



Frenchs Forest Planned Precinct

Urban Tree Canopy Audit

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Abbreviations

Abbreviation	Description
CHM	Canopy Height Model
DCP	Development Control Plan
DFSI	NSW Department of Finance, Services and Innovation
DPIE	Department of Planning, Industry and Environment
DTM	Digital Terrain Model
DSM	Digital Surface Model
ELA	Eco Logical Australia
LEP	Local Environment Plan
LiDAR	Light Detection and Ranging

Executive Summary

An audit of the current configuration of the tree canopy across the Frenchs Forest Planned Precinct was carried out to provide base information to build and enhance the urban environmental values as well as support the development of relevant policies and goals for the Precinct.

The audit comprised of a spatial analysis of existing data and some field validation to develop relevant maps and statistics regarding the distribution of tree canopy across the Precinct, including canopy type, classification, age classes and heights.

Key findings of the audit identified that:

- Generally, the Precinct has a tree canopy of between 27% and 30%
- More than three quarters of the tree canopy across the areas of the precinct is in private ownership
- About 75% of the tree canopy across the areas of the Precinct are planted native or exotic tree species, the remainder being made up of remnant native vegetation, some of which is classified as threatened vegetation
- The majority of the canopy trees across the Precinct range in size between 5 and 25 metres
- Over 90% of the tree canopy across the areas of the Precinct is made up of mature trees, but of a range of ages and with a considerable life expectancy.

1 Background

1.1 Introduction

Following announcement of Frenchs Forest as a Priority Precinct in 2017; precinct investigations are being carried out to guide the rezoning of the Frenchs Forest Planned Precinct.

One of the key initiatives of the Draft Green Infrastructure Policy for NSW, is to identify and enhance a network of greenspaces (including features such as street trees) designed to deliver multiple environmental, economic, and social values and benefits to urban communities. These benefits include enhancing biodiversity values, functional environmental values, as well as increased social and health values across our urban environment.

An audit of the current configuration of the tree canopy across the Frenchs Forest Planned Precinct provides the base information to build and enhance the urban environmental values as well as provide a starting point to set longer term policies and goals for the Precinct. Included in this is the aim to register for a Green Star rating with the Green Building Council of Australia for the Hospital precinct.

1.2 Project Objectives

The aims of this project are to provide an audit of the makeup of the current tree canopy across the Frenchs Forest Planned Precinct. The audit will update existing information and describe the current status of tree canopy cover across the identified development phases of the Planned Precinct.

The audit will provide a series of maps and associated statistics, which will assist in developing future urban tree canopy guidelines for the precinct.

1.3 Project approach

The approach to prepare the urban tree canopy audit includes:

1. Review and collate existing background information and suitable data including:
 - Planned Precinct Boundaries (extended area)
 - Street centre lines / road reserves
 - LEP Zoning
 - Best available aerial photography
 - Best available LiDAR data
 - Significant tree definition / location
 - Vegetation mapping
2. Analysis of LiDAR and spatial data
3. Desktop validation and field survey to validate tree canopy age classes
4. Mapping and statistical analysis

2 Methods

2.1 Information and data review

A data audit was carried out to identify and assess available base information. The audit identified the suitability of each data set with regards to relevance and suitability to the analysis.

Spatial data identified for use in the analysis is shown in Table 1, below.

Table 1: Analysis data

Data layer	Source	Description
LiDAR point cloud	ACOR Consultants	2013 complete point cloud (LAS files) and ground only point cloud (MKP files) covering the study area. Used for determination of canopy height and surface model for the study area.
Study area	DPIE	Frenchs Forest Planned Precinct extended audit study area boundary.
Development Phase	DPIE	Breakdown of development phases within the Frenchs Forest Planned Precinct.
Imagery	Nearmaps	Nearmaps image dated 20 January 2018. Provides current land cover configuration to update tree canopy cover.
Streets	NSW DFSI / Spatial Services	Areas of registered roads from NSW Digital Cadastral Database (DCDB). Assists in determining street tree canopy cover.
Vegetation	Northern Beaches Council	Native vegetation community mapping. Determines remnant native vegetation and endangered vegetation.
LEP zones	DPIE	Warringah Local Environment Plan 2011 zoning (Public recreation, Residential, Environment Conservation, Business, Infrastructure). Assists in determining tree canopy typology (Private land, Open Space, Street Trees).
LEP Heritage sites	DPIE	Areas of heritage significance from the Warringah Local Environment Plan 2011 (i.e. heritages items such as Former Holland's Orchard Trees).

Further information regarding the definition of significant trees was sourced from the Northern Beaches Council DCP, being:

“A “significant tree” is a tree that is over 5.0m in height and, that impacts on the streetscape by virtue of its size, appearance, type, age, condition and heritage/cultural significance”. (Warringah Council 2011).

2.2 Urban canopy audit analysis

The initial urban tree canopy analysis consisted of a spatial analysis incorporating GIS software to analyse LiDAR point cloud data, Aerial Photo Interpretation (API) and the combination of a number of

spatial data layers to derive a suite of attributes to the urban tree canopy extent within the study area (Figure 1). Methods for each component is discussed further in the following sections.

