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Barriers and Solutions for Increased Tree Canopy in Victoria's New Communities

Victorian Planning Authority

HIP V. HYPE

WHO WE ARE

HIP V. HYPE Sustainability provides advice that is commercially grounded, yet ambitious. We pursue exceptional outcomes that are socially, economically and environmentally sustainable and enable action across government, institutions and organisations.

We seek to partner with those who are willing to think strategically to achieve better. We lead, collaborate and support others to deliver impact and build Better Cities and Regions, Better Buildings, and Better Businesses.

This project was a partnership between HIP V. HYPE Sustainability and Dr Judy Bush, Faculty of Architecture Building and Planning, the University of Melbourne.

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Contents

Executive Summary

The development of the growth areas of greater metropolitan Melbourne are guided by Precinct Structure Plans (PSPs). An update to the guide for preparation of a Precinct Structure Plan "Precinct Structure Planning Guidelines: New Communities in Victoria' (the Guidelines)" is due for public release in October 2021.

As part of these guidelines a new target is proposed for public realm tree canopy coverage - "Potential canopy tree coverage within the public realm and open space should be a minimum of 30% (excluding areas dedicated to biodiversity or native vegetation conservation)". Prior to the release of the final Guidelines, the VPA is seeking an evidence base to understand the barriers and solutions for canopy tree provision in the public realm, acknowledging that canopy cover within streets in particular is essential in urban centres due to its ability to simultaneously deliver a range of benefits, known as ecosystem services.

HIP V. HYPE, supported by the University of Melbourne have been engaged to develop the evidence base for public realm canopy tree coverage, including a review of academic literature, regulatory influences and a selection of case study examples from Precinct Structure Plans delivered in the last 15 years alongside three established area examples. This study focuses on public realm canopy cover and street tree canopy coverage in particular.

Collectively this evidence increases understanding of the practicality of the proposed 30% public realm canopy tree cover target and the critical success factors, barriers and solutions required to allow it to be more routinely achieved.

The ability to deliver a good canopy tree cover outcome is dependent on a range of design, construction and occupancy phase factors. The evidence is presented across five development stages, including precinct structure planning, subdivision planning, detailed design, construction and occupancy (which supports long term tree growth). Each development stage (refer p. 6) needs to set up the pre-conditions for the next stage to be successful. There is simply a lot that needs to go right and a lot that can go wrong which impact street trees, and collectively canopy tree coverage in streetscapes.

A complex regulatory environment, environmental conditions and competing stakeholder interests all present challenges. Design factors contribute to the potential canopy tree coverage outcome by dictating space allocation, tree planting frequency and density and species selection. Construction factors can limit the ability for projected tree canopy to be reached by compomising growing conditions and establishment and the occupancy stage recognises that ongoing management is essential to reach successful projected mature canopy size.

PRECINCT STRUCTURE PLANNING

Our analysis highlighted key regulatory influences as Precinct Structure Plans and stakeholders involved in this phase as the VPA, developers, VicRoads and Councils. The analysis of the PSP's indicated that for the most part, the PSP's provided limited direction beyond cross sections that has a bearing on canopy tree cover outcomes. Generally speaking the PSP's followed the cross section guidance contained in the PSP's.

The analysis also noted the VicRoads Tree Policy, restricting the ability for higher canopy tree coverage outcomes to be achieved on arterial roads.

The case studies demonstrate a wide range of outcomes are being delivered through PSP processes and that the cross sections are insufficient on their own to deliver positive canopy tree coverage outcomes. Additional guidance within PSP's is required to ensure that outcomes are consistently positive (canopy cover targets, planting frequency, species selection, passive irrigation guidance etc.).

The analysis found that the canopy tree coverage target proposed in the updated Guidelines is appropriate, but the flexibility to adopt a different canopy tree coverage target (higher or lower) based on local conditions will ensure that the targets developed through PSP processes are site responsive.

Separate targets for road reserves and other open space will improve accountability in future development stages. This is because depending on the programming of public open space (active / passive etc.) significantly different canopy tree coverage outcomes will be sought.

The additional target to use stormwater to support canopy trees is strongly supported by analysis, however we do note that during establishment phases and extended periods of lower than average rainfall that passive irrigation alone will not be sufficient to ensure canopy tree health.

The PSP Guidelines will need to be supported by further guidance (in the form of Guidance Note) to clarify methods of calculating projected canopy cover and provide accountability for future stages against the PSP targets. PSP Guidance Notes such as the proposed Movement and Place can also support improved urban design objectives and principles to improve outcomes in subsequent stages.

The case study analysis and the review of literature and relevant studies all highlighted the need for future development stages to support targets set through the PSP stage.

SUBDIVISION PLANNING

Within the subdivision stage, outcomes for canopy trees have in many cases been 'let down' by urban design layouts which simply do not support the space requirements of a medium to large canopy tree, due to constraints relating to vehicle access (cross overs) to private lots and reducing frontage widths in response to higher density targets. The subdivision planning stage locks in several aspects related to planting frequency or density, in particular road pavement widths, verge widths, lot frontage widths and sometimes cross over location. Given landscape plans are often submitted as a condition on permit this can limit tree planting opportunities during the detailed design stage.

There was no obvious evidence that regulatory processes had not been followed. The poor outcomes within subdivision were driven not so much by regulation that was not followed, rather that regulation as it currently standards does not sufficiently restrict poor urban design and street tree outcomes and does not adequately support positive outcomes. The most influential factor in canopy tree coverage from a design perspective is planting frequency or density and to a lesser extent species selection, but more support could be provided in planning schemes for the retention of healthy non-native vegetation.

Clause 56 is the major regulatory influence during this stage and requires review with a view to elevating the importance of canopy tree coverage in decision making elevating the role of DELWP as a key stakeholder, alongside developers (and their teams) and Councils. This report (p.21) outlines some potential solutions for improvements to Clause 56 and the Small Lot Housing Code.

DETAILED DESIGN

At the detailed design stage, the critical issue highlighted through the analysis was poor integration between engineering and landscape design. Improvements to the Engineering Design and Construction Manual (EDCM) offers opportunity for reinforcing good canopy tree coverage through reduction in conflicts between services and soil volumes capable of supporting large trees and better integration of design documentation and assessment. The role of VPA, Council and development teams (engineering and landscape) are critical.

The guidance in the EDCM and local Landscape or Street Tree Guidelines was followed, but both can be improved to provide for improved outcomes in relation to canopy tree coverage.

High-level analysis of Council species lists highlighted opportunities for improvement to refocus on canopy width and climate adaptability and preferencing selection of medium or large trees rather than smaller species.

We recommend to improve consistency, guidance related to species and project canopy cover be elevated to the metropolitan level (still accounting for local variations) in the interests of standardising assumptions.

CONSTRUCTION

Both the literature review and the case studies highlighted the importance of the construction stage in implementing landscape designs and setting up the growing conditions for successful canopy trees. Civil and landscape construction teams become important during this implementation phase. The study found major barriers including poor soil conditions, poor water regimes during the establishment phase, poor planting technique and stock and tree damage were all influential in limiting the ability for canopy tree coverage to be practically delivered in line with projected (modelled) canopy cover.

There was evidence that the construction phase did not fully implement landscape plans. Generally speaking there was attrition between the designed landscape plan and what was actually delivered. Sometimes this was a result of conflict with other infrastructure (signage, bus stops etc.), however on other occasions the reason for the gap between designed and delivered is unclear.

Solutions to improve construction outcomes centred on education and compliance, which Council may need to modify practices to willingly support. There is opportunity to improve accountability of landscape / horticultural construction teams, requiring demonstration of best practice through evidence.

OCCUPANCY AND TREE GROWTH

The occupancy phase commences when local Councils take over management of street trees. Our analysis found limited regulatory influences, but highlighted the importance of community values and programs in shaping stewardship of street trees as valuable community assets.

It was not within the scope of this project to analyse the extent to which management of canopy tree coverage by Councils conformed with local guidelines for tree management. The evidence reviewed did not extend to pruning, pest management techniques, watering regimes etc. The literature review highlighted a number of contributing factors to a successful occupancy or tree growth phase however and a number of barriers.

Barriers include a lack of community support, funding and organisational priority as well as management regimes which don't deliver required water supply or tree maintenance. Additionally, a lack of longer term monitoring and evaluation relating to street tree success has hampered understanding.

Recommended solutions centre on the role of Council in delivering community programs and elevating the role of street trees as capable of delivering a range of community (ecosystem service) benefits. Further improvements to watering and maintenance regimes are recommended.

Additionally, to further improve understanding, improved monitoring and evaluation will enable evidence-based decision making for design and operational improvements. The literature review highlighted a range of research projects the outcomes of which are yet to be published. VPA is recommended to maintain a watching brief on this research.

Street tree planting and understorey vegetation at Cape Paterson Ecovillage
Photography by Kim Landy

CASE STUDY FINDINGS

The table on page 55 outlines the high level results from the case studies. The findings are mixed, but clearly demonstrate with regulatory improvement, good design, establishment and growing support that canopy tree coverage in excess of 30% is practically achievable in road reserves in a growth area context.

The case studies examined the potential for the PSP areas to deliver street canopy tree coverage outcomes in excess of 30%. The analysis undertaken assumed that the trees in the ground (noting some are as young as two years old) will grow to 75% of their optimal canopy width, for example a species with an optimal canopy width (according to a range of landscape guidelines) of 8m will provide 100% canopy coverage equating to a 6m diameter.

In practice, poor construction techniques may already have limited this (for example, inadequate soil volumes are not necessarily apparent in the first few years of growth) and occupancy phase tree management may further limit potential. Due to this uncertainty, the case studies examine the realistic potential of delivering canopy tree coverage based on the first three stages of the development process and unless it is obvious through examination of the growth rates that trees will not reach projected canopy maturity we have assumed they will.

Applying this method, two of the PSP case study areas will likely reach a canopy tree coverage in excess of 30% if construction practices have not limited potential and best practice tree management is applied. Best practice tree management includes formative and maintenance pruning: to ensure good canopy development, removal of damaged or diseased growth; regular monitoring of street trees to check for healthy condition and replanting dead or damaged trees. A third case study has a reasonable likelihood of reaching the canopy cover target (the projected canopy cover is almost exactly 30% across case study streets).

A further PSP case study area will potentially reach 30% canopy tree coverage if the gap between what was designed and what has been delivered to date are addressed with reinvestment in street tree planting (we note that a number of case study areas have opportunities for re-investment in street trees - additional rows of planting, tree outstands etc.).

The other three PSP case study areas will likely not reach 30% canopy tree coverage even with the best practice tree management. The limiting factors in these examples are varied, but insufficient planting frequency or density is a key factor, with species selection, infrastructure conflicts (both below and above ground) and construction related issues all contributing to the outcome.

Executive Summary
Key Influence Overview

	PRECINCT STRUCTURE PLAN	SUBDIVISION PLANNING	DETAILED DESIGN	CONSTRUCTION	OCCUPANCY AND TREE GROWTH
Key Activities	– PSP Development – Stakeholder alignment – Land use and density mix and locations – Water servicing	– Subdivision plan – Urban design layout	– Functional layout – Engineering cross sections and drawings (service design) – Irrigation design – Landscape planning – Approved	– Excavation and soil preparation – Road and footpath construction – Infrastructure servicing – Street tree planting – Formative pruning – Demonstrates statement of compliance	– Maintenance and pruning – Irrigation – Monitoring
Key Regulatory Influences	– PSP Guidelines (existing and proposed) – Vicroads - Guidance for Planning Road Networks in Growth Areas, November 2015	– Planning Scheme (Clause 56 in particular) – Urban Design Guidelines for Victoria, Department of Environment, Land, Water and Planning, 2017 – Sustainable Subdivisions Framework (non-statutory)	– VPA's Engineering Design and Construction Manual (2019) – including standard drawings – Council Landscape Guidelines and Species lists – Trees-for-Cooler-and-Greener-Streetscapes (not-statutory)	– Council Landscape Guidelines and Species lists – Council tree planting guidelines	– Code of Practice for Management of Infrastructure in Road Reserves – Council maintenance guidelines
Critical Success Factors	– Clear objectives, goals and targets relating to canopy tree provision – Responsive to underlying environmental conditions – Species guidance – Urban design guidance for streetscapes and housing density which values canopy tree provision – Standard street cross sections provide sufficient space allocation – Alternative water supply	– Vehicle access and lot frontage widths that can support large canopy trees – Retention of healthy existing trees – Road alignment to contours (where possible) – Pedestrian focused, low speed residential streets – Maximised urban heat benefit from landscape design – Integrated water management approach that supports passive irrigation of street trees	– Landscape and engineering design integration – Species selection (climate resilient, sufficient canopy size and shape) and spacing – Passive irrigation – Service location	– Soil: quality and structure; volume; topsoil retention; – Irrigation and permeability – Best practice tree planting – Robust tree establishment (protection from damage and disturbance)	– Community values – Ongoing water availability and management (including passive irrigation maintenance; ensure protection from waterlogging) – Street tree maintenance (pruning) and replacement; Weed and disease management monitoring
Key Stakeholders	– Victorian Planning Authority – Council – Developers – VicRoads	– DELWP – Council – Developers – Service Authorities	– Victorian Planning Authority (via EDCM) – DELWP – Council – Developers – Service Authorities	– Council – Developers – Construction teams (Civil and landscape)	– Council – Community members and visitors

This project aims to provide an increased understanding of critical success factors, barriers and solutions for achieving increased levels of canopy tree coverage in the public realm of growth area communities.

PROJECT CONTEXT

The Victorian Planning Authority (VPA) is a State Government statutory authority that reports to the Minister for Planning. A critical role of the VPA is to guide the process that plans for growth area communities. For the purposes of this project, this includes the municipalities of Wyndham, Melton, Hume, Whittlesea, Mitchell, Casey and Cardinia.

The development of the growth areas of greater metropolitan Melbourne are guided by Precinct Structure Plans (PSPs). The existing PSP Guidelines have been in place since 2009. An update "Guidelines for Precinct Structure Planning in Victoria's New Communities" was released for public consultation in September 2020. The final updated guidelines are due for public release in October 2021.

As part of these guidelines a new target is proposed for tree canopy coverage as outlined below.

- Target 13: Potential canopy tree coverage within the public realm and open space should be a minimum of 30% (excluding areas dedicated to biodiversity or native vegetation conservation).

Prior to the release of the final Guidelines, the VPA is seeking an evidence base to further test barriers and pathways to implementation.

Project Purpose

Canopy cover is essential in urban centres due to its ability to simultaneously deliver a range of benefits, known as ecosystem services, which include urban heat regulation, stormwater run-off mitigation, habitat for biodiversity as well as a range of cultural services such as recreation. The impact of climate change on the urban environment is a key area of focus for policy makers. Research has clearly demonstrated that canopy tree coverage in the public realm and streets specifically is an effective measure for reducing the urban heat island effect which is exacerbated due to increases in average temperatures and greater incidences of extreme heat (Duncan et al. 2019; Gunawardena et al. 2017; Santamouris et al. 2018).

The purpose of the project is outlined as follows:

- To assess the extent to which current growth area planning is delivering effective canopy tree coverage in streets and the gaps or limitations to reaching the proposed target
- To clearly outline the critical success factors for delivering effective canopy tree coverage within the public realm across the full development timeframe from Precinct Structure Plan through to the establishment and occupancy phases of new communities
- To highlight key barriers to an effective canopy tree coverage being delivered in the public realm including governance, policy, environmental and implementation barriers
- To, where possible, identify solutions which could be further considered to overcome key barriers

Project Scope

To deliver the project the VPA has engaged HIP V. HYPE Sustainability to undertake a rapid research project and deliver a technical report to gain historical insights and support the release of the Guidelines and the proposed target.

HIP V. HYPE are supported by the University of Melbourne to undertake the project. The key deliverables for the project are outlined below:

- To review available academic literature and other studies which provide evidence for the critical success factors, barriers and solutions to effective canopy tree cover within the public realm and streets in particular
- To review regulatory framework influences for streets, including planning scheme requirements, standards and guidelines including the VPA's Engineering Design and Construction Manual and associated drawings and individual growth area Council Landscape Guidelines
- To develop a selection of case study examples from Precinct Structure Plans delivered in the last 15 years alongside three established area examples

The outcomes of these reviews have been documented in this report, which provides an evidence base which reflects on current practice and the critical success factors for effective canopy tree coverage. This is supported by an assessment of barriers and solutions for maximising the opportunity to meet the public realm target set out in the Guidelines.

Water Sensitive Urban Design at Sunvale Park, Sunshine.
Photography by Emma Cross

Method

The research for the project has centred on three separate sources of evidence:

- **Academic literature and consultant studies**
- **Regulatory influences which impact street tree provision and success**
- **Case studies which demonstrate a range of street tree canopy outcomes**

This section of the report outlines the method applied to the project.

METHOD OVERVIEW

Academic literature and consultant studies

The project team, led by Dr Judy Bush (University of Melbourne), undertook a review of academic literature to identify key Australian research on street tree establishment and maintenance in urban contexts. The identification of relevant research focused on locally relevant literature that highlights barriers and solutions to achieving canopy cover outcomes in a greenfield context. The literature search terms (Street tree; Establish*; Maintain*; Urban; Greenfield; Development) sought to identify Australian research on the conditions required for effective tree establishment and canopy development. The literature review found that most Australian research has focused on horticultural perspectives of tree establishment (soil conditions; water sensitive urban design, passive irrigation and drought; heat impacts and heat mitigation; climate change impacts). There is a lack of Australian research on urban design factors affecting street tree establishment.

The results of the review are discussed in the following section of this report.

Regulatory influences which impact street tree provision and success

The project team undertook a scan of relevant regulatory influences which guide the provision and success of street tree canopy outcomes in growth areas. This included:

- A review of the planning scheme with particular reference to Clause 56 which guides residential subdivision applications
- A high level review of landscape guidance as they relate to street tree provision, including; species selection, offset requirements, soil volume guidance as relevant
- A review of engineering guidance developed by the VPA, guidance by VicROADS and where it exists by councils
- A review of non-statutory guidance such as the Sustainable Subdivisions Framework and the DELWP Trees for Cooler and Greener Streetscapes

Landscaping at The Cape. Photography by Kim Landy

The review followed a similar basic structure as the review of academic literature and consultant studies, adopting a research framework which considered barriers, solutions and critical success factors relevant to delivering effective canopy tree coverage outcomes. In particular, the review focused on identifying issues with the current regulatory environment and policy solutions that could help drive improved outcomes.

