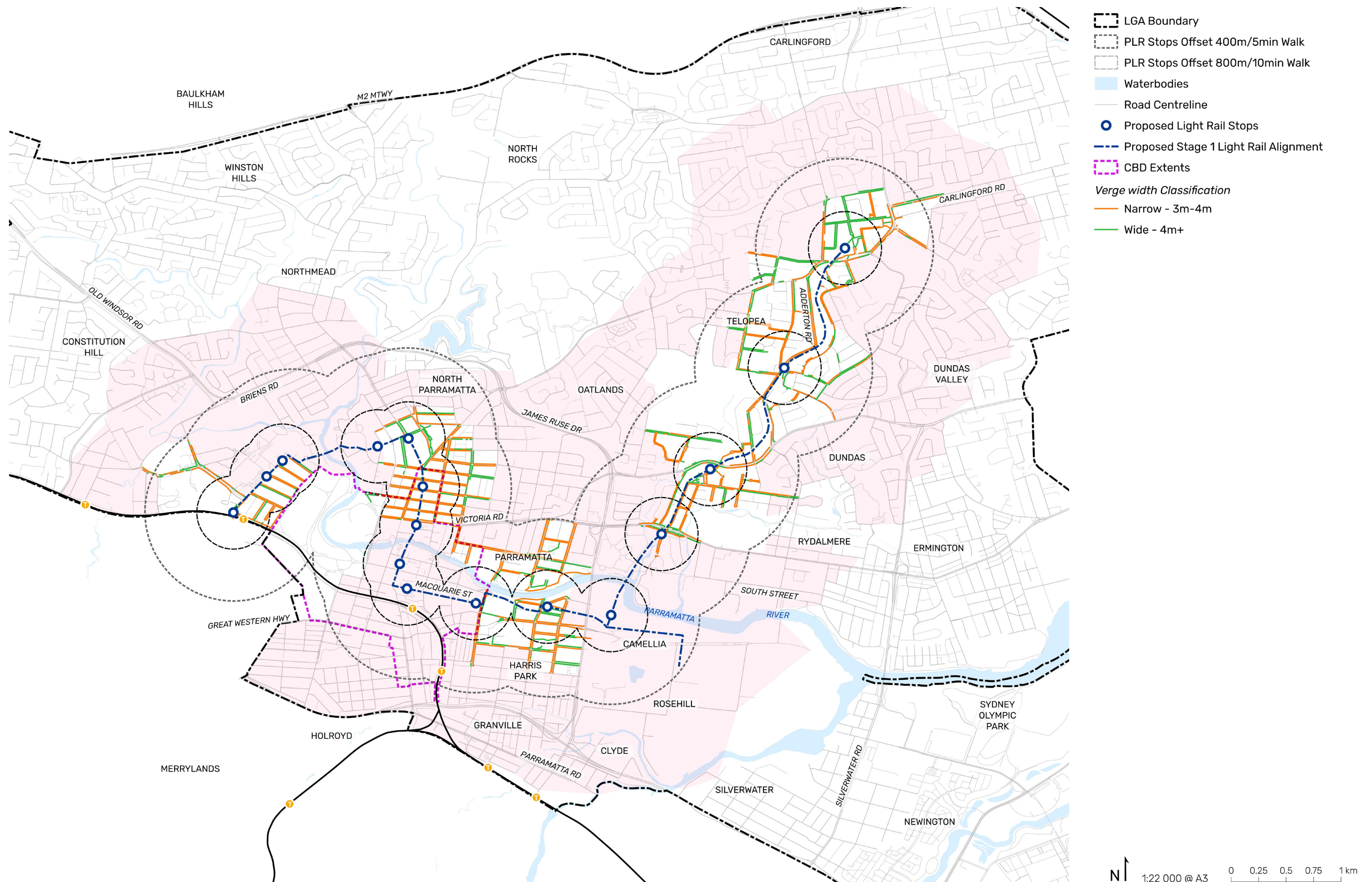


Figure 42: Verge width analysis analysis to inform street typologies

8.7. Open space and biodiversity

Figure 44 shows the locations and types of bushland remnants of native vegetation communities, relative to open space areas.

For bushland and biodiversity planting, offset tree planting species must be chosen to be consistent with indigenous ecological communities in the locations where they are to be planted.