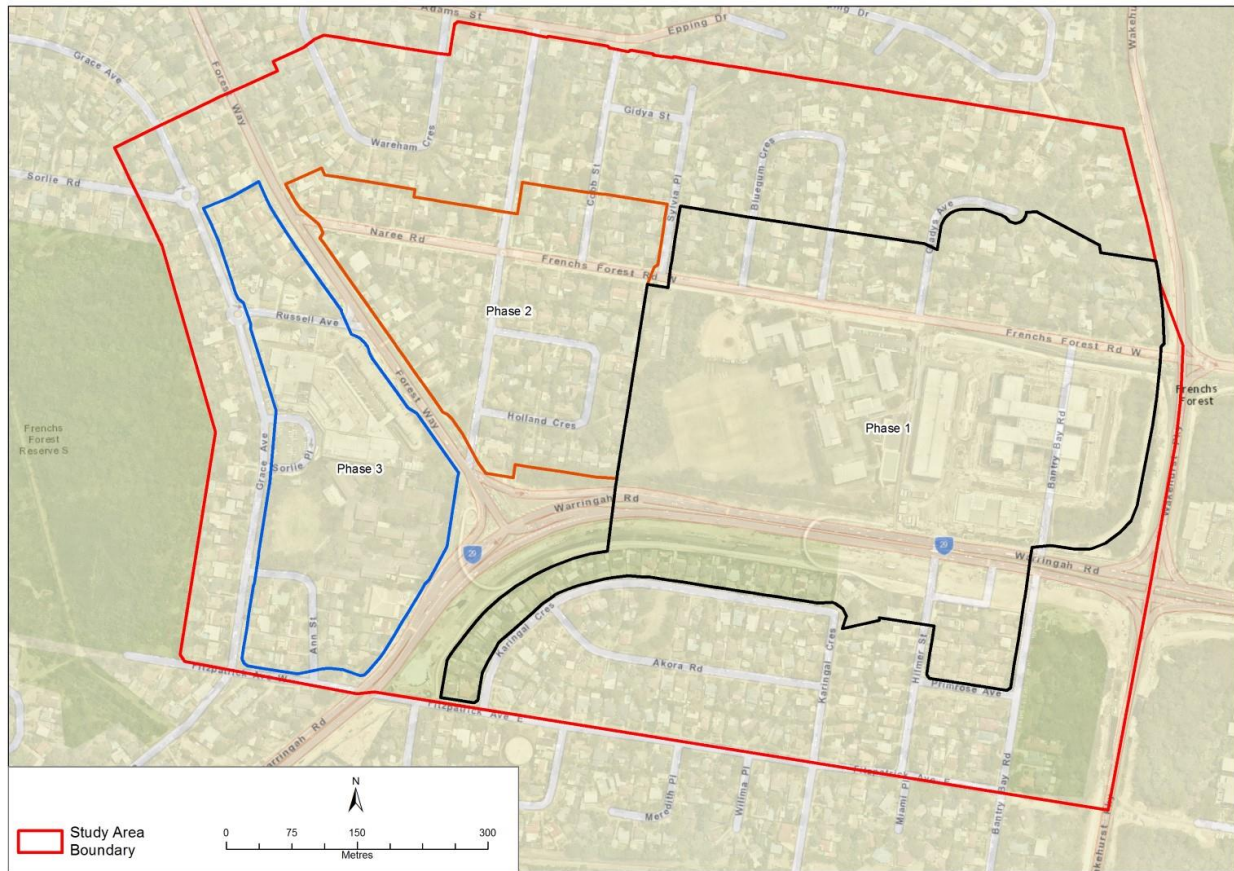


Figure 1: Frenchs Forest canopy tree audit study area

2.2.1 LiDAR analysis

LiDAR point cloud data was analysed and converted into a 2 metre resolution Digital Terrain Model (DTM) and Digital Surface Model (DSM) using Quick Terrain Modeler software.

The spatial analyst extension of ArcGIS was then used to develop a Canopy Height Model (CHM) by subtracting the DTM (2m) from the DSM (2m).

The raw CHM covered all land surfaces within the study area and an initial pre-configured building filter from the LAS data was applied to exclude areas identified as buildings.

2.2.2 API

The CHM overestimated the vegetation cover across the study area due to:

- Date of the LiDAR point cloud data (2013) – there had been considerable changes across the study area due to development; and
- Some variation in the analysis filters in the interpretation of buildings (primarily pitched roofs) as vegetation

A systematic API process was carried out at a scale of 1:800 to refine the extent of tree canopy cover across the study area, and a mask was developed to remove areas of non-vegetation (buildings, roads, cleared land).

The mask was applied to the CHM to revise the layer to address areas of vegetation only.

2.2.3 GIS analysis

A GIS analysis of the CHM was undertaken using a process model in ArcGIS based on available data in order to further classify the CHM. The data was filtered to include all tree canopy greater than 5m and exclude other vegetation, in accordance with the local Council definition of a significant tree.

The analysis included the development of the following four key components for the derived layer.