The results of the review are embedded in the following section of this report.

Case studies method

The development of nine case studies has driven much of the analysis for this report. The method for their development is outlined below.

We identified Precinct Structure Plan areas with a preference for those which were delivered by GAA or VPA as the lead agency, with at least 6 years from PSP gazettal (to allow for development and establishment of street tree growth). Three additional case studies were sourced from established areas, targeting an Eastern Melbourne and a Western Melbourne example of high levels of canopy tree coverage. The intention with the established area case studies was to examine the levels of canopy cover acheived and understand the critical success factors. They are indicative of the canopy cover outcome that would meet and exceed the proposed 30% canopy cover target.

We designated a case study boundary which includes at least two street types and at least four different individual streets. The case study boundaries were aligned to property boundaries.

Using QGIS, GIS layers were created relating to the case study area, including:

- Case study boundary area
- Cadastral boundaries
- Street names
- Urban heat data (DELWP)
- Canopy cover data (DELWP)
- Bushfire overlay (if applicable)

We sourced the underlying soil types for each case study area (from Victorian Geological survey maps (http://earthresources.efirst.com.au)) and the average annual rainfall for each case study area (sourced from Bureau of Meteorology data - http://www.bom.gov.au/climate/data/). Melbourne's soil types, and their underlying geology, can be summarised as: Basaltic (heavy clays) to the north and west; Silurian derived sedimentary clays and loams (to the north-east and east); and Tertiary sands (to the south east) (Bull 2014).

Streetscape planting at The Cape. Photography by Kim Landy

We then undertook a review of two street typologies within each case study area; documenting information relating to key above ground street components, including footpaths, landscape strips, bike lanes and road pavements. A comparison of the built outcome was made against both PSP documentation (street sections) and where available landscape and engineering drawings sourced from the relevant Council. This assessment notes conflicts with the actual outcome from the designs (including missing street trees where obvious) and notes any conflicts with engineering (including service locations) and street tree locations.

Using Nearmap, we established as accurately as possible the age of the street trees. This is documented alongside the gazettal date in each case study. This allowed for observations as to whether selected species have grown at expected rates. Further observations are made in relation to urban design, missed opportunities for street planting and tree failure.

Using Google Street View, we undertook a review of the following:

- Species selection within the case study streets (including an assessment of average canopy width at full maturity and alignment with any relevant landscape guidelines for the municipality)
- Presence of passive irrigation
- Any observations of tree health or distress (only if obvious)

Separately, landscape plans endorsed as part of the Council process were reviewed where available and using the nominated street tree species.

We have adopted a method for calculating projected canopy cover which is restricted to street reserves only. If the 30% target is proposed to be set for all public realm including open space then we recommend that subdivision stages be accountable to the target for street reserves separately, as inclusion of open space within one subdivision stage is likely to skew results if there is active open space (which has very low canopy cover) included within the calculation.

The calculation method is based on a combination of the first two methods adopted by the MESH target testing work, where the optimal tree canopy represents the theoretical maximum canopy width and the projected canopy is discounted slightly to represent the actual outcome expected. It is outlined as follows.

1. Projected canopy cover of a single tree = $\pi (0.75 \times \text{Optimal tree canopy width} / 2)^2$)

2. Aggregate all trees within study area using this method taking account of any species differences

3. Estimate the area of any overlapping canopies using a manual method and adjust the total projected canopy cover accordingly

4. Divide the aggregated projected canopy cover by total street reserve area (excluding all private lots and non-street reserve open space)

An analysis of the actual canopy cover outcomes in the case study areas was undertaken using two methods. To obtain accurate data, we used QGIS (an open source Geographic Information System application), and point sampled aerial imagery to determine land cover class within the street reserve within the defined boundary. Points were manually classified as either hard surface, tree canopy or other. These points were then used to determine statistical cover for each land cover classification. The result of this analysis was documented and then compared to a 2021 aerial and observations on change during the intervening period noted. Both of these results are documented in the case studies.

Key findings from each case study are summarised including analysis on whether (in the fullness of time), the street is expected to deliver a canopy tree coverage of 30% and if not what the key limitations to this being achieved are.

*One of our recommended solutions is to standardise canopy widths by developing a Melbourne based guide for street trees and canopy widths which would become a reference for the calculation. This will reduce confusion and improve consistency.

Critical Success Factors, Barriers and Solutions – Overview

This section of the report discusses critical success factors for positive canopy tree coverage outcomes. The graphic on the following page summarises the key activities, regulatory influences, critical success factors and key stakeholders involved in each stage of the development process. This graphic sets the structure for analysis for this section of the report.

For canopy tree coverage to reach its full potential a lot has to go right. The key activities of each development stage need to set up the preconditions for successful future stages.

Healthy and diverse streetscape canopy cover. Photography by City of Charles Sturt

Critical Success Factors, Barriers and Solutions – Overview

	PRECINCT STRUCTURE PLAN	SUBDIVISION PLANNING	DETAILED DESIGN	CONSTRUCTION	OCCUPANCY AND TREE GROWTH
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Key Stakeholders	– Victorian Planning Authority – Council – Developers – VicRoads	– DELWP – Council – Developers – Service Authorities	– Victorian Planning Authority (via EDCM) – DELWP – Council – Developers – Service Authorities	– Council – Developers – Construction teams (Civil and landscape)	– Council – Community members and visitors

Critical Success Factors, Barriers and Solutions – Precinct Structure Planning

The scope of the precinct structure planning stage offers significant opportunity to influence canopy tree coverage outcomes.

As outlined in the above diagram the critical success factors to ensure this phase sets up communities for success include:

- **Clear objectives, goals and targets relating to canopy tree provision**
- **Responsive to underlying environmental conditions**
- **Species guidance**
- **Urban design guidance which values canopy tree provision**
- **Standard street cross sections provide sufficient space allocation**
- **Alternative water supply**

The key stakeholders included in the Precinct Structure Planning stage in relation to street tree provision include:

- **Victorian Planning Authority**
- **Council**
- **Developers**
- **VicRoads**

The relevant regulatory influence in this stage is the PSP Guidelines and associated guidance notes.

CRITICAL SUCCESS FACTORS

Clear objectives, goals and targets relating to canopy tree provision

The PSP process creates opportunity to set objectives, goals and targets relating to canopy tree provision. Within the suite of PSPs reviewed as part of the case study development there were varying degrees of focus on street tree canopy provision as a clear objective or goal, but no PSP set a specific target for street tree canopy cover. Further, there is no obvious evidence of PSP requirements or guidelines setting up accountability in future development stages for meeting objectives and goals. The updated Guidelines has a strong opportunity to address this lack of direction in the current PSPs. The strongest focus on street tree provision was the Cranbourne East PSP, where street trees were a clear component of the vision. This theme then cascaded through the document and informed more practical outcomes such as species selection for different street types. The proposed 30% target in the updated PSP Guidelines has been drafted to address this issue.

The Truganina PSP sets a guideline that “Trees in streets and parks should be larger species wherever space allows (to facilitate continuous canopy cover)”. This may mean however, that larger species are only adopted when there is space created through an isolated, rather than routine opportunity.

Responsive to underlying environmental conditions

PSPs should be responsive to the specific site context. This is routinely achieved well in relation to the integration of waterways and open space etc., however there was no obvious evidence that PSPs had responded to other site conditions, such as localised climate change risks or underlying soil conditions. For example, only the Taylors Hill West PSP noted low rainfall and basaltic soils as part of site conditions, but even in this example there was no clear or related direction to ensure that landscaping responded to these underlying conditions.

TYPICAL ROAD CLASS	PLANTING SPACE WIDTH	SELECTED FROM: BOTANICAL NAME
Arterial Roads	3m-6m	*Corymbia maculata* *Eucalyptus tetracornis** *Eucalyptus pauciflora** *Quercus coccinea* *Quercus rubra*
Connector Street (collector road)	3m+ (preferably 3.5m+)	*Acacia melanoxylon** *Corymbia citriodora* *Angophora costata* *Eucalyptus tetracornis**
Access Street Level 2 (local road)	3m+	*Corymbia citriodora* *Eucalyptus cineria* *Eucalyptus mannifera ssp maculosa* *Eucalyptus pryoriana**
Access Street / Place Level 1 (local road)	2.5-3m	*Eucalyptus scoparia* *Eucalyptus leucoxylon spp megalocarpa* *Pyrus calleryana 'Chanticleer'*

Some tree specifications from the Cranbourne East PSP.
Image by Growth Areas Authority

Species guidance

PSPs provide a range of guidance on species selection. Most of the case study PSPs set out some guidance in relation to species selection, although in most cases this has been undertaken at an objective or guideline level, rather than as a requirement. Additionally, guidance in these cases is limited to a preference for native species or drought tolerant species or both.

For example, the Truganina PSP requires that “Street tree planting must use locally appropriate species and be consistent with the Wyndham Street Tree Policy, Subdivision Landscape Works Standards and Specifications Manual and any guidance provided on the relevant cross section within this Precinct Structure Plan.” The Truganina PSP also highlights a minimum mature height of 12m on some streets and 15m on others. Whilst minimum height requirements are a useful addition, no guidance is provided on canopy size, which is a more critical determinant in urban heat mitigation. The proposed 30% target and Public Realm Plan requirement will support improved species selection.

Of the PSPs reviewed, only the Cranbourne East PSP takes the step of outlining preferred species for each typical road class. Further discussion on species selection is included in the section on Detailed Design, however specific species recommendations are beyond the scope of this report.

Critical Success Factors, Barriers and Solutions – Precinct Structure Planning

Crossover design was not discussed in any of the PSP reviewed. The outcome above, where multiple driveways are combined but not consolidated in width – reduces the allocation for nature strips and tree plantings . Photography by Google Street View

Urban design guidance which values canopy tree provision

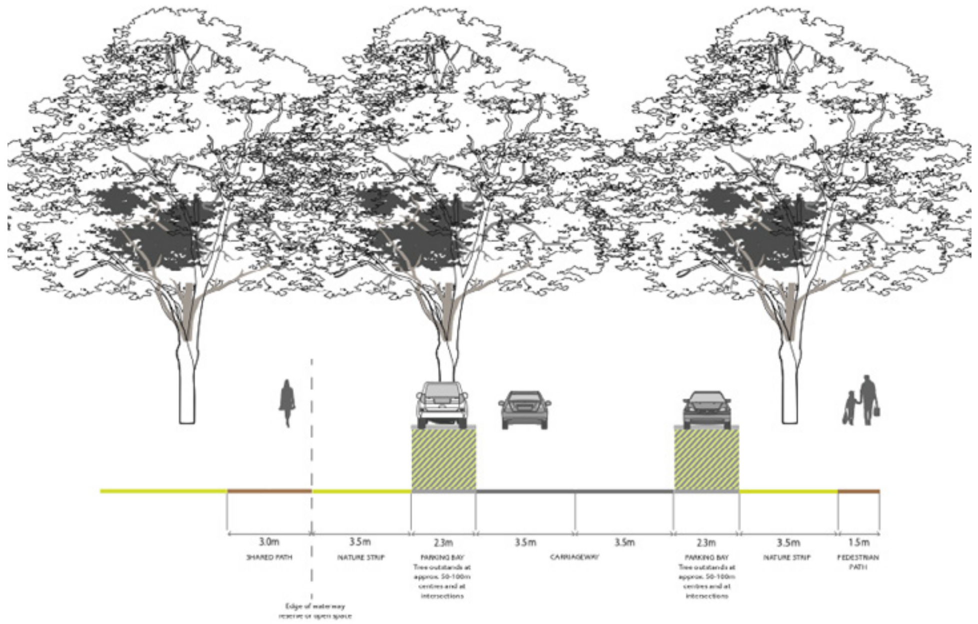
PSPs have the opportunity to set pre-conditions for higher levels of canopy tree coverage in the subdivision planning stage through urban design principles or guidance. Two critical urban design factors which impact street tree provision are density and vehicle access to private lots. Over the last 15 years, densities in growth areas have increased. Whilst this has positive ramifications for the walkability of neighbourhoods, efficient service provision and minimising loss of productive agricultural land, increased density does have the potential to impact the ability to site street trees within the road reserve because of a reduction in lot frontage width, leading to a greater proportion of verges being given over to crossovers.

There was no guidance in any of the PSPs reviewed that highlighted the conflict between street tree provision and vehicle crossovers (potentially indicating that this is too detailed a consideration for PSPs and that the subdivision planning stage is the opportune stage in the development timeframe to resolve these conflicts). PSPs did however set residential densities which have a flow on impact on this outcome.

There is potentially a missed opportunity for setting minimum requirements for canopy tree provision for a subdivision plan to respond to. For example, the Truganina PSP sets in place a requirement that "configuration of vehicle access to lots from a public street must ensure that there is sufficient separation between crossovers to allow for a minimum of one on-street car park for every two residential lots."

Similar guidance could be more routinely provided within PSP's to preserve adequate space allocation for street trees; street sections (discussed below) only sets in place the landscape verge widths.

Of further note in relation to the Truganina PSP, is that it outlines a requirement for functional layout plans to include street trees, however the Engineering Design Construction Manual (EDCM) contradicts this by expressly noting that they not include them. (Refer discussion in detailed design section of this report).



Cross-sections such as the one above, do not identify location of services. Image by Metropolitan Planning Authority (Truganina PSP)

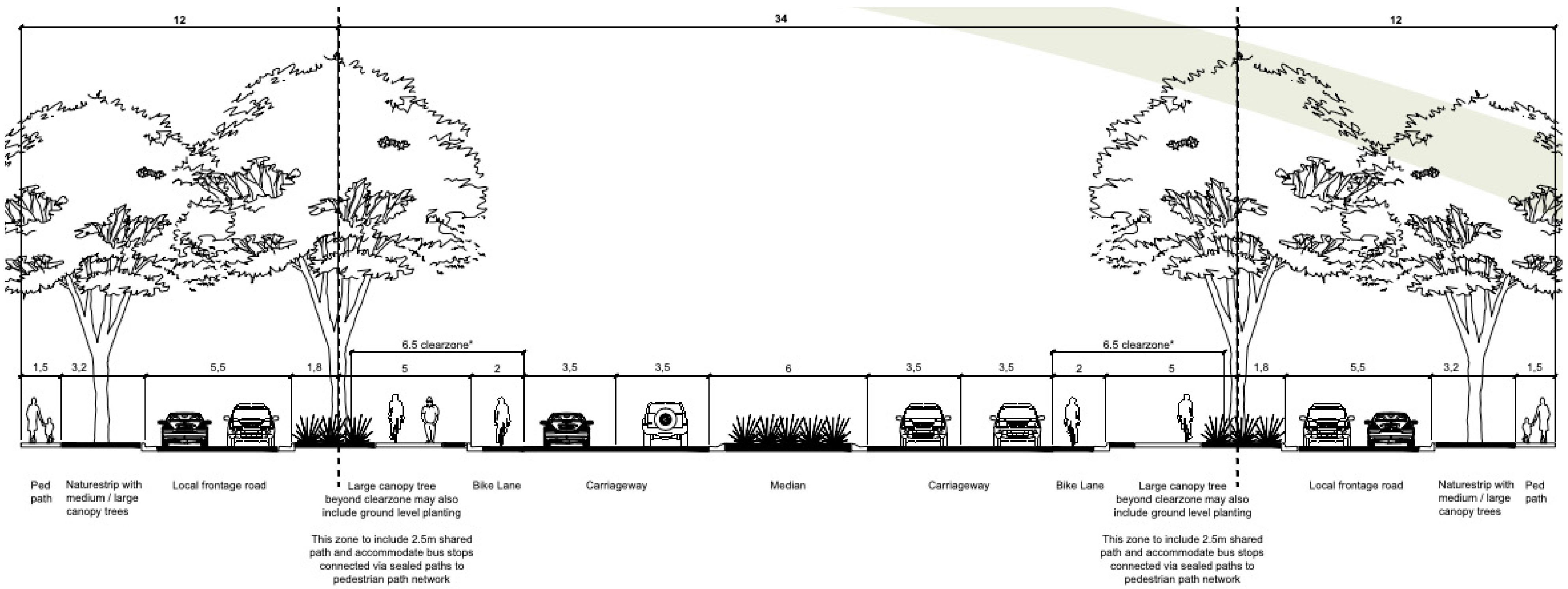
Standard street cross sections provide sufficient space allocation

Existing PSP processes set up standard street cross sections which then influence subdivision planning. Our review highlighted that in the vast majority of cases, the street tree cross sections provided adequate landscape verge width to support a medium or large canopy tree (generally in excess of 2.7m in an Access Street). This width will only deliver effective soil volumes however, if there is adequate space between crossovers, reduced conflict with underground services and if other conflicts such as crossovers light poles, service pits etc. are resolved during later development stages. Street cross section evidenced in PSPs only tells part of the story of space allocation within streetscapes, in that they don't highlight locations of underground infrastructure and do not communicate street elements which can only be demonstrated in plan view. There is opportunity for the PSP stage to highlight preferred underground servicing zones (minimum depths and general locations) and to at least indicatively present streetscape treatments in plan view.

Critical Success Factors, Barriers and Solutions – Precinct Structure Planning

Some PSP cross sections represented missed opportunities for street tree provision. For example, in the Taylors Hill West PSP, Taylors Rd cross sections (pictured below) miss opportunities for a central tree canopy to be provided, because to do so would be require barrier protection to accord with VicRoads Tree Policy (80km/h restrictions apply).

It also appears that many street cross section diagrams are 'optimistic' in terms of the canopy cover breadth that will be delivered, especially given some locations such as Taylors Hill West have challenging underlying soil types and lower rainfall.



Some opportunities, such as central median tree plantings in Arterial Roads were evident among the PSP reviewed, but generally speaking did not include a large canopy tree consistent with VicRoads policy. Image by Growth Areas Authority

Alternative water supply

PSPs set up the service provision for a wide range of infrastructure. As water availability is a critical determinant of ongoing street tree health, there is opportunity for PSPs to better support street tree health through objectives and commitments related to passive irrigation and precinct recycled water supply to supplement additional watering during summer months and dry/drought periods" (ie research indicates that while WSUD and passive irrigation are important for stormwater management, it is likely that most trees will not have their water needs met by passive irrigation only). This ongoing irrigation support is especially critical for areas in the west of Melbourne where the historical ecological vegetation class is grassland rather than trees, the underlying soil type is basalt clay and the rainfall is lower (long term averages of less than 500mm).