Table 26 lists the major canopy species for each identified ecological community, based on *Life in our City* and OEH threatened species information.

Table 26: Indigenous ecological communities and signature tree species

Botanical name	Common name
BLUE GUM HIGH FOREST	
<i>Allocasuarina torulosa</i>	Forest Oak
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Elaeocarpus reticulatus</i>	Blueberry Ash
<i>Eucalyptus paniculata</i>	Grey Ironbark
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Syncarpia glomulifera</i>	Turpentine
CUMBERLAND SHALE PLAINS WOODLAND	
<i>Acacia parramattensis</i>	Parramatta Wattle
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Corymbia maculata</i>	Spotted Gum
<i>Eucalyptus amplifolia</i>	Cabbage Gum
<i>Eucalyptus crebra</i>	Narrow-leaved Ironbark
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus fibrosa</i>	Red Ironbark

Botanical name	Common name
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus tereticornis</i>	Forest Red Gum
RIVERFLAT FOREST	
<i>Acacia binervia</i>	Coast Myall
<i>Acacia floribunda</i>	White Sallow Wattle
<i>Acacia parramattensis</i>	Parramatta Wattle
<i>Acmena smithii</i>	Lillypilly
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Backhousia myrtifolia</i>	Grey Myrtle
<i>Casuarina cunninghamiana</i>	She-Oak
<i>Casuarina glauca</i>	Swamp Oak
<i>Eucalyptus amplifolia</i>	Cabbage Gum
<i>Eucalyptus botryoides</i>	Bangalay
<i>Eucalyptus elata</i>	River Peppermint
<i>Eucalyptus ovata</i>	Swamp Gum
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Eucalyptus robusta</i>	Swamp Mahogany
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Eucalyptus viminalis</i>	Ribbon Gum
<i>Livistona australis</i>	Cabbage Tree Palm
<i>Melaleuca decora</i>	White Feather Honeymyrtle
<i>Melaleuca linariifolia</i>	Snow-in-Summer
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
<i>Tristaniopsis laurina</i>	Water Gum

Botanical name	Common name
SWAMP OAK FLOODPLAIN FOREST	
<i>Acmena smithii</i>	Lillypilly
<i>Alphitonia excelsa</i>	Red Ash
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Angophora subvelutina</i>	Broad-leaved Apple
<i>Callistemon salignus</i>	Willow Bottlebrush
<i>Casuarina glauca</i>	Swamp Oak
<i>Cupaniopsis anacardioides</i>	Tuckeroo
<i>Eucalyptus moluccana</i>	Grey Box
<i>Eucalyptus tereticornis</i>	Forest Red Gum
<i>Glochidion ferdinandi</i>	Cheese Tree
<i>Melaleuca ericifolia</i>	Swamp Paperbark
<i>Melaleuca styphelioides</i>	Prickly-leaved Tea Tree
TURPENTINE IRONBARK FOREST	
<i>Angophora costata</i>	Smooth-barked Apple
<i>Angophora floribunda</i>	Rough Barked Apple
<i>Eucalyptus eugenioides</i>	Thin-leaved Stringybark
<i>Eucalyptus globoidea</i>	White Stringybark
<i>Eucalyptus paniculata</i>	Grey Ironbark
<i>Eucalyptus pilularis</i>	Blackbutt
<i>Eucalyptus punctata</i>	Grey Gum
<i>Eucalyptus resinifera</i>	Red Mahogany
<i>Eucalyptus saligna</i>	Sydney Blue Gum
<i>Syncarpia glomulifera</i>	Turpentine