Table 2: Tree canopy cover components - GIS analysis

Item	Data	Classes
Tree Canopy Height Classes	LiDAR CHM	Five height classes were produced to classify the CHM grid data. Classes were: 5-10m; 10-15m; 15-20m; 20-25m; >25m
Tree Canopy Typology	LEP Zoning Cadastre	Zoning and cadastre data was incorporated in to the vectorized CHM based on the following: <u>Private Land</u> – areas of CHM that occurred within areas mapped as Local Centre, Low Density Residential and Neighbourhood Centre from LEP Zoning. <u>Open Space</u> – areas of CHM that occurred within areas mapped as Public Recreation from LEP Zoning. <u>Street Trees</u> – areas of CHM that occurred within areas designated as road reserve in the cadastre data (includes footpaths) or Infrastructure from LEP Zones. This was then validated through API to determine if the tree was actually within the road reserve or in front yards.
Tree Canopy Classification	Vegetation LEP Heritage	Existing vegetation type and heritage mapping was used to determine tree canopy classification: <u>Endangered Vegetation</u> – all areas mapped as an endangered ecological community from vegetation type mapping were identified and refined and validated through API. <u>Significant Trees</u> – areas identified in the LEP heritage layer (Former Holland's Orchard Trees) was incorporated into the mapping. <u>Remnant Native Vegetation</u> - all areas mapped as remnant native vegetation from vegetation type mapping were identified and refined and validated through API. <u>Planted Native / Exotic Trees</u> – areas of vegetation not identified as remnant native vegetation from vegetation type mapping were considered to be planted vegetation. The planted vegetation incorporated a range of tree species, both native and exotic.
Tree Canopy Age	CHM Nearmaps Google Imagery	An initial breakdown of age classes was prepared based on API of the most current aerial photography. Areas within the CHM were initially broken down into three observable classes of Semi-mature; a combination of Semi-mature/Mature clusters and Mature. An initial desktop validation process was carried out using high resolution

Item	Data	Classes
		aerial photography as well as Google Streetview imagery.

A single vector layer (shapefile) based on the CHM extent was prepared which incorporated each of the four classifications and relevant attribution.

2.3 Site validation

A site survey was carried out between 17th May and 23rd May 2018 to validate the desktop mapping. Key aims of the site survey were to validate the tree canopy age classification.

Age classes were defined as:

- Semi-mature (SM) - Semi-mature refers to a tree at growth stages between immaturity and full size.
- Semi-Mature – Mature (SM - M) –refers to a group of trees that include a mix of observable age classes from Semi-mature to Mature.
- Mature (M) - Mature refers to a large, well established tree with capacity for further growth and longer remaining life cycle
- Late Mature (LM) - refers to a full-sized tree with little capacity for growth that is not yet about to enter decline
- Over Mature (OM) - refers to a tree about to enter decline or already declining

The site survey was carried out primarily by vehicle and on foot. Each of the accessible streets within the study area was traversed and the general age class of trees was compared against the initial classification.

Following site validation, the age class mapping was updated based on field observations.

2.4 Limitations

There were a number of limitations identified for the tree canopy audit analysis. These are listed below:

- Field survey limitations included:
 - The survey was limited to areas that were publicly accessible for observation only.
 - Validation observations were made primarily from what was visible from street fronts and public reserves.
 - Naree road was not accessible during the survey, observations were made from each end of the road at Frenchs Forest Road West and Forest Way.
- The tree canopy layer does not depict individual trees, but the area of tree canopy (ie each polygon may be made up of a number of separate trees with overlapping or adjoining canopy).
- Resolution of the area of tree canopy is based on a 2 x 2 metre grid derived from the LiDAR data
- It is outside the scope of this project to determine specific tree species information.
- An initial filter to include all areas of mapped canopy height of 3m or greater (broader definition of the height of a tree) was carried out, however, there were no areas of tree canopy identified from the available data between 3 and 5 metres in height.
- Juveniles, or young tree plantings were not included in this assessment as they did not meet the definition of a significant tree.

3 Results

An area and percentage breakdown of tree canopy coverage across the development phases of the study area was identified. The canopy cover was classified into four key attributes, made up of distribution of tree canopy typology; tree canopy classification; tree canopy height; and tree canopy age classes.

3.1 Tree canopy cover

The total study area covered an area of 84.66ha in total. This was broken down into 3 planning/development phases and the remainder of the study area (context). Table 3, shows the breakdown of areas by development phase and the proportion mapped through GIS analysis as general tree canopy cover, based on LiDAR data (2013) and aerial imagery dated 20 January 2018.

Table 3: Tree canopy cover by development phase

Development Phase	Total Phase Area (ha)	Area of Mapped Canopy (ha)	% Tree Canopy
Phase 1	26.30	7.09	27%
Phase 2	9.34	2.70	29%
Phase 3	8.43	2.50	30%
Context Area	40.58	12.18	30%
Study Area Total	84.66	24.47	29%

There was approximately 36 ha of vegetation (tree canopy) in total, across the study area at the original date of LiDAR capture (2013). Vegetation loss of about 12 ha between that time and the date of the most recent aerial photography used (2018); was primarily due to development (roads and hospital etc), mostly contained within Phase 1 of the precinct.

The canopy tree cover is further broken down in the following sections.

3.1.1 Tree canopy typology

The distribution of land typology across the study area is shown in Figure 2. The tree canopy cover analysis results were then broken down by this typology (Figure 3).