The PSP's reviewed for this project indicated that only Truganina and Cranbourne East were connected to a recycled water supply, and there was no consideration of passive irrigation of street trees within PSPs (although several Councils including Melton are now pursuing this strategy more routinely). Overall, WSUD was supported at the objective level, but mostly in relation to broader precinct stormwater management, streets were not specifically highlighted as a key WSUD opportunity. The updated Guidelines set a clear target for stormwater to support street trees and so future PSP's are likely to better address this issue.

The Cranbourne East PSP noted that "Further opportunities for on-street and onsite WSUD will be explored during the detailed subdivision design phase of development to comply with Melbourne Water requirements." Opportunities to improve passive irrigation through other development phases are considered later in this report.

Critical Success Factors, Barriers and Solutions – Precinct Structure Planning

BARRIERS AND SOLUTIONS FOR PRECINCT STRUCTURE PLANNING					
Barriers	**No canopy tree coverage targets prescribed within PSP's, limiting accountability for further development stages to deliver on high levels of canopy tree coverage.**	**Mismatch between underlying soil types and other environmental conditions and canopy tree coverage.**	**Lack of urban design guidance for future development stages compromises space allocation for street trees.**	**Current Street cross sections fail to set up pre-conditions for effective canopy tree coverage outcomes.**	**Lack of direction for alternative water supply to street trees.**
Solutions	1. VPA to update PSP Guidelines to include a 30% target (as is proposed) for canopy tree coverage within streetscape reserves (note that a separate target could be set for open space that is not part of a streetscape). 2. VPA to develop a Guidance Note to support the PSP Guidelines articulating a clear method for how canopy tree coverage should be calculated as 'in accordance' with set targets during future development stages in accordance with the Test proposed in the PSP Guidelines (Public Realm Plan) 3. To further support targets being met; Guidance Note or PSP Guidelines to require PSPs to nominate minimum street tree densities (e.g. per 100m) and minimum canopy sizes for each road classification in addition to street cross section diagrams	1. Guidance Note to include a process requirement for a site-based climate risk assessment (or similar) to be undertaken as part of PSP development and for site specific responses to be embedded within the corresponding PSP. Embedding this process requirement would highlight challenges with underlying soil types, rainfall and drought considerations, specific urban heat challenges for each precinct able to prompt specific responses for maintaining canopy cover outcomes. 2. Where the underlying soil conditions are found to be challenging for successful street tree growth, additional species and other guidance should then be provided to ensure that species selection, soil volumes and water supply are fit for local conditions (note that research is currently being undertaken on tree growth correlation with rainfall gradients across Melbourne).	1. VPA to direct objectives, requirements and guidelines in PSPs to specify key urban design outcomes to support stree tree provision in future development stages, including: a. Preferences for 'combined' cross overs (which allow potential for 3 street trees for every 2 lots if frontage width is sufficient) b. Minimum lot frontage widths before rear loaded access is required c. Preferences for medium density solutions which support a reduced number of cross overs (e.g. four-packs or other design solutions) The implementation mechanism is flexible, likely best delivered through a guidance note (potentially integrated with the proposed Movement and Place Guidance Note).	1. Movement and Place Guidance Note (or alternative) to require PSP street cross sections to designate preferred underground servicing 'zones' in street cross sections, noting a stakeholder driven approach is required to support updated Guidance Notes if this measure was to be adopted 2. Indicative streetscape plans to be included for each road classification demonstrating how future conflicts with other streetscape components can be avoided and features which support tree canopy such as outstands (which can only be demonstrated in plan view) are encouraged 3. VicRoads Tree Policy to be reviewed to highlight alternative, cost-effective methods to achieving central median canopy tree planting on arterial roads while maintaining safety requirements	1. Future PSP's should more routinely explore alternative water supply from a range of sources, including how this could support street trees over their lifetime 2. Future PSP's should set clear objectives and requirements for passive irrigation to street trees the proposed target (that all streets containing canopy trees should use stormwater to service their watering needs) is strongly supported The proposed Integrated Water Management Guidance Note presents the most obvious implementation mechanism building on the target outlined in the updated PSP Guidelines (noting that research suggests passive irrigation needs to be supported by other forms of irrigation through extended periods of lower rainfall).

Critical Success Factors, Barriers and Solutions – Subdivision Planning

The subdivision planning stage offers significant opportunity to influence canopy tree coverage outcomes, in particular through urban design of subdivisions.

As outlined in the table on p. 20, the critical success factors that will ensure this phase builds successfully on the precinct structure planning phase include:

- **Vehicle access and lot frontage widths that can support large canopy trees**
- **Retention of healthy existing trees**
- **Road alignment to contours (where possible)**
- **Pedestrian focused, low speed residential streets**
- **Maximised urban heat benefit from landscape design**
- **Integrated water management approach that supports passive irrigation of street trees**

The main day-to-day stakeholders in the subdivision planning stage include Councils, developers and their teams (including land surveyors) and referral authorities. DELWP has a regulatory role through their management of the planning scheme, in particular Clause 56.

The regulator influences include the Small Lot Housing Code and VicRoads Tree Policy.

CRITICAL SUCCESS FACTORS

Regulatory influences during the subdivision planning stage are primarily driven by Clause 56 (Residential Subdivision) of the Planning Scheme which sets the requirements and conditions upon which subdivisions are assessed. Other influences include the Small Lot Housing Code and the Subdivisions Act 1988, but both the Urban Design Guidelines for Victoria, Department of Environment, Land, Water and Planning, (2017) and Sustainable Subdivisions Framework (currently being trialled by 28 local governments including growth areas) all have influence over the canopy tree canopy outcomes.

Vehicle access and lot frontage widths can support large canopy trees

Clause 56.05 sets out objectives and requirements for subdivision in relation to urban landscape.

Landscape plans are often required through a condition on permit. Submitting landscape plans at this point (where other urban design outcomes are locked in) may result in street trees being forced to 'make do' with the left over spaces created. This can negate the ability to practically assess whether the remaining space will be adequate to support the preferred street tree density (or planting frequency) or whether lot frontage widths preclude a good outcome. A good example drawn from case studies is 13 to 23 Combine Drive, Truganina (pictured top-right), where because of reduced frontage width this section of the street only supports two obvious locations for street trees for six dwellings. If these dwellings were rear loaded for example, the canopy could have been contiguous, affording these dwellings excellent protection from harsh, low angle, western sun.

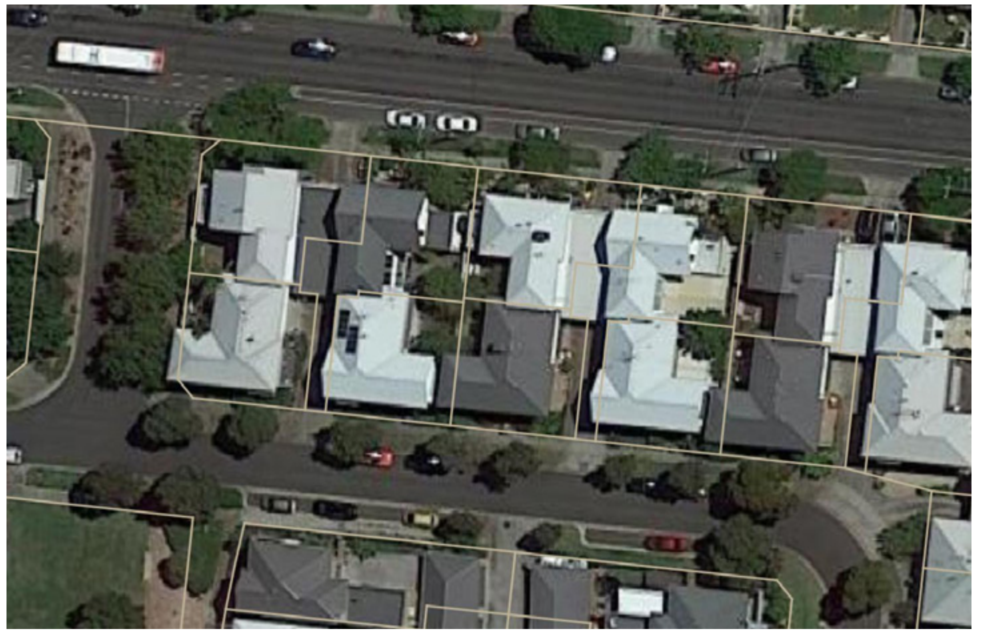
One option which may be able to support increased density whilst preserving space allocation for street trees is the 'four-pack' example. In this example from Maidstone (1 - 9 Ringtail Cct) a single cross over supports four dwellings, which has resulted in 8 street trees on one side of the street within approximately 90m of road pavement (pictured on page 19).

Reduced lot widths with crossover provision reduce potential for streetscape vegetation. Image by Google Earth/QGIS

A subdivision plan will also lock in any tree outstand areas, which provide excellent opportunity for boosting canopy tree coverage. If this isn't considered through the urban design layout then street trees will be limited to standard 2.5m to 3m verges. Subject to servicing locations, tree outstands often have less encumbered underground servicing conflicts (also pictured page 19).

If densities of 20 lots per hectare as envisaged under the updated PSP Guidelines are to be achieved, the Small Lot Housing Code will apply in an increasing number of cases. Not withstanding the challenges of achieving private canopy cover on smaller lots, the Code requires dwellings with frontages 6m or less to be rear loaded. Our analysis indicates that the soil volumes per lot in a street with even 8m frontages (assuming 2.5m verge, 3.5m crossover width and 1m available depth) are insufficient to support a medium to large canopy tree which requires a minimum of 15m3 of quality soil to grow to full maturity. Provision of rear loading does not automatically 'fix' the problem however as rear lanes are included within the streetscape definition area and are generally incapable of delivering canopy vegetation.

Critical Success Factors, Barriers and Solutions – Subdivision Planning



‘4-pack’ configuration can reduce crossover provision to allow more space for streetscape vegetation. Image by Google Earth/QGIS

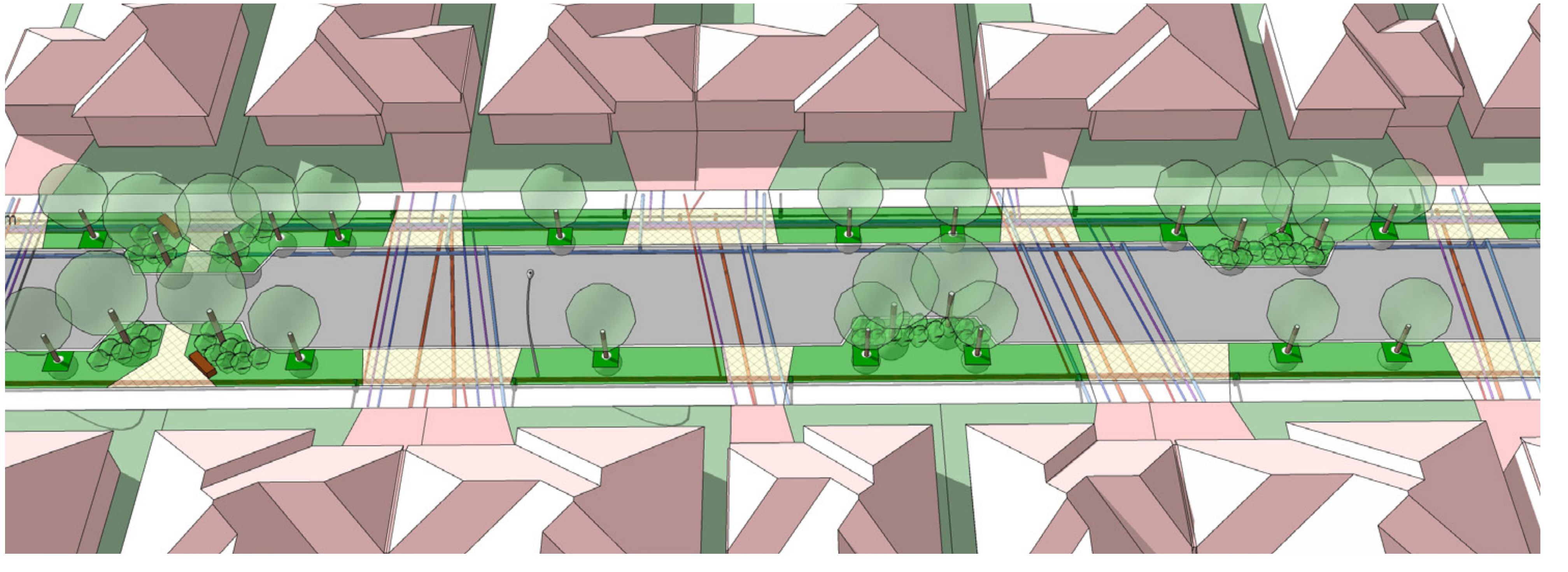
Retention of healthy existing trees

Trees in any growing conditions will require at least 15 years (usually longer) to reach canopy maturity and deliver full community benefit. Retention of existing vegetation can assist in delivering canopy tree cover from day one of a new community. The subdivision stage locks in retention or removal of trees. Where a PSP process preceeds subdivision these decisions are made generally in accordance with an approved Native Vegetation Precinct Plan. Whilst requirements at the PSP stage and in the planning scheme focus on the retention of native vegetation, further consideration could be given to maintaining healthy non-native canopy trees based on their ability to provide immediate benefit.

Road alignment to contours (where possible)

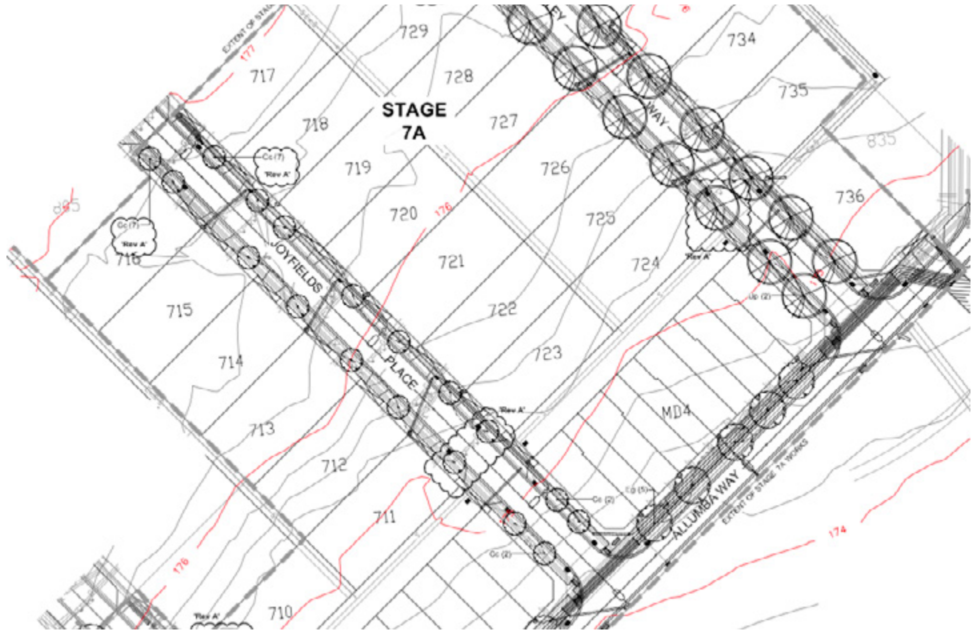
The subdivision stage embeds road layout for new communities through the subdivision plan. An urban design approach which is highly responsive to existing topography allows for improved outcomes for vegetation generally, because the construction process removes less topsoil to create the required shape to support streetscapes and private lots.

The Whittlesea case study example illustrates this well (pictured page 20). The contour lines run at crossways to the street creating easy drainage and minimising cut and fill. Unfortunately this results in a challenging orientation for passive solar design.



Tree outstands often have less encumbered underground servicing conflicts. Image by Spiire

Critical Success Factors, Barriers and Solutions – Subdivision Planning



As-built streetscape plan highlighting that the road has largely aligned with the existing topographic contours. Image by Whittlesea City Council

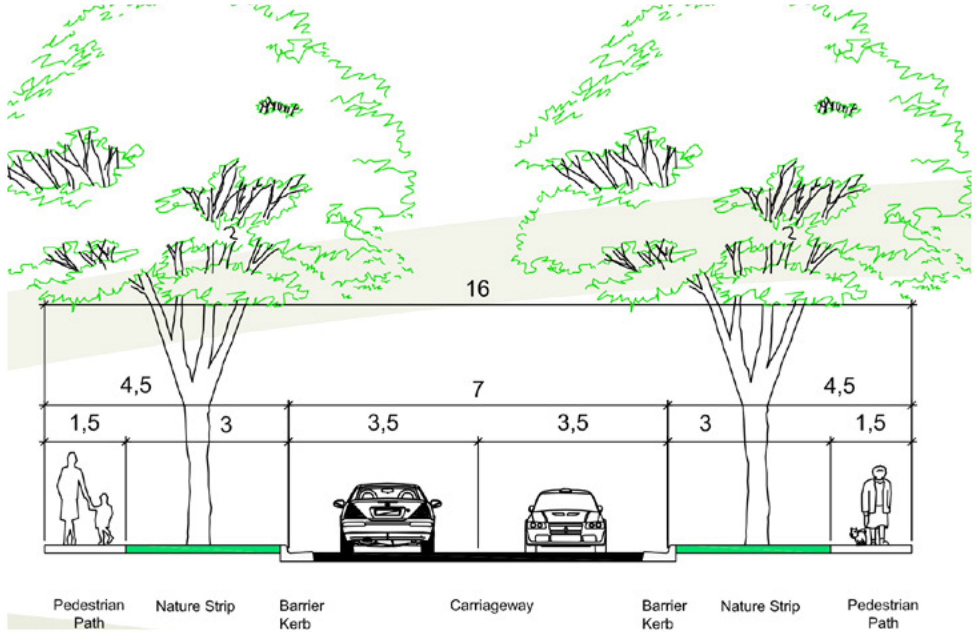
Pedestrian focused, low speed residential streets

Whilst a PSP process will set up road classifications and the corresponding street cross sections, the subdivision planning process has a degree of flexibility in how streets are delivered 'generally in accordance with' the PSP. Justification for 7m or more road pavements is generally driven by expected traffic volumes and higher target speeds, which are at odds with the promotion of walking and cycling.