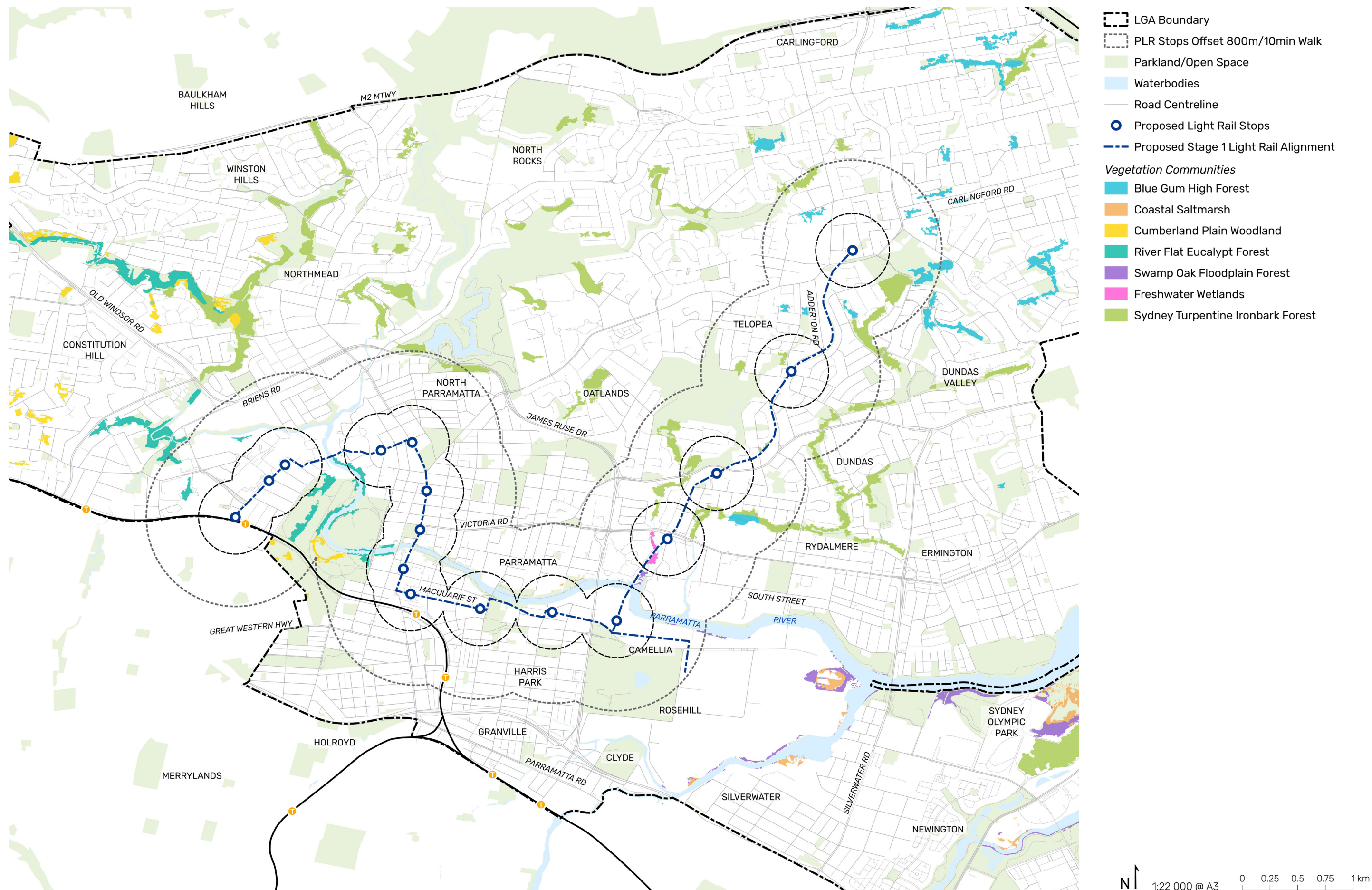


Figure 43: Remnant ecological communities

Appendix 2

9.1. Potential offset tree locations

Unique offset strategies

Alternate offset options

Table 27: Potential offset tree locations

Alternate planting locations	Potential benefits	Potential risks / drawbacks
Public education providers: › NSW Department of Education (primary and high schools) › TAFE NSW	A greener campus could positively contribute to: › Heat mitigation › UV protection › Enhanced outdoor learning environments › Environmental education/awareness › Physical and mental health › Enhanced learning outcomes/student performance › Positive behavioural outcomes Would support NSW policy for shared community facilities through increased amenity. Consistent messaging between government agencies/departments in terms of increasing green cover reinforcing policy objectives to the public. Potential positive community initiative/good news story. Could be combined with/co-promoted through other events such as National Tree Day.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and ongoing monitoring/maintenance › Space/growth constraints on many campuses may limit capacity: unlikely to make a major contribution to the Offset Strategy › Highly risk-averse land/asset owner › Highly constrained asset maintenance ability › Negotiations would be required with both the Department and individual principals, potentially putting a strain on delivery time frames.