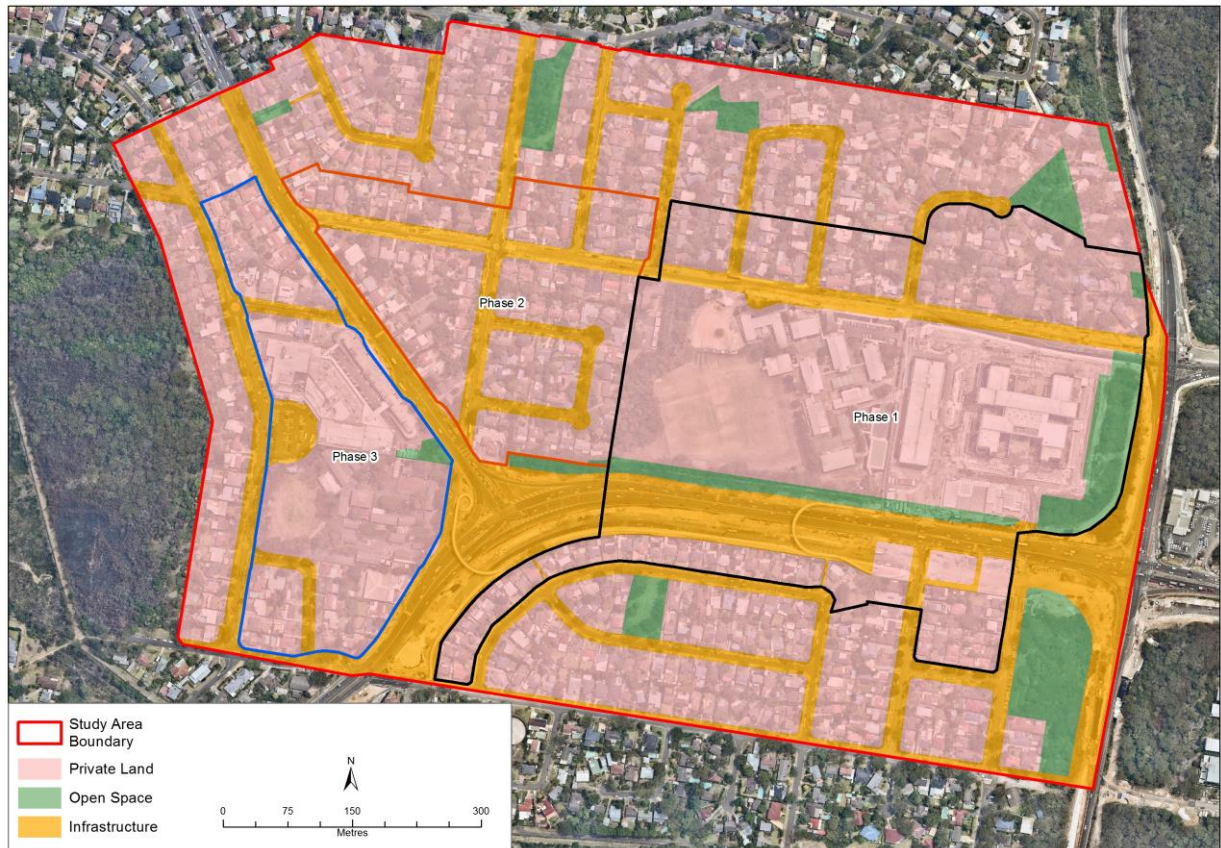


Figure 2: Land use typology within the study area

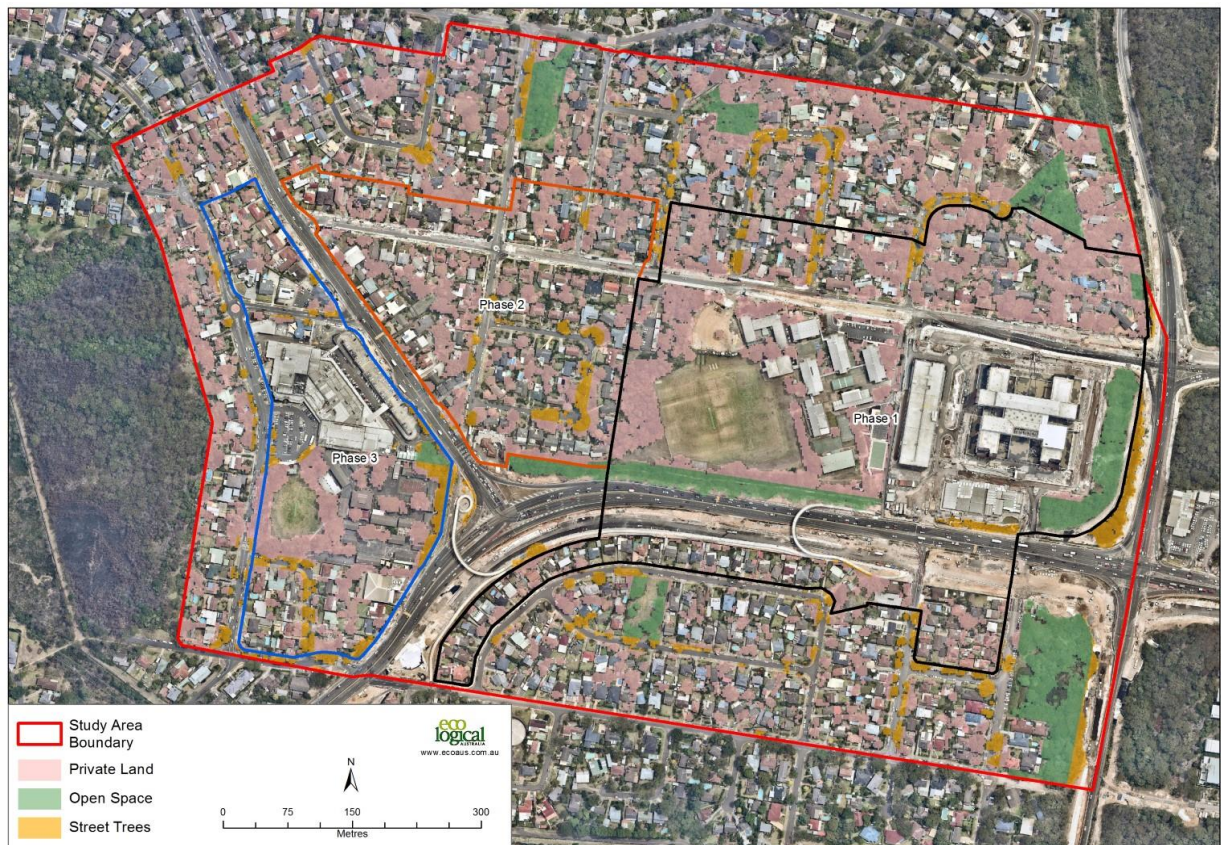


Figure 3: Distribution of tree canopy typology

From the GIS analysis, the estimated breakdown of tree canopy type (typology) is shown in Table 4 and Figure 4.

Table 4: Distribution of tree canopy typology

Development Phase	Tree Canopy Type (ha)			
	Open Space	Private Land	Street Trees	Total
Phase 1	1.33	5.39	0.37	7.09
Phase 2	0.01	2.35	0.34	2.70
Phase 3	0.07	1.76	0.68	2.50
Context	2.54	7.82	1.82	12.18
Total	3.95	17.32	3.20	24.47

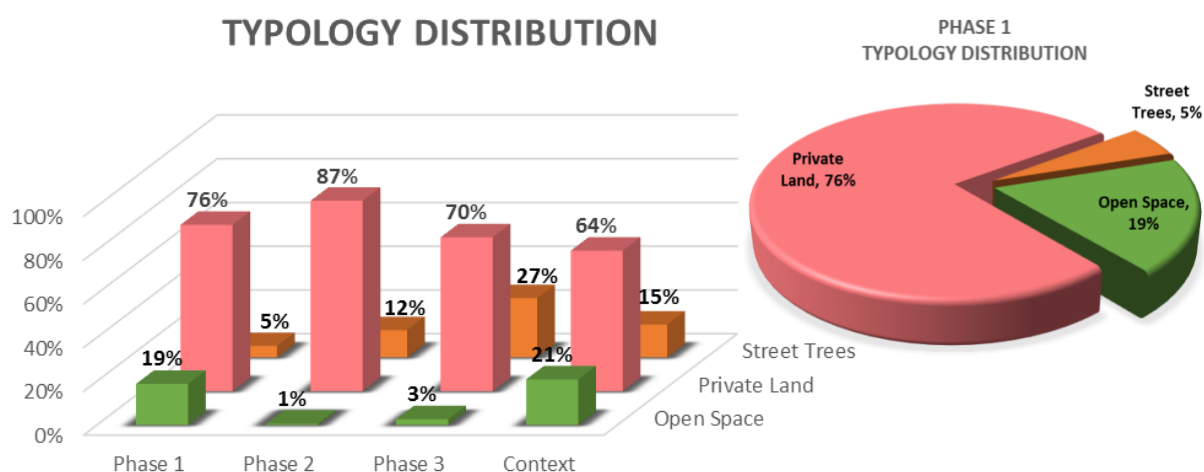


Figure 4: Percentage distribution of tree canopy typology

3.1.2 Tree canopy classification

The distribution of tree canopy cover classification across the phases of the study area is shown in Table 5 and in Figures 5 and 6. The majority of the tree canopy cover within each Phase over the study area is made up of planted native / exotic tree cover, making up about 75% of the canopy across the study area. There is a small area identified as heritage significance (Former Holland's Orchard Trees), located within Phase 1, which also includes some newer tree plantings. This makes up less than 1% of the tree canopy in Phase 1.