When target speeds are 30km/h or lower and residential streets traffic volumes of less than 1000 vehicle movements per day, a pavement width of 5.5m can be appropriate. This is fully supported by Clause 56.06 Access and Mobility Management, but all of the PSP's reviewed required a minimum of 7m pavement at these estimated volumes. The Cranbourne East PSP is a case in point, where volumes of up to 1000 vehicle movements per day require a 16m reserve and 7m pavement (pictured right).

Even assuming the reserve remains the same, there is a significant amount of space which could in theory be reallocated to support larger tree canopies (even now as a retrofit opportunity). Reducing pavement width not only has positive ramifications for space allocation for canopy tree coverage it actively reduces the area of exposed asphalt, which has high levels of solar absorption and therefore contributes to urban heat island effect.

In some circumstances, provision of on-street car parking has reduced soil volumes otherwise available to street trees. The Craigieburn example in Mundaring Cresent illustrates this (pictured page 21), where the space allocation available to a street tree is approximately 7.5m³ (assuming 1m soil depth) a volume not capable of comfortably supporting a medium to large tree to full canopy maturity.



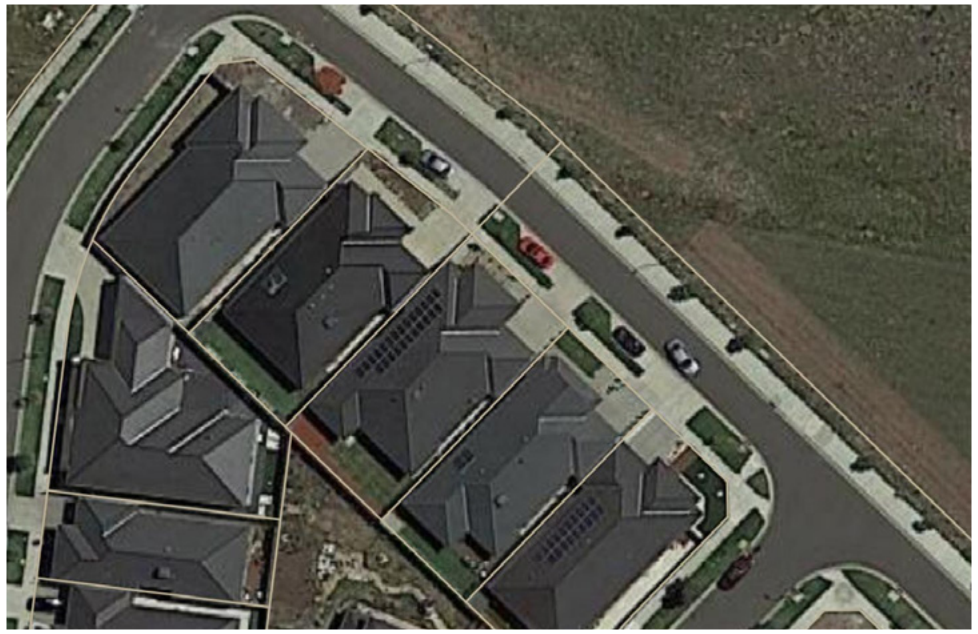
Traffic-calming urban design allows for a reduced road pavement width of 5.5m, resulting in increased vegetation provision. Image by Growth Areas Authority (Cranbourne East PSP)

Maximised urban heat benefit from landscape design

Whilst the number of street trees able to be delivered is important, Thom et al. (2016) highlighted the importance of street tree location in urban design for delivery of maximum thermal benefits. They recommended that placement should consider: street height to width ratio (h:w); street orientation; placement in the street (to maximise adjacent wall shading); tree clustering; tree arrangement (clustered trees interspersed with open areas to provide daytime shading while allowing nocturnal cooling and ventilation).

Considering tree shade during subdivision planning can support delivery of optimal shade to encourage active transport (walking and cycling) during operation and growth phase; digital design tools are being developed to consider the combination of pedestrian access modelling, tree-scape shade modelling and shade optimization (Langenheim et al. 2020).

Critical Success Factors, Barriers and Solutions – Subdivision Planning



On-street parking as designed above in Mundaring Cr significantly reduces the allocation for soil volume and canopy trees. Image by Google Earth/QGIS

Modification of street microclimates using tree canopy cover can provide important benefits to pedestrians (Sanusi et al. 2016), as well as contributing additional benefits such as pollution reduction and biodiversity habitat (Norton et al. 2015). Sanusi et al. (2016) found that reductions in air temperature under high-percentage canopy cover were greater for E-W streets (2.1°C) than for N-S streets (0.9°C); N-S streets, air temperature, mean radiant temperature, and solar radiation were greater on the east pavement in the early morning and greatest on the west pavement in the mid-afternoon.

The cooling benefit of street tree canopies increases as street canyon geometry shallows and broadens. This should be recognised in the strategic placement, density of planting, and species selection of street trees (Coutts et al. 2016).

Clause 56.05 sets out objectives and requirements for subdivision in relation to urban landscape.

There is no specific objective related to tree canopy coverage or the role of canopy tree coverage (or indeed the benefit of landscape overall) in mitigating urban heat. There is opportunity for Clause 56 to reinforce this as a priority as has been achieved through recent work that has embedded these principles of promoting tree canopy within private lots through multiple clauses of the Particular Provisions. The Sustainable Subdivisions Framework, (which is currently being trialled by 28 local governments in Victoria) proposes a tree canopy target within streets of 25% or more at 15 years as a minimum standard, demonstrable through a landscape plan at subdivision planning stage. This standard is relatively consistent with the 30% canopy tree coverage standard at full maturity proposed in the updated PSP Guidelines.

The critical point is that before the subdivision layout is approved, the capacity to meet the target must be demonstrated. There is opportunity for future PSP's to direct this as a requirement of the subdivision stage and for Clause 56 to be amended to further support a target where there is no PSP or a PSP is silent on this issue. This may require modification of Council practices to support a more integrated outcome.

Currently landscape plan requirements do not require any analysis on what canopy cover would be achieved through the species selection and location.

The landscape plans that had been developed for the case study areas within PSP's showed no evidence that a projected canopy tree coverage had been calculated through landscape design.

Integrated water management approach supports passive irrigation of street trees

Clause 56 supports a strong focus on integrated water management, but presently fails to fully capture the opportunity for stormwater to be routinely considered as an asset for street tree health. Clause 56.07 Stormwater Management highlights the opportunity for stormwater to support local cooling and local habitat improvements, but does not provide explicit policy support for directing stormwater flows to support canopy tree development through passive irrigation. Although the detailed design stage will lock in any specifics of passive irrigation, because the subdivision stage is generally where stormwater modelling is undertaken (e.g. MUSIC to support meeting Clause 56.07) it is important that passive irrigation is embedded at this stage so that it can be integrated with the overall integrated water management approach (potentially allowing for a reduction in the size of other stormwater infrastructure).

Critical Success Factors, Barriers and Solutions – Subdivision Planning

BARRIERS AND SOLUTIONS FOR SUBDIVISION PLANNING					
Barriers	**Landscape planning often is undertaken after the subdivision urban design layout is documented.**	**Lot frontage widths do not provide adequate space allocation for street trees.**	**Policy does not adequately promote canopy tree coverage as a key objective of the subdivision process.**	**Clause 56 and the PSP process do not offer protection to healthy, locally appropriate, non-native canopy trees**	**Road pavement widths in low traffic volume and speed streets are excessive – reducing allocation for landscaping and increasing urban heat island effect through higher levels of solar absorption**
Solutions	1. Councils to routinely request development teams to nominate street tree locations, tree outstands and preferred cross over locations on subdivision plans submitted for assessment, and willingly accept the impact of increased up front approvals to facilitate an integrated outcome 2. DELWP could reinforce this voluntary practice with a regulatory change to update Clause 56 to reflect that design response / subdivision plans are required to include this information 3. VPA to develop guidance (either through Guidance Note or updated Small Lot Housing Code or both) as to preffered crossover treatments to maintain space for higher street tree planting frequency	1. Councils to undertake assessment of crossovers as a proportion of streetscape length, encouraging adoption of medium density typologies which reduce this proportion (such as four-packs) - this could be reinforced through changes to Clause 56 2. VPA to review the small lot housing code to ensure that street tree canopy in excess of 30% (with adequate soil volumes) can be delivered when lot frontage widths are 9m or less 3. Councils to encourage adoption of consolidated crossovers which reduce interruptions to landscape verges - this could also be reinforced through amendments to Clause 56	1. DELWP to investigate a new sub-clause for Clause 56.03 – which promotes complete and liveable streets, focusing on encouragement for residential streets that are slow moving, pedestrian focused and offer protection from climate hazards, including highlighting street trees as a key tool in urban heat mitigation. 2. DELWP to modify Clause 56.05 to highlight street tree canopy as a clear objective (including potential adoption of an indentical 30% street canopy target), and including requirements for landscape plans to demonstrate compliance with any target set through a PSP process, within Clause or provide consistency with any locally adopted Urban Forest Plan or similar 3. DELWP to modify Clause 56.07-4 - Stormwater management objectives to better highlight passive irrigation of street trees as an objective of stormwater management. 4. VicROADS to review their Tree Policy to explicitly reference canopy tree coverage as an objective and review general guidance for 50km/h to 80km/h roads to increase canopy tree coverage (especially in wider reserves where more intensive tree planting can be supported in verges and central medians).	1. DELWP to review Clause 56 to better support retention of existing canopy trees where they are in good health and can make a positive contribution to the streetscape. The intention would not be to retain every non-native tree, rather to recognise that existing non-native trees offer immediate canopy cover for residential streets.	1. VPA to develop a 15m / 16m standard cross section which has a reduced road pavement width of 5.5m or 6m with direction that this can substitute existing cross sections put in place through PSPs where it can be demonstrated that traffic volumes will be less than 1000 or 2000 vehicle movements per day (this is consistent with Clause 56 of the Planning Scheme)

Critical Success Factors, Barriers and Solutions – Detailed Design

The detailed design stage documents all detailed engineering and landscape design in preparation for the construction phase. The good design intent of the previous stages can fall down during this stage if there is a lack of integration between engineering and detailed landscape design.

As outlined in the overarching diagram, the critical success factors to ensure this phase confirms the intended tree canopy outcome and include:

- Landscape and engineering design integration
- Species selection (climate resilient, sufficient canopy size and shape) and spacing
- Passive irrigation
- Service location

Regulatory influences during this stage include:

- VPA's Engineering Design and Construction Manual (2019) – including standard drawings
- Council Landscape Guidelines and Species lists
- Road Management Act
- DELWP's Trees-for-Cooler-and-Greener-Streetscapes (not-statutory)

The main day to day stakeholders in the detailed design stage include Councils (both engineering and landscape departments), developers and their teams (including land surveyors) and referral authorities. The VPA maintains regulatory influence through their management of the Engineering Design and Construction Manual (EDCM).

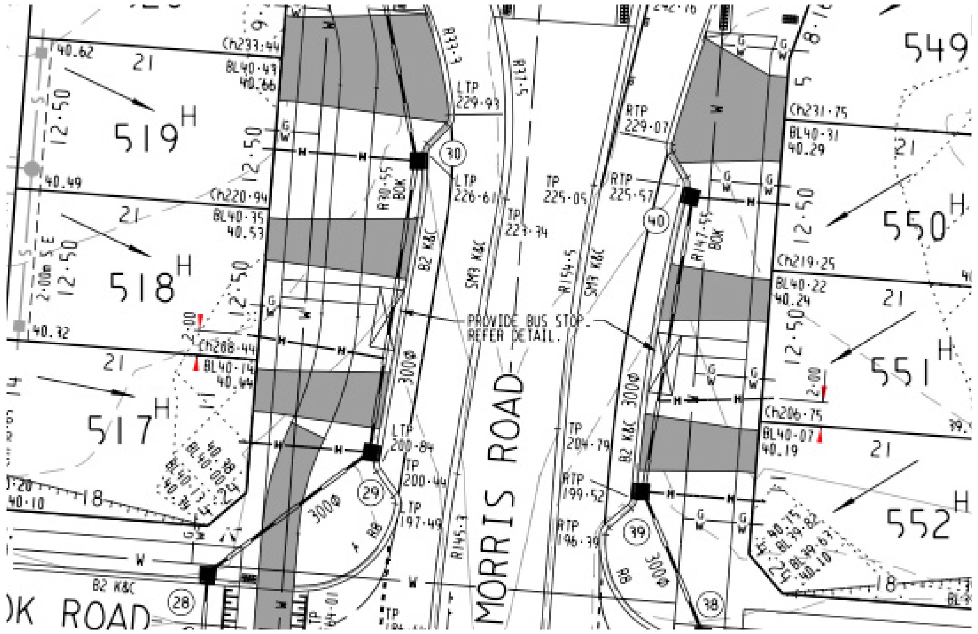
CRITICAL SUCCESS FACTORS

Landscape and engineering design integration

The integration of landscape and engineering design is a critical determinant of canopy tree coverage outcomes in growth area development. Historically this is not done well, which has tended to erode the space available to plant a successful canopy tree.

VPA's EDCM is influential in the development of a functional layout plan (FLP), a key document in the detailed design stage. Under Section 5.7 of the ECDM, the FLP specifically directs landscaping design as not being required to be documented. With the amount of infrastructure locked in through the FLP (underground service offsets, kiosk locations etc.) the inability to undertake an integrated assessment of landscape plans and engineering layouts is a key challenge. The failure is borne out in some of the case study documentation where there is a clear conflict between the FLP and street tree provision which may have been highlighted if the documentation had been integrated.

There is a key opportunity to integrate these design processes and represent street tree locations on FLP's. Wyndham Council is trialling documenting a 1.5m circle around street tree locations with the intention that this become a potential exclusion zone for underground services. Additionally, landscape plans should build on the engineering CAD base so landscape planning can identify known constraints and key stakeholders within development teams and within different parts of Council are aware of conflicts. To reinforce this division, for most of the Councils who provided data to support this project, landscape and engineering drawings were sourced from two separate departments.



The Morris Rd Engineering Plan demonstrates a reduction in verge space available for street tree planting where a shared path and footpath have been specified right next to each other. Image by Wyndham City Council

Species selection (climate resilient, sufficient canopy size and shape) and spacing

Emerging research is considering how to identify climate resilient species (particularly for drought and thermal tolerance). Recent research has suggested that using climatic envelopes for species selection (ie the climate thresholds for the species' place of origin) may be inaccurate and overly simplistic, so more research is required (Hanley et al. 2021).

The canopy area potential of full grown trees is different for different species and tree species selection is an important consideration for addressing shading and cooling benefits as well as meeting canopy targets (Sanusi et al. 2017).

Plant and Sipe (2016) argue that downsizing of urban trees is often a symptom of above and below ground space constraints, and a common response to the issues of infrastructure damage and risk. Joyfields Place (see over as an example).

Critical Success Factors, Barriers and Solutions – Detailed Design

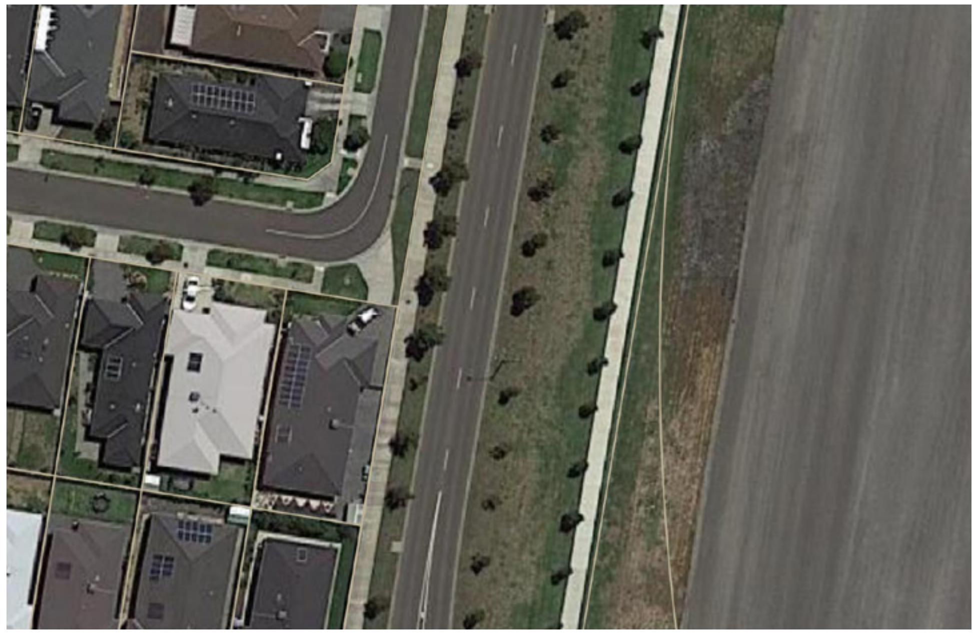
Joyfields Place has a lower density planting of dwarf species. Image by Google Street.

Several landscape species lists were reviewed at a high level as part of this project, but a detailed review was not within scope. A review on the appropriateness of trees for local conditions, availability of quality stock, growth rates etc. was beyond this study. Of the landscape species list reviewed we noted that all but one of the case studies used trees which were on Councils preferred species list, with the exception of Platanus which has been widely specified in boulevard planting in the case study areas.

From a canopy coverage perspective, the main issue is a lack of standardised information on canopy coverage (only height is specified in most lists). Some eucalypts provide good height for example, but not breadth. Canopy cover is compromised when a small or medium tree instead of large is selected and is incapable of providing the intended canopy tree coverage. There is opportunity for these lists to standardise (to the extent possible given different local environmental conditions) the projected canopy cover of each street tree. This will allow for landscape architects to easily model the projected canopy cover percentage in each street at design stage and very quickly understand whether there are issues with meeting a prescribed target.

The case study research found that for a standard 16m street if the canopy size is evaluated according to the adopted method for this study, then to meet a 30% canopy tree cover target streets must have a tree placement frequency of 5.8m (equalling 11.6m on each side of the street) at 8m optimal canopy width.