Alternate planting locations	Potential benefits	Potential risks / drawbacks
Universities, colleges and global corporations (i.e. corporate volunteer planting days)	A greener campus could positively contribute to: › Heat mitigation › Enhanced image through better environmental (outdoor) amenity › Enhanced learning outcomes/student/staff performance › Enhanced student and staff satisfaction including ability to attract and retain staff. Generally a higher level of appreciation of the direct and indirect benefits of higher amenity environments. Likely to be a less risk averse stakeholder than government organisations.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and maintenance › Space/growth constraints may limit capacity: unlikely to make a major contribution to the Offset Strategy › Willingness to support/help out government projects is unknown – could get caught up in trade-offs
Health institutions	A greener campus could positively contribute to: › Heat mitigation › Enhanced outdoor environments and amenity for patients and staff › Support physical and mental health including improved/accelerated healing and recovery › Enhanced patient and staff satisfaction including ability to attract and retain staff	› 3rd party land owner: requires negotiation of a separate agreement for both installation and maintenance › Space/growth constraints may limit capacity: unlikely to make a major contribution to the Offset Strategy › Ability/willingness to maintain and monitor the asset likely to be highly variable between institutions including between public and private › Willingness to support/help out government projects is unknown – could get caught up in trade-offs

Alternate planting locations	Potential benefits	Potential risks / drawbacks
Parramatta Park Trust	Large open space offers potentially greater capacity to accommodate offset trees. Potential for offset tree to complement existing park trees and character for community benefit.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and ongoing monitoring/maintenance › Capacity difficult to assess at a strategic level › Significant heritage values may limit planting potential and/or may require additional assessments/studies before decisions can be reached › Open space planting less beneficial for urban heat mitigation than street tree planting.
Private open spaces (i.e. golf courses)	Greener private open spaces could positively contribute to: › Heat mitigation › UV protection › Increased canopy and habitat	› 3rd party land owner: requires negotiation of a separate agreement for both installation and ongoing monitoring/maintenance › Capacity difficult to assess at a strategic level › Functional constraints (i.e. fairways) › Willingness to support/help out government projects is unknown – could get caught up in trade-offs › Open space planting less beneficial for urban heat mitigation than street tree planting.
Other agencies and organisations:	Potential to extend green corridors to mitigate urban heat and enhance movement corridors.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and ongoing monitoring/maintenance › Highly risk-averse asset owners › Ability/willingness to maintain and monitor the asset likely to be low › Capacity hard to assess at a strategic level but likely to be limited by space/functional/safety constraints: unlikely to make a major contribution to the Offset Strategy › Open space planting less beneficial for urban heat mitigation than street tree planting.

Alternate planting locations	Potential benefits	Potential risks / drawbacks
Fisheries	Potential to extend green corridors to mitigate urban heat, enhance movement corridors and enhance ecological systems along riparian corridors. Potentially more receptive stakeholder.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and maintenance › Ability to monitor the asset likely to be low › Capacity hard to assess at a strategic level but likely to be limited by space constraints: unlikely to make a major contribution to the Offset Strategy › Open space planting less beneficial for urban heat mitigation than street tree planting.
Urban Renewal Areas	Potential to deliver a higher level of canopy cover/green infrastructure than developers might be willing to offer – would need testing/investigation to confirm or otherwise.	› 3rd party land owner: requires negotiation of a separate agreement for both installation and maintenance › Timing unlikely to be aligned with PLR project approval requirements › Depending on planning progress/status capacity may be hard to assess › Potential overlap/conflict with approval conditions for urban renewal areas (i.e. need to accommodate/deliver own tree offsets and public domain benefits)
Private (residential) land owners	Opportunity to offer impact mitigation where space constraints within public lands preclude compensatory tree planting. Potential positive community initiative/good news story	› 3rd party land owner: requires negotiation of a separate agreement for both installation and maintenance › Very limited capacity for each negotiated agreement › Difficulty in securing and enforcing longevity/longer-term survival and protection of trees.