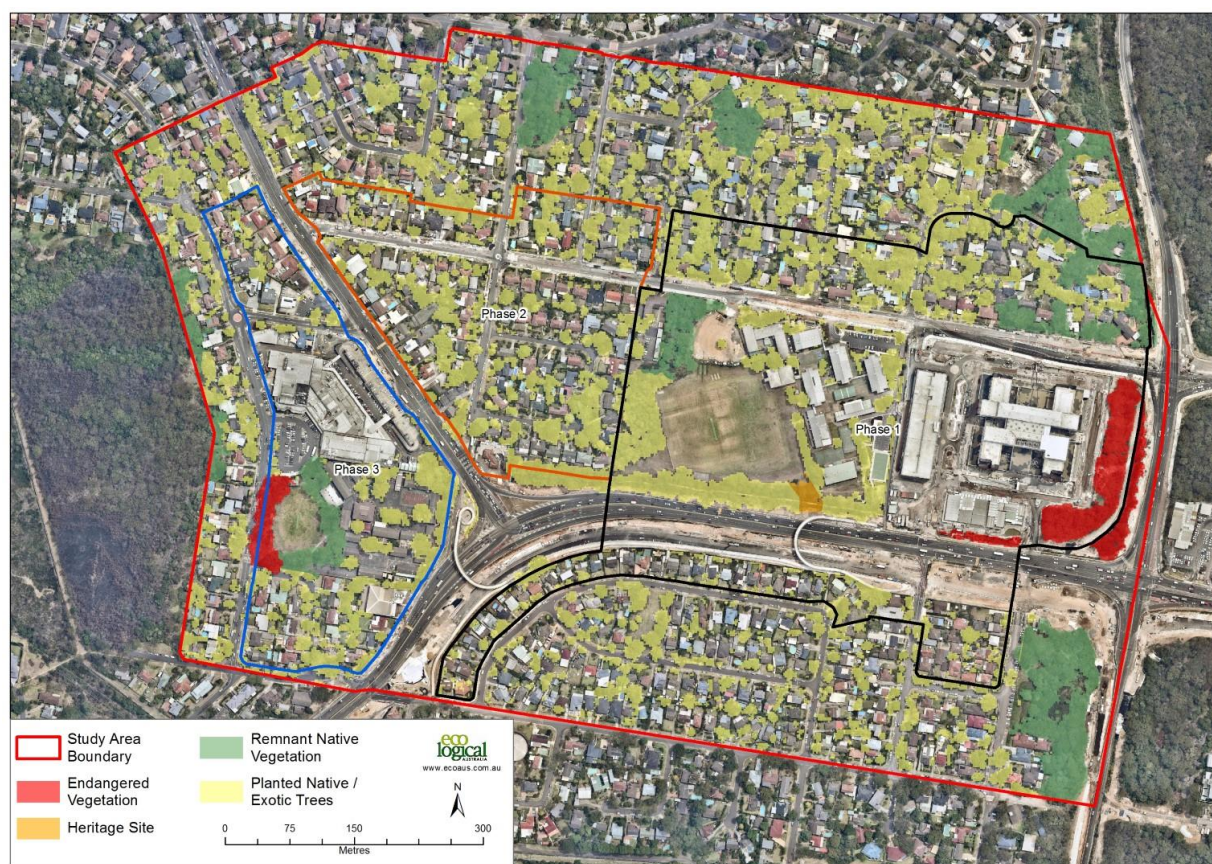


Figure 5: Distribution of tree canopy classification

Nearly 25% of the canopy across the whole study area is made up of areas of remnant native vegetation (endangered and non-endangered) and all (100%) of the tree canopy class across Phase 2 is made up of planted native / exotic trees (Figure 6).

Table 5: Distribution of tree canopy classification

Development Phase	Tree Canopy Classification (ha)				
	Endangered vegetation (Native)	Planted Native / Exotic Trees	Remnant Native vegetation	Heritage	Total
Phase 1	0.80	5.14	1.06	0.09	7.09
Phase 2	-	2.70	-	-	2.70
Phase 3	0.31	1.79	0.41	-	2.50
Context	0.25	8.68	3.25	-	12.18
Total	1.36	18.32	4.71	0.09	24.47

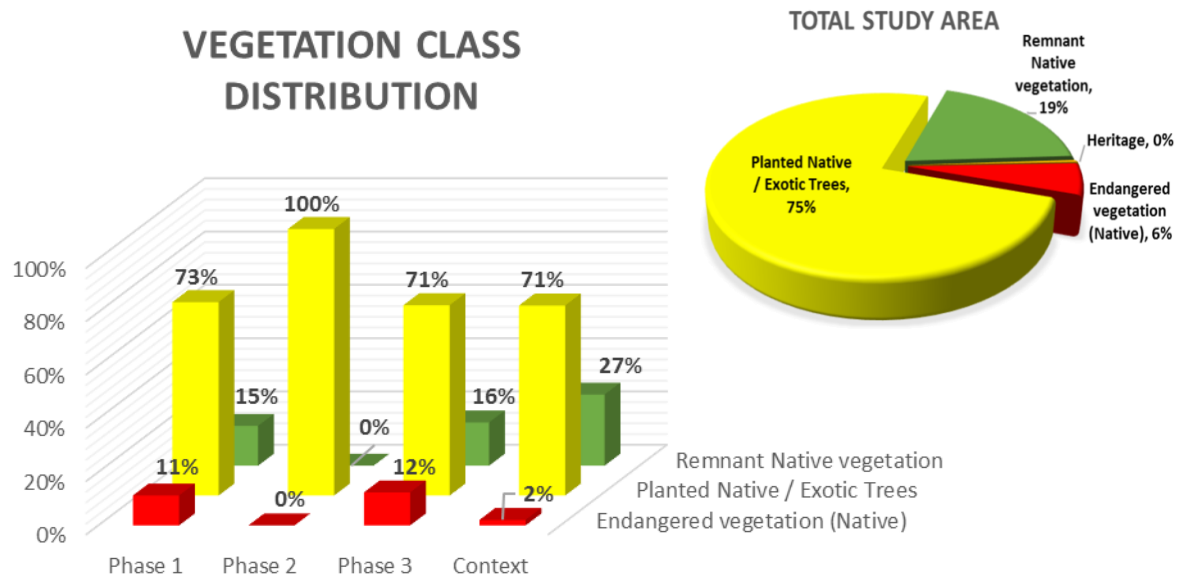


Figure 6: Distribution of canopy class percentages

3.1.3 Tree canopy height

The distribution of height classes across the study area is shown in Table 6 and Figure 8. In Phase 1, the majority of tree canopy is evenly distributed between 5 and 25 metres, which is also common across more than 90% of the whole study area (Figure 7).