An example of where the 8m optimal canopy width will be incapable of delivering 30% canopy cover is Joyfields Place, Wollert. Dwarf Corymbia citriodora (Lemon-scented Gum) is specified at 8.2m spacing, far in excess of what is required to meet at 30% canopy tree cover target. This was however an uncommon example with the vast majority of specified species theoretically capable of meeting the canopy tree cover target if the spacing is close enough together and if construction stage (implementation) issues are addressed (see next section). We note that in some cases the number of street trees specified in the landscape plan outstripped what was actually planted and properly established by as much as 30% - refer Kalkallo case

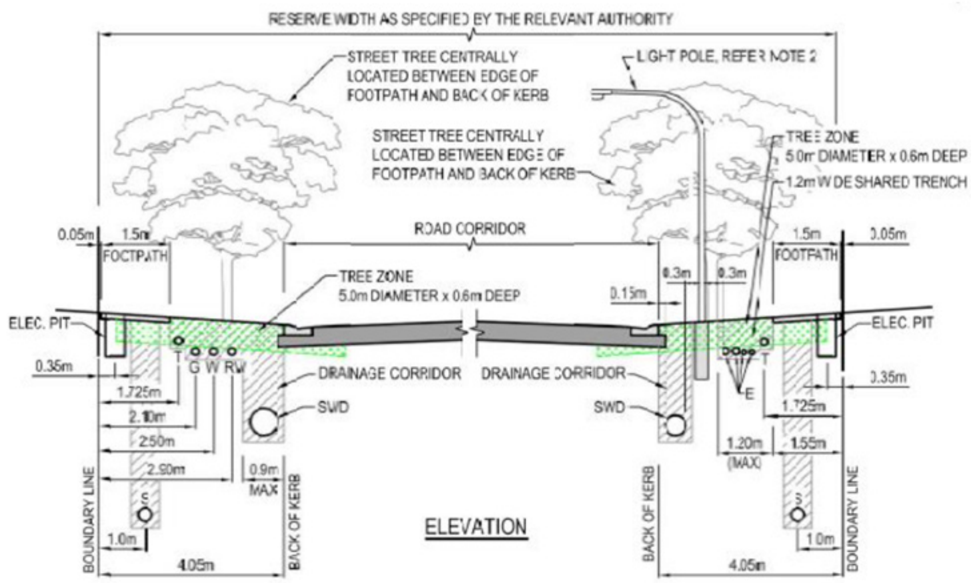


Multiple rows of tree plantings on Casey Fields Boulevard. Image by Google Earth/QGIS

study example where 39 trees were specified, but only 29 had successful establishment.

This minimum planting frequency increases to 9.2m (equalling 18.4m on each side of the street) when a 10m optimal canopy width is adopted. If we revert to our Year 8 maths, because canopy cover area is related to the square of the radius each small increase in diameter has a significant effect on canopy coverage.

Wider arterials deliver additional opportunity for intensification of street tree planting. An example is Casey Fields Boulevard (pictured above) where the eastern side of the road caters for two rows of trees, resulting in a tree frequency of 3.8m. The increased width however, means that tree frequency needs to be much higher or species selection larger to maintain canopy tree cover in excess of 30%. The eastern side of the road in this example could actually support additional street tree planting between the two rows, resulting in almost complete canopy cover in that verge at full maturity. VicRoads Tree Policy does not directly prohibit this outcome.



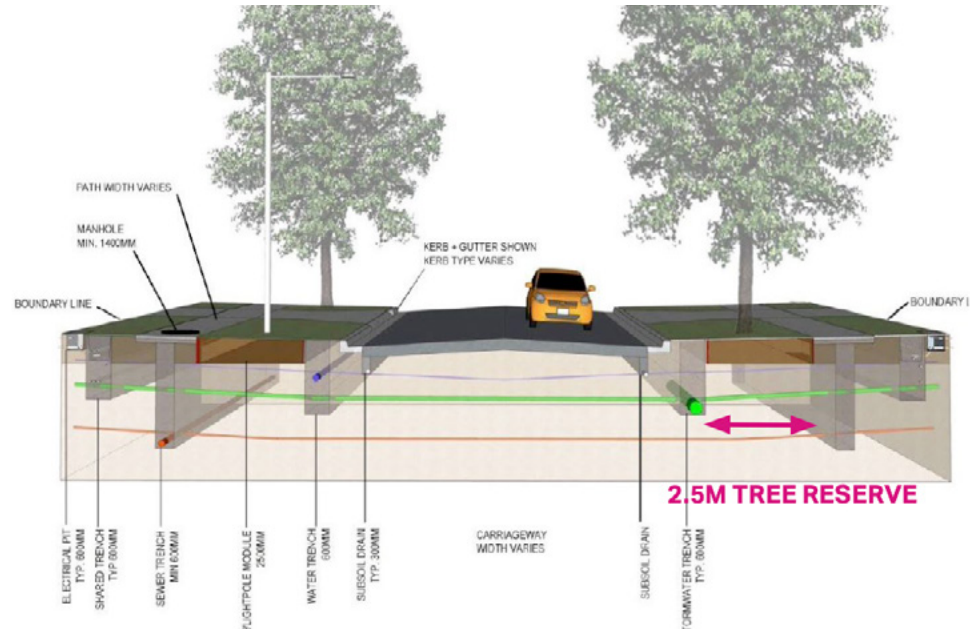
EDCM Standard Cross Section. Image by Growth Areas Authority

Passive irrigation

Water availability is a strong indicator of successful street tree outcomes. This is addressed in detail as part of the occupancy section of this report, but we note that it is the detailed design stage which locks in opportunities for passive irrigation of street trees. None of the case studies reviewed (including the best practice examples) had evidence of passive irrigation being implemented as part of the landscape and engineering design, indicating that it is potentially not a critical success factor when trees are supported through their establishment phase and when rainfall levels are higher as they are in the northern and particularly in the south-eastern case study examples (note the Malvern East example has rainfall in excess of 700mm per annum). DELWP's Trees-for-Cooler-and-Greener-Streetscapes provides excellent guidance on options for embedding passive irrigation in streetscapes, which could also be applied in growth areas. The Green Streets Issues Paper highlighted Melton's trial approach to passive irrigation as worthy of further exploration. The Melton designs provide for 0.9m3 of water storage in tree pits fed from street captured stormwater.

Service location

For the purposes of this report, services location includes underground electricity, gas, sewer, water supply, communications and refers to both the horizontal offset and the depth. With the exception of the established areas where the servicing location was somewhat unclear (but appeared to be mostly under edge of road pavement in most examples where dial before you dig queries were run) all the case study examples located services underneath the landscape strip. No engineering documentation cited specifically nominated service depth, however the ECDM nominates a minimum depth of 0.6m for most services and 0.45m for telecommunications. The ECDM clearly nominates the landscape strip as the preferred location for services setting up an obvious conflict when minimum depths are so shallow. Because of different offset requirements in each Council (including other infrastructure such as light poles) some engineers may respond with a set of standard (conservative) assumptions which 'please everybody'.



Placing the utilities into a shared corridor beneath the shared path or footpath reserves space for the tree zone. Image drawn from ACT Verges Municipal Infrastructure Standards

Legal advice obtained as an input into the Green Streets project also funded by the VPA has indicated under the Road Management Act that Council can direct service authorities to place services under footpaths and direct them to fully reinstate footpaths fully after maintenance, in practice this is not routinely done and these offset requirements are driven by the EDCM and the service authorities. One Council engineer suggested smaller tree sizes were becoming the norm because of these requirements imposed by service authorities. The opportunity for servicing under footpaths is highlighted in the AECOM Geelong Maximising Street Trees study, citing an example from ACT Verges Municipal Infrastructure Standards 06, 2019 reserves which nominates all services underneath footpaths. A secondary option is servicing depth needs to be significantly increased to deliver soil volumes capable of supporting medium to large canopy trees, however stakeholders would need to be satisfied that maintaining services at this depth didn't further compromise street tree health. The Green Streets Issues Paper notes a small cost impact of $125 per lot.

Critical Success Factors, Barriers and Solutions – Detailed Design

	BARRIERS AND SOLUTIONS FOR PRECINCT DETAILED DESIGN			
Barriers	**Poor landscape and engineering documentation integration.**	**Poor species selection for canopy cover outcomes**	**Missed street tree planting opportunities**	**Conflict with underground service locations and tree roots**
Solutions	1. VPA to update EDCM to expressly require street tree locations to be nominated on Functional Layout Plans (FLP's) 2. DELWP to update landscape plan requirements through Clause 56 to expressly require underground servicing to be nominated on landscape plans as well as projected canopy cover based on species selection 3. Councils to investigate the provision of combined landscape and engineering designs being integrated with Council GIS systems (potentially through a pilot) – the potential advantage being that street trees could then be overlaid with aerial imagery to easily monitor and evaluate tree growth. An output of this initiative would be seamless transition of street trees as part of Council's asset register.	1. Councils (potentially through State funding) to establish a Melbourne Wide resource for street tree selection (noting this could build on the work City of Melbourne undertook to rate potential climate change adaptability of various common species). This resource could provide for local variation (based on environmental conditions) but attempt to standardise optimal and projected canopy widths and reflect the latest advice on species selection. This investment could refocus on canopy width rather than height, provide guidance on minimum planting frequencies and appropriateness to different streetscape settings. It could also ensure trees which are poorly adapted to climate change such as platanus are not further encouraged.	1. Council assessment could better highlight missed street tree planting opportunities. 2. Further guidance (potentially State funded) could provide guidance to Councils and development teams which highlight specific opportunities for more intensive planting such as in arterial road reserves and lots on corners (where a side boundaries of approximately 30m presents an opportunity for up to 5 trees)	1. VPA to update EDCM cross sections to reduce landscape and service conflicts - there is potential to nominate an exclusion zone where underground areas within a certain offset distance (for example 0.75m) of a street tree location can not be used for underground servicing (this may require an increased number of services to be located under footpaths). Through this process, the roles of service authorities and Councils need to be clarified, to ensure that service authorities are accountable for maintenance of Council assets which are damaged through their maintenance, that it is clear that all stakeholders are accountable to referral time frames and that governance is consistent with the Road Management Act which sets out responsibilities for the management of streets (note Maddocks advice) 2. DELWP to undertake a review of Clause 66 to clarify role of gas distribution network authority as a referral authority. Restricting the referral to where gas is proposed only would allow developers to go 'all electric' with improved confidence, assist in meeting the State emission reduction targets, as well as partly address underground servicing conflicts with street trees (by removing a non-essential service from already cluttered underground servicing arrangements)

Critical Success Factors, Barriers and Solutions – Construction (Implementation)

The construction and tree establishment phase is central to the ultimate achievement of canopy targets. The critical success factors are:

- **Soil: quality and structure; volume; topsoil retention;**
- **Irrigation and permeability**
- **Best practice tree planting**
- **Robust tree establishment (formative pruning; protection from damage and disturbance)**

The regulatory environment that covers the construction phase is an extension of the detailed design stage. The planning permit issue sets up a number of requirements which need to be met before a statement of compliance can be issued. Our analysis in this stage centred on construction practices and how they can impact outcomes for street tree provision. There is potential that solutions outlined may be embedded in future permits issued by Councils, but this has not been a focus of the research.

Key stakeholders identified in this stage are Councils, developers (including their consultant engineers) and civil and landscape construction teams.

CRITICAL SUCCESS FACTORS

Soil: quality and structure; volume; topsoil retention

For healthy growth and thriving trees, creating effective soil conditions at planting time is critical. There is a range of aspects that need to be addressed: soil quality (nutrients); soil structure (not compacted); soil volume (available space for root development) and soil surface (including retention of or reapplication of stockpiled topsoil, and consideration of the composition of surrounding surfaces).

Soil compaction can be a major impediment to tree growth as it damages soil physical and biological properties and reduces plant available water; both tillage and incorporation of organic matter have been found to improve soil physical and biological properties (Somerville et al. 2020).

Further, research found that deep tillage temporarily improved physical properties of compacted urban soils; and tillage with added municipal green waste compost led to long-term soil property benefits (Somerville et al. 2018).

To prevent sunscald and heat damage for young and newly planted trees, Leers et al. 2017 found that surfaces most suitable for placement adjacent to young trees were mulch and granitic sand.

Site visits were not included in this project, however the Taylors Hill West PSP area indicated high levels of soil compaction which may have impacted tree health outcomes. In particular the central median of City Vista Court (pictured above)was already very narrow and appears to have suffered significantly. This is exacerbated by dryer conditions and basalt clay underlying soils.

A narrow planting strip and compacted (basalt clay) soil can hinder tree growth. Image by Google Street

Irrigation and permeability

Trees, particularly newly planted stock, require water for establishment and healthy growth, both at the time of planting and ongoing (Loci 2021). With appropriately designed inlets, street tree stormwater control measures have significant potential to retain runoff (Szota et al. 2019). Directing runoff to street trees can increase tree growth during establishment (Grey et al. 2018), with newly planted trees responding positively to passive irrigation systems (Szota et al. 2019). The design of these systems should ensure that waterlogging conditions are avoided with instillation of underdrains or limiting installation to soils with a sufficiently high exfiltration rate (Grey et al. 2018). In research on the use of permeable paving in areas of expansive clay soil ('reactive clay'), Johnson et al. (2020) found that tree water use and stormwater infiltration through pervious paving can be integrated to improve stormwater management to work towards restoring balance to urban hydrological cycles and to enhance tree growth. Melton Council was unable to provide examples within the project timeframe but personal communications indicated a real focus on passive irrigation given the existence of lower rainfall and challenging soils in this location.

Critical Success Factors, Barriers and Solutions – Construction (Implementation)

Best practice tree planting

A number of factors associated with the planting phase can influence successful street tree establishment, including selection of good quality, healthy planting stock; planting technique; sufficient irrigation; weed control and adequate maintenance (Leers et al. 2018). Best practice guides and training are widely available. Street trees should be planted by skilled horticultural crews. This case study example from Kalkallo indicates a landscape verge in good condition, with good mulch. Positive growth has occurred over the past three years which may at least in part be attributed to good tree planting and establishment.

Robust tree establishment (protection from damage and disturbance)

Street trees are often planted in subdivisions before or during sale of lots. When construction occurs on individual sites (potentially months or years after street tree planting), there may be significant damage or removal of street trees associated with the building process and access of trades and equipment. Measures to address this risk is either to schedule street tree planting after individual blocks have been constructed (although this may considerably slow time for canopy establishment and create uneven street canopy development), or strengthen tree protection mechanisms, including both physical protection (fencing and cages for trees) and financial protection (tree bonds during construction and establishment period, of sufficient magnitude to be a deterrent).

During the establishment phase, street trees may also suffer damage due to vandalism or unintentional damage. Regular inspection and prompt replacement or remedial pruning is essential.

Mulched verge in Kalkallo. Image by Google Street

Critical Success Factors, Barriers and Solutions – Construction (Implementation)

	BARRIERS AND SOLUTIONS FOR OCCUPANCY AND MAINTENANCE			
Barriers	**Poor soil conditions leading to stunted growth; growing conditions for street tree roots are generally harsh with restricted space and soils compacted from streetscape infrastructure (Moore et al. 2019).**	**Poor water regimes: Drought, flooding and waterlogging.** **Trees will die during prolonged drought; lack of water will weaken trees making them more susceptible to pests and diseases.** **Waterlogging associated with flood events, heavy soils and poor drainage (either due to lack of soil structure, soil compaction or poorly designed WSUD treatments) will damage or kill trees**	**Poor planting technique and poor planting stock can significantly contribute to poor establishment and slow growth**	**Tree damage: vandalism; damage during adjacent construction works**
Solutions	Soil amelioration prior to planting. There are many existing technical, horticultural guides available. Key elements include: 1. Ensure soil quality: addition of organic matter such as municipal green waste to improve soil structure and soil nutrients; 2. Ensure soil structure and volume: address soil compaction by tillage and addition of organic matter; consider 'structural soil' treatments and design sufficient soil volume (depth and width) for root development. 3. Replace/return topsoil: topsoils should be stockpiled during construction processes and replaced during tree planting Options to improve compliance with the above practices were not explored in this project, but may include a system analagous to building code checks and balances, submission of photographic evidence of good practice, updates to Australian Standards, industry education etc. Councils would need to willingly acceptance a greater role in monitoring compliance with construction related outcomes.	Construction teams demonstrating provision of water at planting and throughout establishment (as well as ongoing); irrigation: both passive (WSUD treatments) and active (additional watering) particularly during dry or drought periods during tree establishment Compliance options are similar to those explored in column 1 (left)	Construction teams: 1. Sourcing healthy plant stock from reputable supplier 2. Demonstrating best practice planting techniques: guidance and best practice notes as well training; planting by horticultural trained teams (Loci 2021) There is a potential opportunity to accredit landscape construction teams with evidence of accreditation linked to satisfactory achievement of compliance with Councils	Construction teams delivering: 1. Protection from damage and disturbance: staking; fencing during adjacent construction; tree bonds payable by adjacent builders to council 2. Regular inspections to ensure healthy well-formed growth 3.Formative pruning to develop good tree form, canopy shape suited to location These practises will assist in ensuring assets transferred to Council are in good health and have the best chance at delivering canopy tree coverage in future

Critical Success Factors, Barriers and Solutions – Occupancy and Tree Growth

The occupancy and tree growth phase, including active management of the street tree population, is also critically important for the ultimate achievement of canopy targets. There are a range of factors that interact to influence tree canopy development.

Recent research (Parker and Simpson 2020) identified eleven factors, including water resource availability; cost of water; soil characteristics; financial investment; community desire; shade requirements; biodiversity/ ecological demand; political influence; climate; extreme weather events; zoning/regulations. Critical success factors are summarised in this report:

- **Community values**
- **Ongoing water availability and management (including passive irrigation maintenance; ensure protection from waterlogging)**
- **Street tree maintenance (pruning) and replacement; Weed and disease management monitoring**

The ongoing responsibility for street tree management is Council following official handover from developers.

The main regulatory influences in this stage relate to Council's own tree management policies and access to maintenance of underground and above ground services.

CRITICAL SUCCESS FACTORS

Community values

Public engagement to encourage street tree stewardship is important in both the establishment and ongoing growth phases; community support for street trees also positively contributes to decision-makers' support and action for street tree resourcing and implementation (Ordóñez et al 2020). The case studies highlight isolated examples where poor street tree stewardship by community members has resulted in tree failure. The varying degree of nature strip health was also evident in the case studies, with some gravelled over, and others dying due to lack of irrigation and/or damage.