9.1.2. Unique offset strategies

While the Tree Offset Strategy has been developed to meet the planning approval requirements for Parramatta Light Rail, it is recognised that the loss of existing trees, particularly significant trees, represents a key community impact as a result of the project. To assist in mitigating these impacts, further offset strategies may be considered by the project team in addition to the statutory offset requirements. Potential additional offset strategies to assist in achieving the objectives of the Tree Offset Strategy are outlined below in Table 28.

Table 28: Unique offset strategies

Unique offset strategies	Opportunity
Potential to extend green corridors to mitigate urban heat, enhance movement corridors and enhance ecological systems along riparian corridors.	For significant trees along the alignment, such as the cluster of fig trees in Cumberland Hospital East campus and the large fig trees in Robin Thomas Reserve. There is an opportunity to support offsets through the taking of cuttings from these trees, propagating at nursery’s and replanting.
Potentially more receptive stakeholder.	CoPC have demonstrated an interest in this approach to propagate cuttings from the significant trees before removal. From a community perspective, taking cuttings shows a level of ‘respect for life’ of each of the trees to be removed which cannot be translocated for practicality reasons. New plantings should be grown to a minimum of 1m in height, or as recommended by the Independent Arborist. The time taken to propagate a cutting to this size can be up to three (3) years so should be taken early in the project programme to assist in delivering before planned operations
Potential to deliver a higher level of canopy cover/green infrastructure than developers might be willing to offer – would need testing/ investigation to confirm or otherwise.	While the planning approval requires offset trees to be 200L or 75L depending on location, there may be opportunities to provide larger mature offset trees to assist in achieving a larger replacement offset quicker than would otherwise be achieved through using standard offset sizes. The sizes of these large mature offsets can be upward of 1,000L and 2,000L. This may be appropriate to assist in offsetting the loss of existing significant trees along the alignment. There would be high upfront costs for purchase / installation and limitations on procurement opportunities so it would be unlikely that this strategy would be appropriate for all situations. However it could be considered for key areas of existing significant tree loss. Refer to Section 9.1.3 Alternate Offset Options for proposed offsetting information.

9.1.3. Alternate Offset Options

Biosecurity Risks

In accordance with the Parramatta Light Rail Planning Approval (Table 1), the definition of a Tree is in accordance with the Australian Standards AS 4970-2009 Protection of Trees on Developing Sites. A Tree is defined as a “long lived woody perennial plant greater than (or usually greater than) 3 m in height with one or relatively few main stems or trunks (or as defined by the determining authority)”. Weedy trees that are considered to have a tree structure, can also be deemed a high biosecurity risk (Biosecurity Act 2015) and/or a key threatening process (Biodiversity Conservation Act 2016) and therefore not defined as a ‘Tree’ by the determining authority (e.g. relevant Councils).

A high biosecurity risk is the risk that the introduction, presence, spread or increase of a plant will have, or may potentially have, an adverse effect on the economy, the environment or the community. TfNSW has a General Biosecurity Duty where it is deemed reasonably practical to prevent, eliminate or contain the risk. Therefore, depending on the location of a tree, it may not be reasonable to offset a biosecurity risk at the ratios prescribed in Condition E107.

TfNSW proposes that where trees are:

- ▶ Identified as a biosecurity risk by the relevant LGA and the accompanying Greater Sydney Regional Strategic Weed Management Plan 2017 – 2022 which has been developed by Greater Sydney Local Land Services.
- ▶ Self-sown or not purposefully planted as amenity or within a heritage setting.

That an offsetting ratio of 1:1 be applied.

It is acknowledged that all loss of trees contribute to a greener environment, tree canopy, visual diversity, and reducing the heat island effect and therefore TfNSW proposes to offset the trees that are biosecurity risks at a rate of 1:1.

Mature Offset Trees

As identified in Table 28 there may be opportunities / locations where a mature (>1,000L) offset tree would be beneficial. It is proposed that where a large mature tree offset is used that it would be considered as equivalent to two x 200l trees, or four x 75l trees due to the mature nature of the tree and the immediate benefits provided.

Tree offset in accordance with Condition E100

As described in Section 3.3.4.3, there are trees that require removal that are part of an ecological endangered community. These communities will be offset in accordance with the E100 Biodiversity Offset Strategy and therefore would not be offset again against Condition E107.