Table 6: Distribution of tree canopy height

Tree canopy height	Development Phase (ha)				
	Phase 1	Phase 2	Phase 3	Context	Total
5 - 10m	2.00	1.41	0.71	5.25	9.37
10 - 15m	2.22	0.74	0.83	4.03	7.82
15 - 20m	2.12	0.38	0.63	2.22	5.35
20 - 25m	0.63	0.13	0.31	0.57	1.63
> 25m	0.11	0.04	0.02	0.12	0.30
Total	7.09	2.70	2.50	12.18	24.47

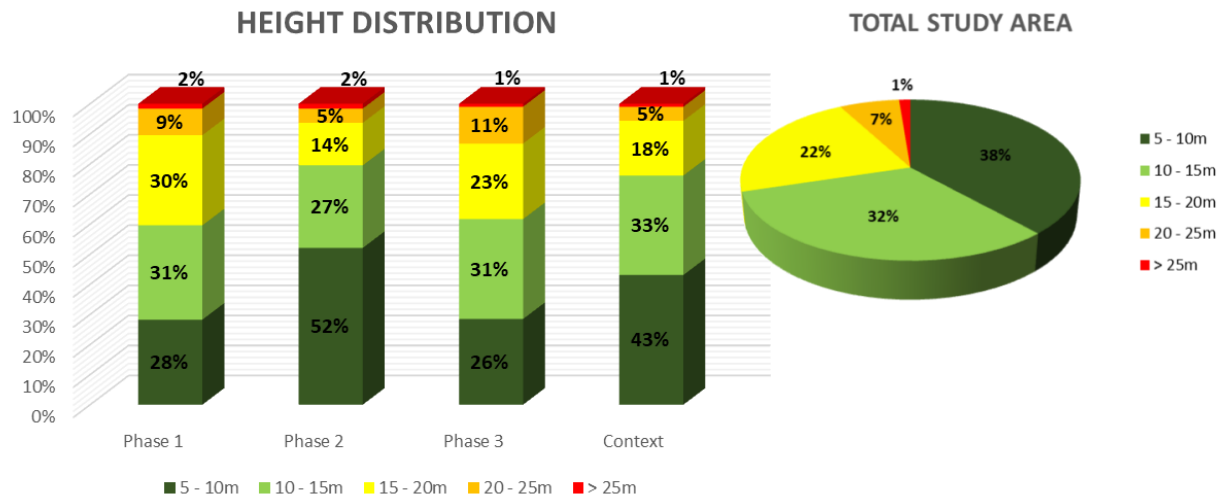


Figure 7: Distribution of canopy height percentage



Figure 8: Distribution of tree canopy height classes

3.1.4 Canopy age classes

Over 90% of the tree canopy cover across the whole study area is made up of a mix of native and exotic mature (M) trees. This includes tree canopy within private land holdings (mainly residential lots) as well as areas of remnant native vegetation in public reserves. The majority of areas of younger tree canopy (SM and SM - M) are mostly associated with recent building / development works in Phase 1. There were no distinct identified areas where tree canopy age could be clearly classed late mature (LM) or over mature (OM), even though there may be individual trees that may fall into this canopy within the

study area. Figures 9 and 10 show the distribution across the study area spatially and statistically (respectively), with the associated breakdown of areas shown in Table 7.

It is important to note that the mapped tree canopy area includes a large range of tree species (both native and exotic), with widely varying age ranges, so a mature age class rating does not imply the same age range for all trees. Also, depending on the species of tree, the overall life expectancy will also vary widely.