A recent survey of Australian local government urban forest managers indicates that there is strong organisational and community support for urban forest management (Hurley et al. 2020). Strong organisational support and resourcing for street tree maintenance is critical, including funding for tree maintenance, replacement, watering and regular inspections and monitoring, as well as enforcement of tree protection mechanisms (Croeser et al. 2021).

Of significance for all stages in the development of canopy cover is fostering leadership and street tree champions, among all actors within each of the stages, including planners, decision-makers, construction and street tree crews, and local residents and businesses (Bush 2020).

Ongoing water availability and management (including passive irrigation maintenance; ensure protection from waterlogging)

Ongoing provision of water for tree health is critical throughout the life of trees (Nitschke et al. 2017). Irrigation can also contribute to wider heat mitigation efforts (Livesley et al 2021). Furthermore, integrating trees into stormwater control measures could provide dual benefits (tree health and stormwater management) for a single management intervention (Thom et al. 2020).

Nature strip health varied throughout the case study areas, with some gravelled (as above) or dying due to lack of irrigation or damage. Image by Google Street

However, some research has shown that while directing runoff to street trees can reduce runoff volumes, trees may continue to suffer drought stress and so would need additional (active) irrigation rather than relying solely on passive irrigation (Szota et al. 2019). The timing of irrigation is an important consideration - late winter provided better results than autumn irrigation for deciduous trees (May et al. 2013). May et al. (2013) found that drip irrigation in late winter was able to recharge soil moisture levels.

Street tree maintenance (pruning) and replacement; monitoring

Councils need robust, and risk focussed tree asset management programs which include dedicated funding and resources. Maintenance programs should include establishment and maintenance of a municipal tree inventory; and regular inspection programs (Hurley et al 2020). Street tree maintenance includes a focus on healthy trees, free from pests and diseases, with strong tree form and active canopy growth.

Critical Success Factors, Barriers and Solutions – Occupancy and Maintenance: Tree Growth

	BARRIERS AND SOLUTIONS FOR CONSTRUCTION (IMPLEMENTATION)			
Barriers	**Lack of community support, stewardship**	**Lack of organisational support (funding and risk management). Experiences of cities from both Europe and Australia suggest that cities struggle with similar issues related to lack of staff; lack of clear, documented processes and risk-averse organisational cultures**	**Incorrect water regimes (drought or waterlogging; successive years of drought had a significant negative influence on radial tree growth)**	**Poorly formed, damaged or dead trees; pest or weed infestations inhibit healthy growth**
Solutions	Local government programs: 1. For community education, engagement and participation to enhance the success of urban forest management 2. To encourage and contribute to community support for flourishing street trees. Support could include community tree plantings; adopt-a-street tree (care and watering) 3. To create opportunities for positive engagement related to trees (City of Melbourne's 'email a tree' creates an opportunity for positive messaging) 4. Timely replacement of vandalised or accidentally damaged trees	1. Councils to maintain and increase organisational support, provision of funding and resources, strong support of Councillors for tree planting and canopy cover as part of creating a healthy municipality and contributing to the achievement of the Municipal Health and Wellbeing responsibilities 2. Registration of trees on asset registers, demonstrating the ecosystem service value provided in economic, environmental and social benefit terms	Council management to provide consistent water throughout trees' life; 1. Irrigation: both passive (WSUD treatments) and active (additional watering) particularly during dry or drought periods 2. Retrofit installation of WSUD treatments (underdrains and/or high-flow diversion)	Council management to provide: 1. Formative and maintenance pruning: to ensure good canopy development, strong tree growth and removal of damaged or diseased growth 2. Regular monitoring of street trees to check for healthy condition; including checking for and treating weed or pest infestations 3. Replanting dead or damaged trees: ongoing program of replanting to fill in 'gaps' in street canopy development and contribute to expectations that the urban forest is a valued and actively managed element of the urban fabric

Case Studies

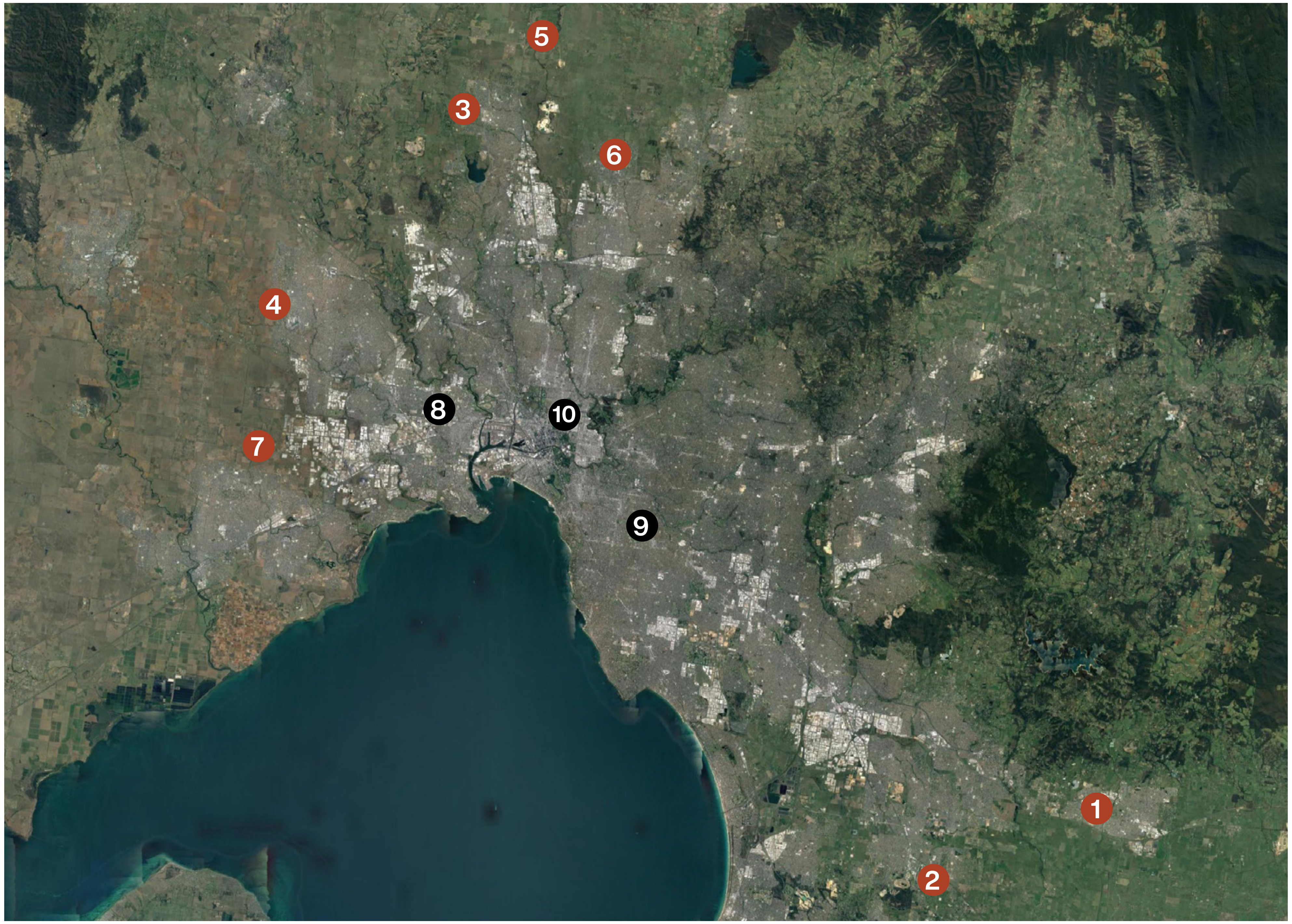
This section of the report includes nine case study examples.

The first seven of these case studies are drawn from growth area Councils (marked in red on the map to the right) :

1. Cardinia Road PSP: Lakeside, Pakenham
2. Cranbourne East PSP: Casey Fields, Cranbourne East
3. Craigieburn (R2) PSP: Highlander Drive, Craigieburn
4. Taylors Hill West PSP: Gladstone Avenue, Fraser Rise
5. Lockerbie PSP: Kalkallo
6. Epping North PSP: Elloura Avenue, Wollert
7. Truganina PSP: Truganina

For comparison, three areas within established suburbs that represent canopy provision at full maturity were also examined (marked in black on the map to the right):

8. West Footscray
9. Malvern East
10. Fitzroy



Case Study locations across Greater Melbourne. Image by Google Earth/QGIS

CARDINIA ROAD PRECINCT STRUCTURE PLAN: Lakeside, Pakenham

DESCRIPTION

Location

Pakenham, 3810 | Cardinia Shire

Case Study Details

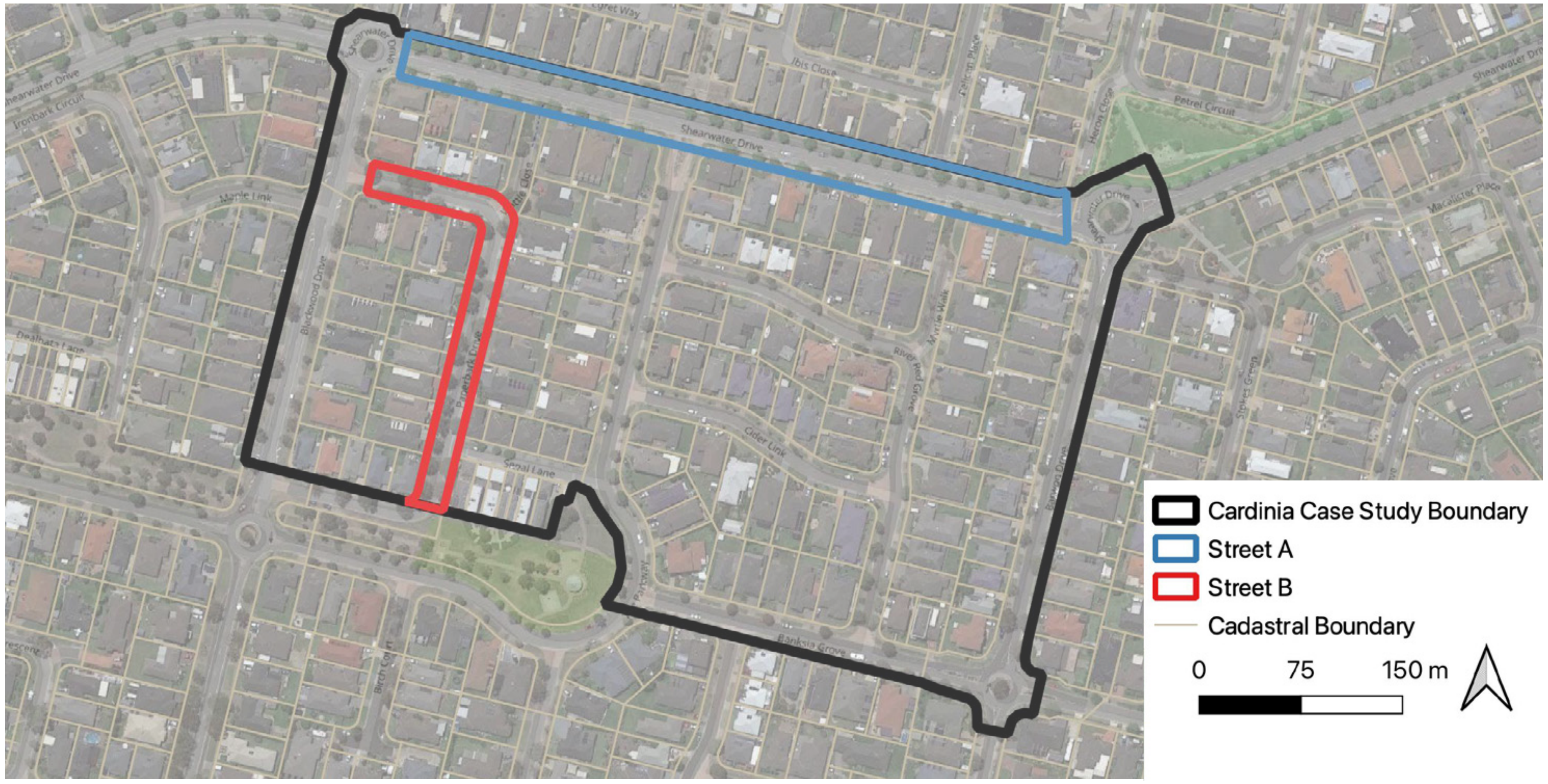
Size: 9.6ha | Private land: 6ha
Private lots: 133 | Average lot size: 451m²

Overview

The subject site is within Lakeside, Pakenham – which is a part of the Cardinia Road PSP, gazetted 20/11/2008 (although some planning preceded the PSP back to 2005)

Street A: Shearwater Drive is a Local Arterial Road (undivided).

Street B: Paperbark Drive is classified as a Court.



Paperback Drive with established, healthy canopy cover.
Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age varies from 2007 to 2013.

Street A: Shearwater Drive - Platanus orientalis (Cyprian Plane), 11m mature canopy width (currently 3 - 8m) - not highly adaptable to climate change.

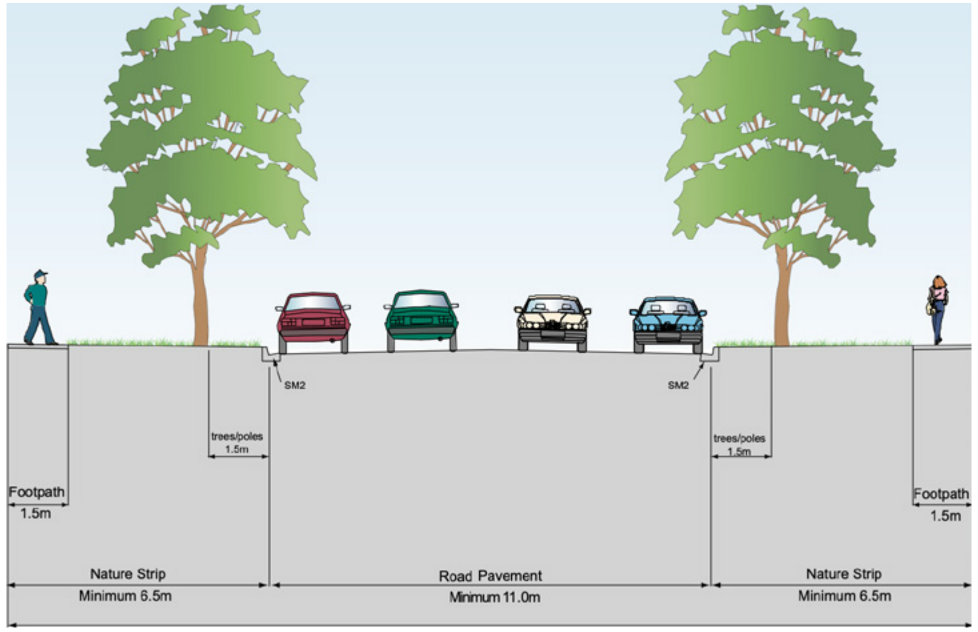
Street B: Paperbark Drive - Corymbia citriodora (Lemon-scented Gum), 12m mature canopy width (currently 6 - 10m).

Environmental Conditions

Soil type - Tertiary sands

The annual mean rainfall for the area is 785.1mm (Station: Koo Wee Rup).Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

	PSP	COUNCIL	AS BUILT
Local Arterial Road (undivided) – Shearwater Drive	– Total reserve width: 24m – Road pavement width: 11m – Nature strip: 5m & 5m – Footpath: 1.5m & 1.5m	– Total reserve width: 22m – Road pavement width: 11.5m – Nature strip: 3m & 3.5m – Footpath: 2m & 2m – Underground services on both north and south side of road – No landscape plans available	– Total reserve width: 22m – Road pavement width: 11.5m – Nature strip: 3m & 3.5m – Footpath: 2m & 2m – The section assessed was 338m in length, with 11 crossovers (with numerous rear-loaded) – Tree frequency of 1 per 6.6m (1 tree per 143m²) – **Satisfactory as built outcome.**
Court (noting the road pre-dates PSP specifications) – Paperbark Drive	– Total reserve width: 15m – Road pavement width: 5.5m – Nature strip: 4.5m & 3.5m – Footpath: 1.5m	– Total reserve width: 14.5m – Road pavement width: 6.5m – Nature strip: 4m & 2m – Footpath: 1.5m – Underground services on eastern side of road (no footpath provision) – No landscape plans available	– Total reserve width: 14.5m – Road pavement width: 6.5m – Nature strip: 4m & 2m – Footpath: 1.5m (only on east) – The section assessed was 212m in length, with 20 crossovers (for 20 dwellings), – Tree frequency of 1 per 7.8m (1 tree per 110m²) – **Satisfactory as built outcome.**



The PSP specifications for Local Arterial Roads (Undivided). Image by Cardinia Shire Council

A view along Shearwater Drive (a local arterial road) within the subject area.
Image by Google Street

OTHER OBSERVATIONS

Shearwater Drive, the Local Arterial Road had minimal crossovers with approximately 19 dwellings accessed from lanes to the north and south, allowing increased space for vegetation and a higher tree frequency outcome.

Along Paperbark Drive there were a number of instances where two crossovers were co-located with a 500mm grass strip in-between (too narrow for tree provision), an outcome that could be condensed into a narrower dual-crossover to allow for more vegetation.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 17.5%. Marginal growth exists between 2018 and 2021 resulting in a 2021 canopy cover of approximately 19%.

Projected canopy cover based on species selection in case study streets is 37% for Shearwater Drive and 56% for Paperbark Drive, however this level of canopy cover cannot be guaranteed (occupancy stage tree management may further limit growth). Council representatives noted this sort of outcome is now harder to achieve due to constraints imposed by service authorities (species selection and street tree locations).

The combination of already high existing canopy cover and a high projected canopy cover based on case study streets indicates that the case study area will likely meet the new PSP Guidelines 30% canopy tree cover target when fully mature.

CRANBOURNE EAST PRECINCT STRUCTURE PLAN: Casey Fields, Cranbourne East

DESCRIPTION

Location

Cranbourne East, 3977 | City of Casey

Case Study Details

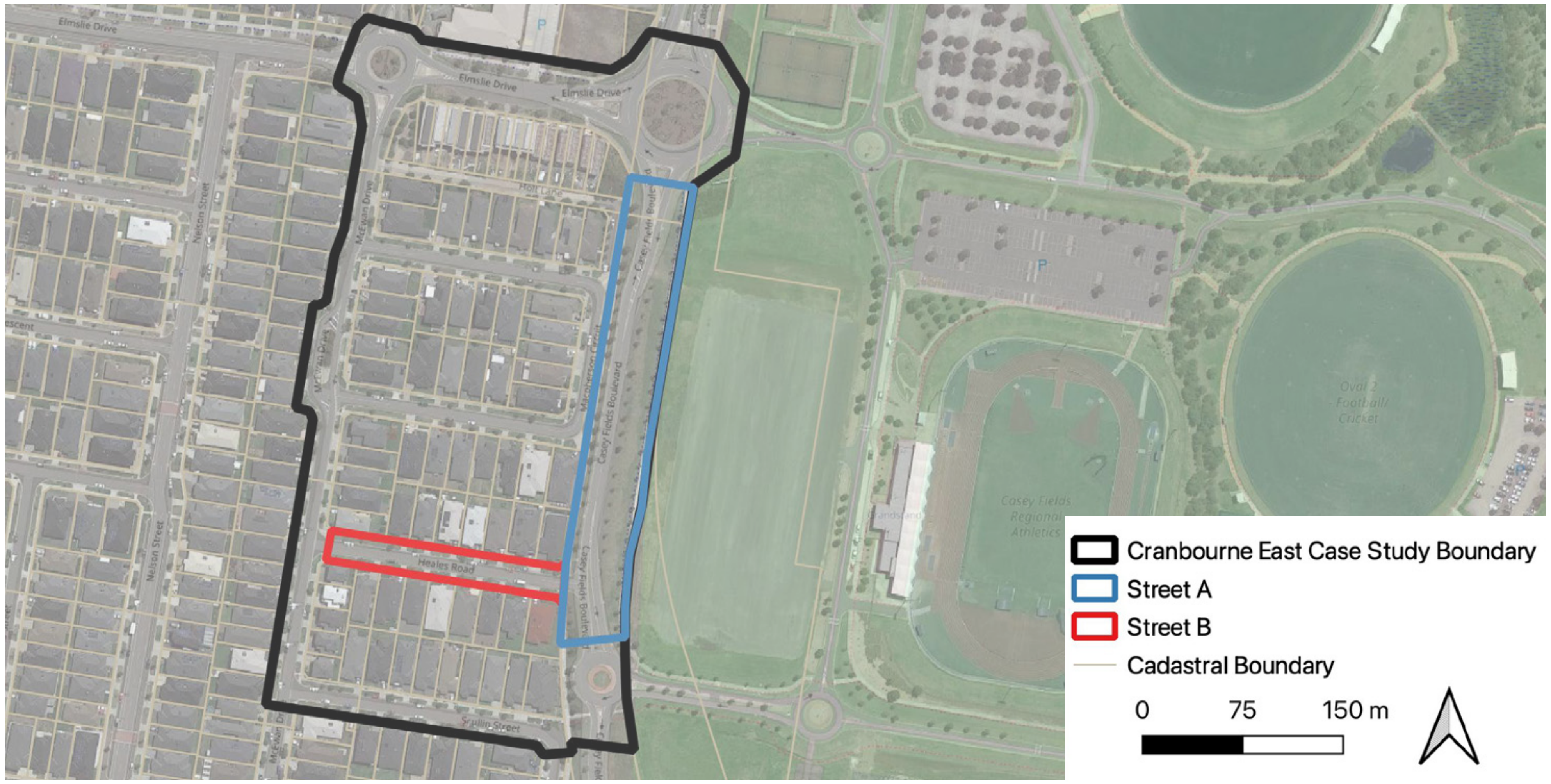
Size: 6.8ha | Private land: 3.2ha
Private lots: 84 | Average lot size: 381 m²

Overview

The subject site is within the Cranbourne East PSP which was gazetted 21/05/2010.

Street A: Casey Fields Boulevard does not correspond to a nominated street type.

Street B: Heales Road is an Access Street Level 1.



Typical streetscape vegetation within the case study area.
Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age varies from 2011 to 2015.

Street A: Casey Fields Boulevard - Corymbia maculata (Spotted gum), 11m mature canopy width (currently 2 - 4m).

Street B: Heales Rd - Eucalyptus leucoxylon (Red Flowering Yellow Gum), 9m mature canopy width (currently 2 - 4m).

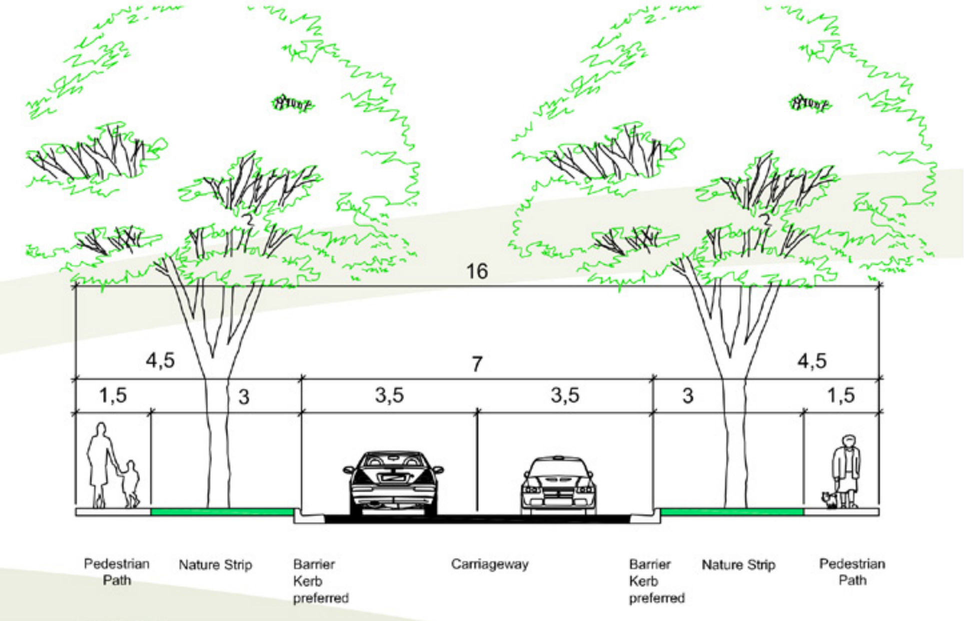
Environmental Conditions

Soil type - Tertiary sands

The annual mean rainfall for the area is 811.1mm (Station: Cranbourne Botanic Garden). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

CRANBOURNE EAST PRECINCT STRUCTURE PLAN: Casey Fields, Cranbourne East

	PSP	COUNCIL	AS BUILT
Casey Fields Boulevard	– No clear corresponding street section.	– Total reserve width: 34m – Road pavement width: 8.5m – Nature strip: 3.5m & 16m – Footpath: 2.5m & 2.5m – Council inspections indicate that the landscape plan was fully implemented with some replacements in 2014.	– Total reserve width: 34m – Road pavement width: 8.5m – Nature strip: 3.5m & 16m – Footpath: 2.5m & 2.5m – Other: Shared path not in-between canopy tree plantings – The section assessed was 244m in length, with 0 crossovers, and a tree frequency of 1 per 3.8m (1 tree per 127.5m²) – **Satisfactory as built outcome.**
Access Street Level 1 – Heales Road	– Total reserve width: 16m – Road pavement width: 7m – Nature strip: 3m & 3m – Footpath: 1.5m & 1.5m	– Total reserve width: 16m – Road pavement width: 7.5m – Nature strip: 2.5m & 3m – Footpath: 1.5m & 1.5m – Council inspections indicate that the landscape plan was fully implemented with some replacements due to damage.	– Total reserve width: 16m – Road pavement width: 7.5m – Nature strip: 2.5m & 3m – Footpath: 1.5m & 1.5m – The section assessed was 125m in length, with 13 crossovers (for 15 dwellings), and a tree frequency of 1 per 7.8m (1 tree per 125m²) – **'Borderline' as built outcome**



Street specifications for an Access Street Level 1.
Image by City of Casey

A view along Heales Road (Access Street Level 1) within the subject site.
Image by Google Street

OTHER OBSERVATIONS

Casey Boulevard on face value presents significant opportunity for increased planting density given its wide verges. There is a missed opportunity for improved shading of shared path (with no underground servicing constraints) and no vegetation in major roundabouts.

Heales Road presents a number of opportunities, with significant lost trees. The west end featured two double-crossovers at 7.5m which is a more efficient outcome compared to other areas (such as Cardinia).

Overall verges were healthy but some damage from vehicles evident.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 9%. Marginal growth exists between 2018 and 2021 resulting in a 2021 canopy cover of approximately 11%.

Projected canopy cover based on species selection in case study streets is 41% in Casey Fields Boulevard and 29% in Heales Rd. There is significant opportunity within the case study area to replace existing lost trees and intensify the planting in Casey Fields Drive. It appears damage by community members has impacted the outcome.

The existing canopy cover of 9%, sound species selection and good environmental conditions indicate that the case study area could reach the new PSP Guidelines 30% target subject to good ongoing tree management, but replacement of lost trees and intensification may be required.

CRAIGIEBURN R2 PRECINCT STRUCTURE PLAN: Highlander Drive, Craigieburn

DESCRIPTION

Location

Craigieburn, 3064 | City of Hume

Case Study Details

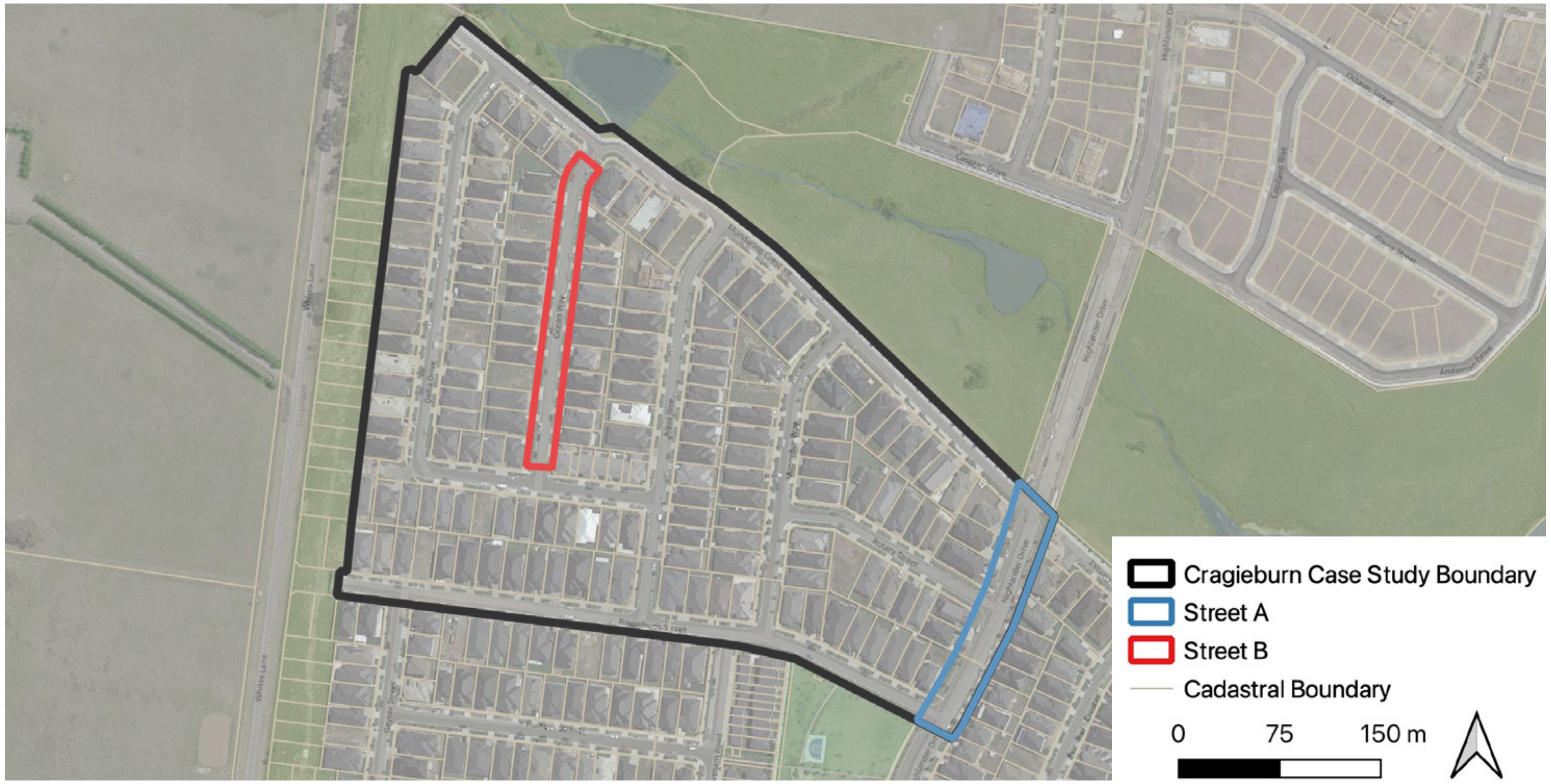
Size: 11.1ha | Private land: 7.5ha
Private lots: 179 | Average lot size: 419 m²

Overview

The Subject Site is within the Craigieburn R2 PSP, gazetted 18/11/2010.

Street A: Highlander Drive is a Connector Street Residential

Street B: Ocean Way is an Access Street level 1.



Typical streetscape vegetation along Ocean Way.
Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age varies from 2016 to 2017.

Street A: Highlander Drive - Corymbia maculata (Spotted gum), 11m mature canopy width (currently 1 - 2.5m).

Street B: Ocean Way - Banksia integrifolia (Coastal Banksia), 7m mature canopy width (currently 1 - 2.5m).

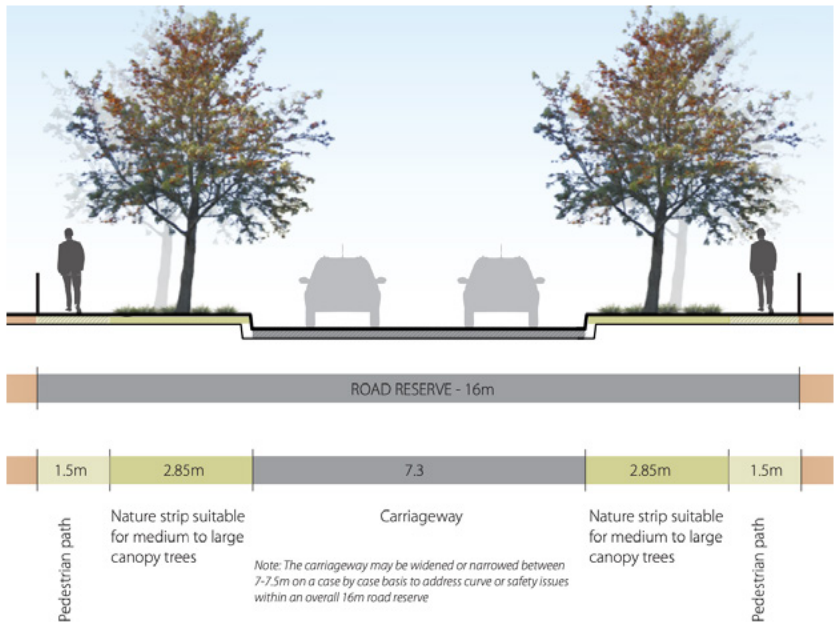
Environmental Conditions

Soil type - Basalt Plains.

The annual mean rainfall for the area is 598.6mm (Station: Greenvale Reservoir). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

CRAGIEBURN R2 PRECINCT STRUCTURE PLAN: Highlander Drive, Craigieburn

	PSP	COUNCIL	AS BUILT
Connector Street Residential – Highlander Drive	– Total reserve width: 26m – Road pavement width: 7m (plus 3.4m bike paths, and 4.6m parking) – Nature strip: 3.5-4m & 3.5-4m – Footpath: 1.5-2m & 1.5-2m	– Total reserve width: 26m – Road pavement width: 15.5m – Nature strip: 3m & 3.5m – Footpath: 2m & 1.5m – Services both sides under verge – Landscape drawings specify (22) Smooth Barked Appled Myrtle at a frequency of 1 per 7.2m (1 tree per 186.7m²)- **Unsatisfactory design outcome.**	– Total reserve width: 25.5-26m – Road pavement width: 15.5m – Nature strip: 3m & 3.5m – Footpath: 2m & 1.5m – The section assessed was 158m in length, with 10 crossovers (for 12 dwellings), and a tree frequency of 1 per 8.3m (1 tree per 216m²) (Species not consistent) - **Unsatisfactory as built outcome.**
Access Street Level 1 – Ocean Way	– Total reserve width: 16m – Road pavement width: 7.3m – Nature strip: 2.85m & 2.85m – Footpath: 1.5m	– Total reserve width: 15.3m – Road pavement width: 7.5m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 1.5m – Services both sides under verge – Landscape drawings specify (31) Coastal Banksia at a density of 1 per 6.3m (1 tree per 100.5m²) – **Unsatisfactory design outcome because of species selection**	– Total reserve width: 16m – Road pavement width: 8m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 1.5m – The section assessed was 195m in length, with 22 crossovers (for 24 dwellings), and a tree frequency of 1 per 6.5m (1 tree per 104m²) – **Unsatisfactory as built outcome because of species selection**



Access Street Level 1 as per the PSP.
Image by Growth Area Authority

Adverse outcomes within the case study area where multiple crossovers had been merged (but not consolidated in size).
Image by Google Street

OTHER OBSERVATIONS

The general health of nature strips throughout is good – with some sporadic areas of dry grass (i.e. Delta Drive), and verges that have been gravelled over.

While the streets assessed had dual crossovers servicing two dwellings at a narrower width that two separate crossovers, there were outcomes elsewhere in the case study area where double driveways and front door access were merged into one large crossover (as per image below) significantly reducing available areas for canopy tree provision.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 2.5%. Slow growth exists between 2018 and 2021 resulting in a 2021 canopy cover of approximately 4%.

Projected canopy cover based on species selection in case study streets is 25% in Highlander Drive and 21% in Ocean Way, noting species replacement of Apple Myrtles for Spotted Gums in Highlander Drive (these have similar canopy covers).

Species selection in streets such as Ocean Way and poor urban design outcomes have restricted potential canopy cover. Highlander Drive could support intensification or reinvestment in canopy tree cover. Overall there are significant gaps between landscape plans and as built outcomes.