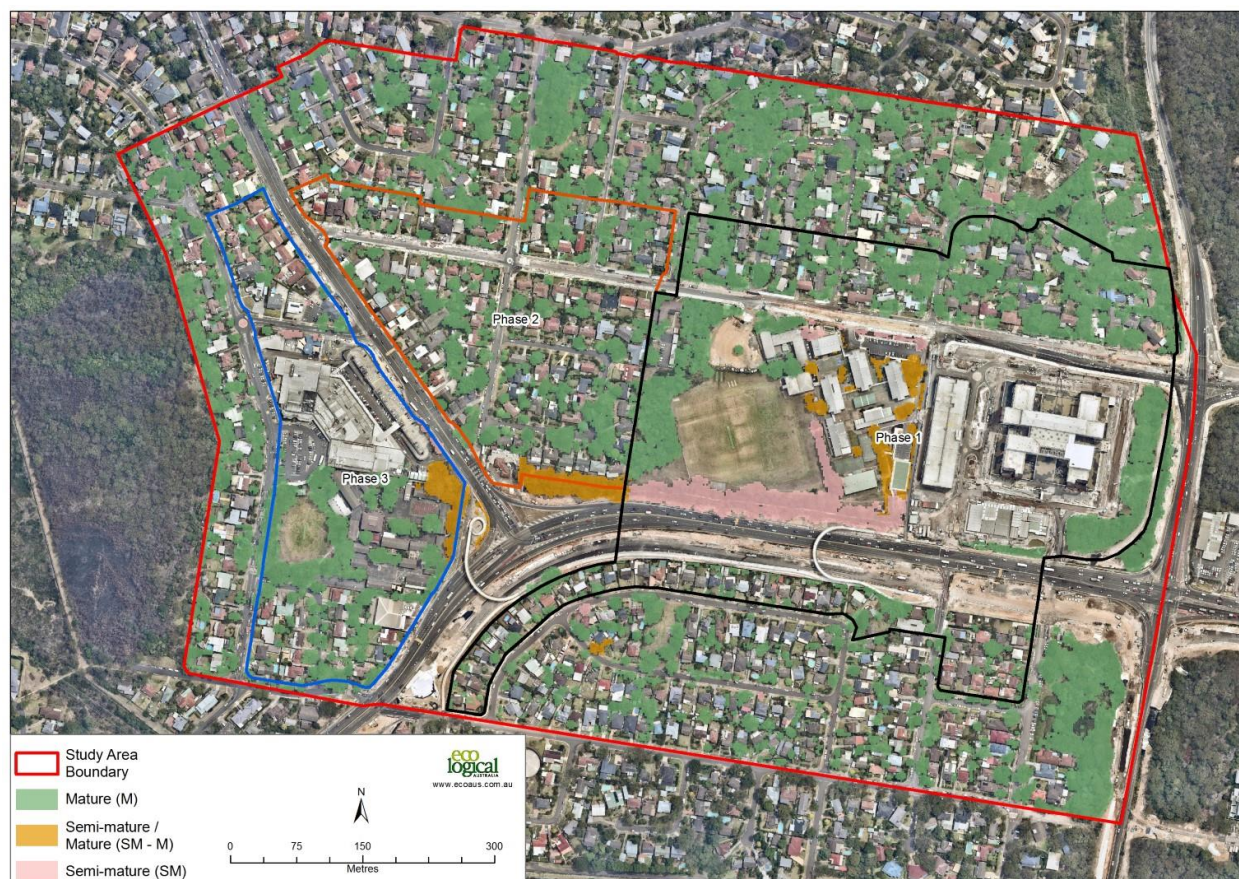


Figure 9: Spatial distribution of general tree canopy age classes

Table 7: Breakdown of general tree canopy age classes

Development Phase	Age Class (ha)			
	Mature	Semi-mature / Mature	Semi-mature	Total
Phase 1	1.12	0.42	5.55	7.09
Phase 2	-	0.14	2.57	2.70
Phase 3	0.06	0.26	2.18	2.50
Context	0.05	0.25	11.89	12.18
Total	1.23	1.06	22.19	24.47

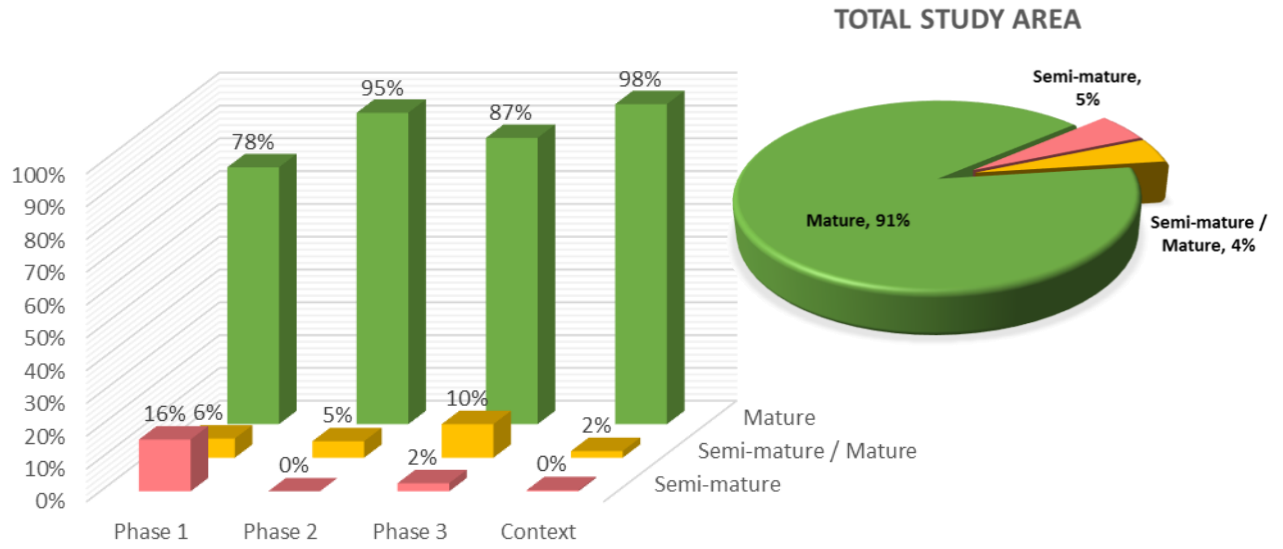


Figure 10: Distribution of general tree canopy age classes

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