The analysis indicates that the case study area will not meet the proposed PSP Guidelines 30% target even with best practice ongoing tree management. The lower density of planting in major roads and specification of smaller tree species in access streets indicate the target is unachievable in this location.

DESCRIPTION

Location

Taylors HIll West / Fraser Rise, 3335 | City of Melton

Case Study Details

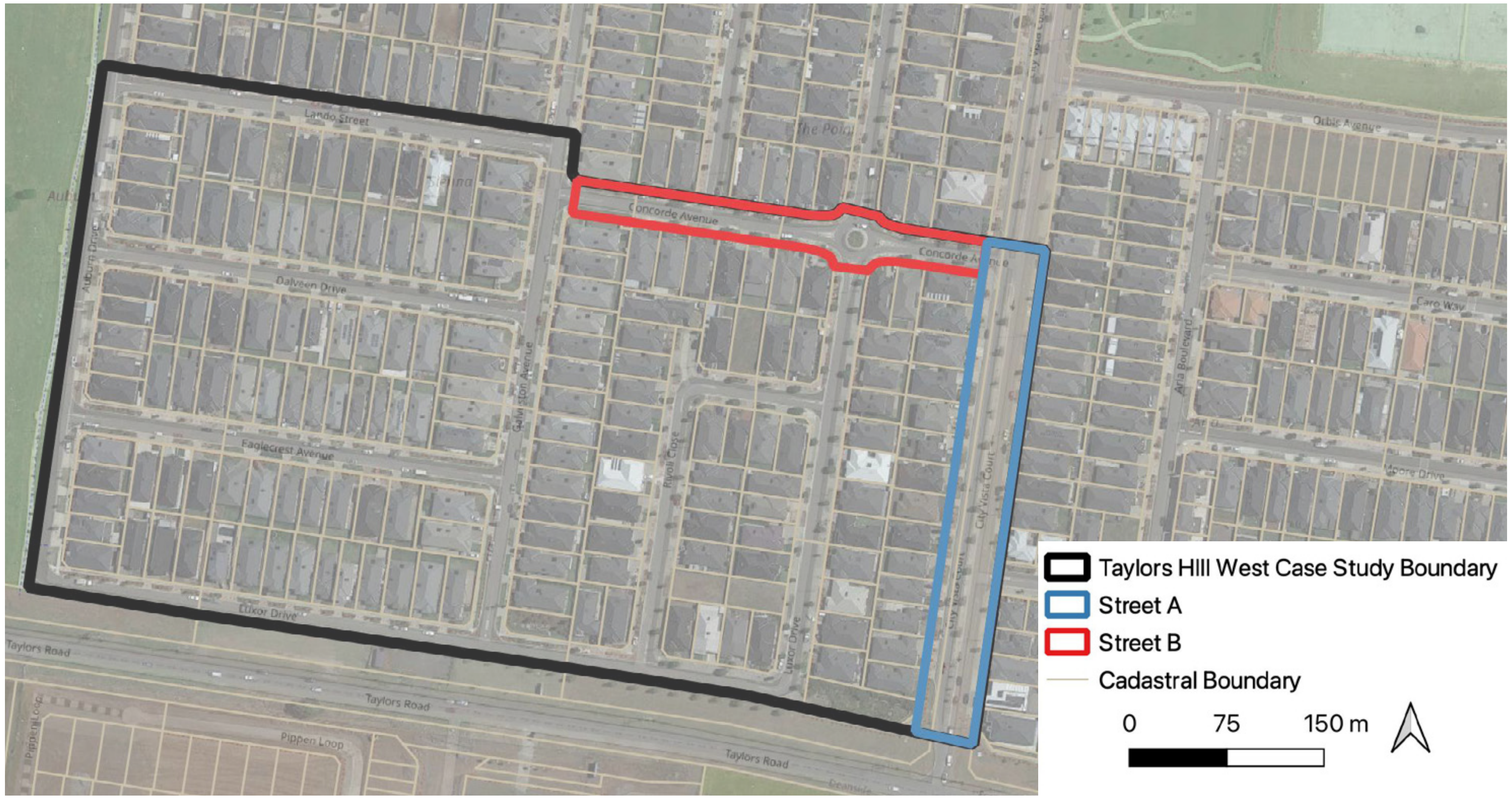
Size: 11.1ha | Private land: 7.3ha
Private lots: 176 | Average lot size: 414.8 m²

Overview

The case study area is within the Taylors Hill West PSP, gazetted 28/10/2010.

Street A: City Vista Court is a North-south connector with median.

Street : Concorde Avenue is a Local Road.



Despite the central median strip on City Vista Court planting was not maximised. Image by Google Street.

VEGETATION CHARACTERISTICS

Vegetation age varies from 2013 to 2017 (east developed first)

Street A: City Vista Court - Corymbia maculata (Spotted gum), 11m mature canopy width (currently 1.5 - 4m).

Street B: Concorde Ave - Ulmus parvifolia (Chinese Elm), 11m mature canopy width (currently 1.5m- 4m).

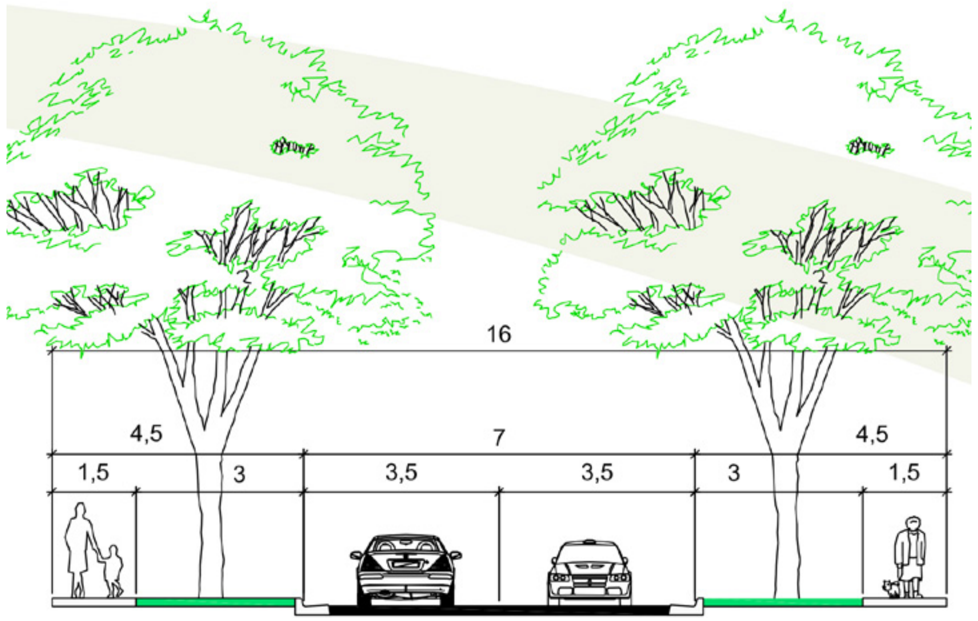
Environmental Conditions

Soil type - Basalt Plains.

The annual mean rainfall for the area is 483.5mm (Station: Burnside). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

TAYLORS HILL WEST PRECINCT STRUCTURE PLAN: Gladstone Avenue, Fraser Rise

	PSP	COUNCIL	AS BUILT
North-south connector with median – City Vista Court	– Total reserve width: 28m – Road pavement width: 15m – Nature strip: 3.5m & 3.5m – Footpath: 1.5m & 1.5m – Other: 3m median strip	No Council drawings were made available by Melton Shire during the project period.	– Total reserve width: 28m – Road pavement width: 15m (inc bicycle lanes) – Nature strip: 3m & 3m – Footpath: 2m & 2m – Other: 3m median strip – The section assessed was 237m in length, with 22 crossovers (for 31 dwellings), and a tree frequency of 1 per 7.9m (1 tree per 221m²) – **Unsatisfactory as built outcome.**
Local Road – Concorde Avenue	– Total reserve width: 16m – Road pavement width: 7m – Nature strip: 3m & 3m – Footpath: 1.5m & 1.5m	No Council drawings were made available by Melton Shire during the project period.	– Total reserve width: 16m – Road pavement width: 8m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 1.5m – The section assessed was 200m in length, with 13 crossovers (for 17 dwellings), and a tree frequency of 1 per 13.3m (1 tree per 213m²) – **Unsatisfactory as built outcome.**



Specifications and cross-section of the Local Road as per the PSP. Image by Growth Areas Authority


As built outcome of a local road (Concorde Avenue). Image by Google Street

OTHER OBSERVATIONS

City Vista Court and Concorde Avenue had numerous consolidated dual-crossovers, which in theory allow for more canopy tree plantings. Tree frequency may be slightly higher than calculated, as the aerial photography showed the development mid-construction, with some nature strips un-planted at the time.

Nature strip health was poor, with compaction, obviously dry, un-planted and gravelled areas, in particular Concorde Avenue had particularly low tree planting frequency.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 3%.

Slow growth took place between 2018 and 2021 resulting in a 2021 canopy cover of approximately 4 - 5%.

Projected canopy cover based on species selection in case study streets is 25% in Concorde Ave and 24% in City Vista Court based on good environmental conditions. Concorde Ave in particular had very low tree planting density. Soil compaction, lower rainfall and poor soils are likely to compound the problem over time, resulting in outcomes which are even lower. Further investment in canopy tree cover is required and remedial management to ensure that existing trees meet project canopy cover.

The projected canopy cover indicates that the case study area will definitely not meet the proposed PSP Guidelines 30% target even with good ongoing tree management. The lower density of planting and the challenging soil and lower rainfall indicates the target is unachievable in this location without extensive reinvestment in street trees.

DESCRIPTION

Location

Kalkallo, 3064 | Mitchell Shire Council, Hume City Council & Whittlesea City Council

Case Study Details

Size: 11.5ha | Private land: 6.8ha
Private lots: 148 | Average lot size: 460 m²

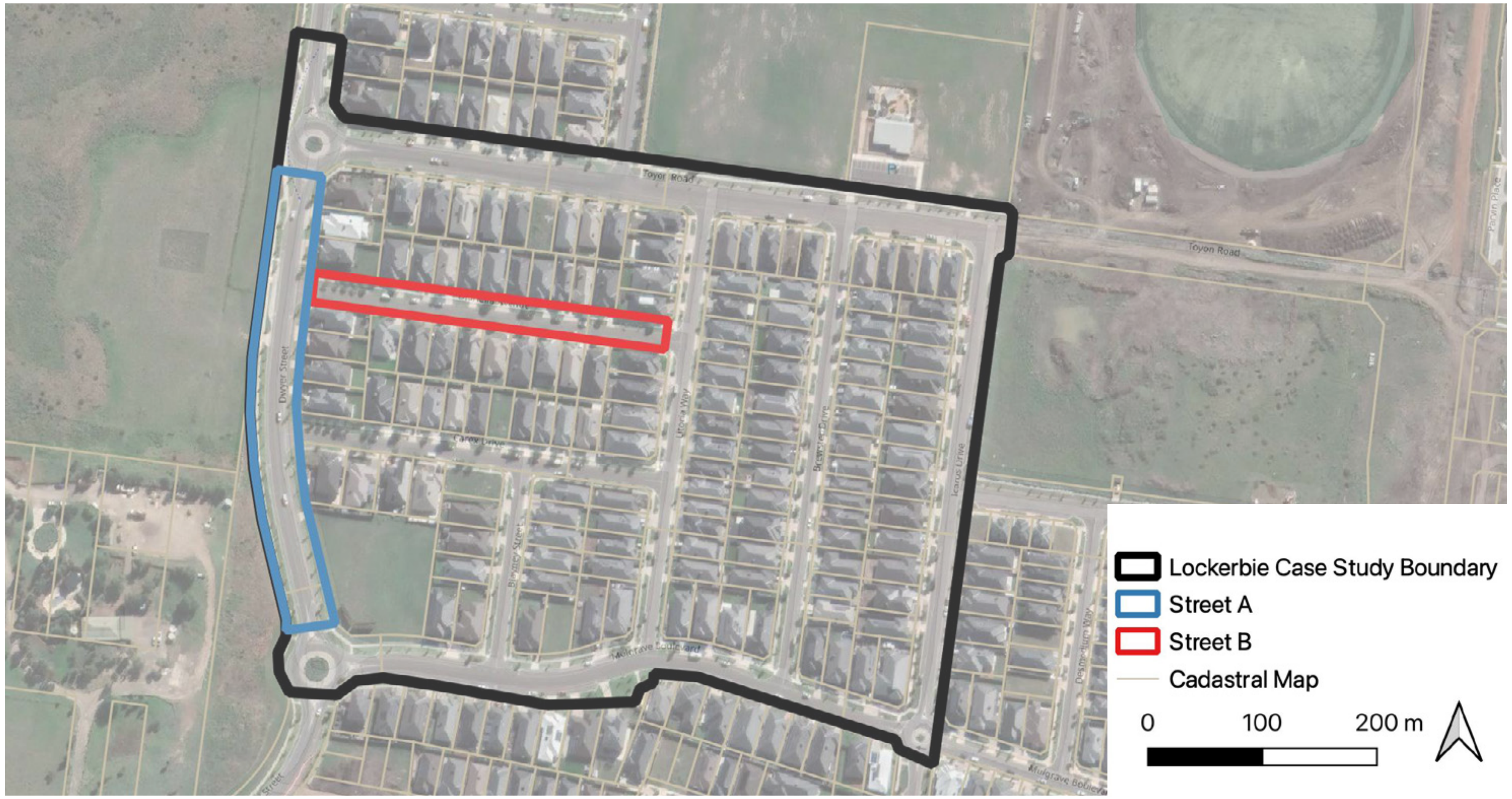
Overview

The case study area is within the Lockerbie PSP, gazetted 28/06/2012.

Street A: Dwyer Street is a Connector Street.

Street B: Dianella Avenue was found to be closest to an Access Street Level 2 (however 4m narrower).

Typical streetscape vegetation within the subject area, note significant missed street tree opportunity on left
Image by Google Street



VEGETATION CHARACTERISTICS

Vegetation age varies from 2015 to 2017

Street A: Dwyer St - Quercus lucitinica (Portugese Oak), 12m mature canopy width (currently 2 - 4m).

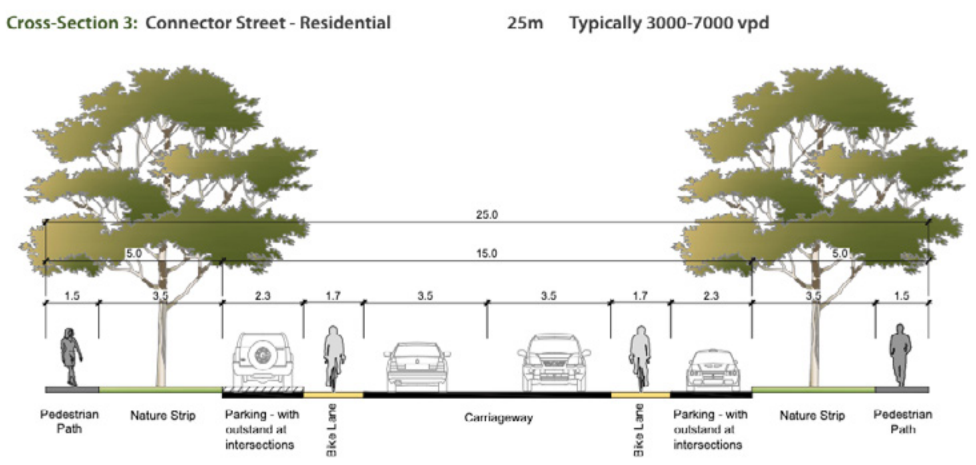
Street B: Dianella Ave - Melia azedarach (White cedar), 7m mature canopy width (currently 2m- 4m).

Environmental Conditions

Soil type - Basalt Plains.

The annual mean rainfall for the area is 648.4mm (Station: Epping). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

	PSP	COUNCIL	AS BUILT
Connector Street – Dwyer Street	– Total reserve width: 25m – Road pavement width: 15m – Nature strip: 3.5m & 3.5m – Footpath: 1.5m & 1.5m	– Total reserve width: 25m – Road pavement width: 7m – Nature strip: 3m & 3m – Footpath: 1.5m & 1.5m – Service location unknown – 16 trees on east side nature strip (tree density not evident on mapping provided)	– Total reserve width: 25m – Road pavement width: 13m (with bicycle paths) – Nature strip: 2.5m & 2.5m & 3.5m – Footpath: 2m & 1.5m – The section assessed was 248m in length, with 7 crossovers (for 8 dwellings), and a tree frequency of 1 per 6.5m (16 on east side) (1 tree per 163m²)– **Satisfactory as built outcome.**
Access Street Level 2 – Dianella Avenue	– Total reserve width: 20m – Road pavement width: 8.6m – Nature strip: 3.2m & 3.2m – Footpath: 1.5m & 1.5m Note: There was no specification for a 'smaller' street typology.	– Total reserve width: 16m – Road pavement width: 7m – Nature strip: 3m & 3m – Footpath: 1.5m & 1.5m – Service location unknown – 39 trees, for a tree frequency of 1 per 4.95m (1 tree per 79m²)– **Satisfactory design outcome.**	– Total reserve width: 16m – Road pavement width: 7m – Nature strip: 3m & 3m – Footpath: 1.5m & 1.5m – The section assessed was 193m in length, with 17 crossovers for 19 dwellings, and 29 trees, for tree frequency of 1 per 6.65m (1 tree per 106.5m²)– **Unsatisfactory as built outcome due to species selection and inconsistency with plans.**



Example of a connector street (Dwyer Street) as per the PSP.
Image by Growth Areas Authority

A view along Dwyer Street (as-built), note sign on right precluding opportunity for additional canopy tree.
Image by Google Street

OTHER OBSERVATIONS

The tree frequency along Dwyer Street is approximate due to varying provision on aerial imagery and Google Street – in addition to an area where 3 street trees were removed for the provision of a bus stop. While the PSP specified parking on both sides, Dwyer only had parking on the east-side where development had occurred.

Significantly fewer trees were delivered on Dianella Ave than specified, indicating either tree loss or there were practical constraints to implementing the landscape plan.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 4%. Positive growth took place between 2018 and 2021 resulting in a 2021 canopy cover of approximately 6 - 7%.

Projected canopy cover based on species selection in case study streets is 39% in Dwyer St and 27% in Dianella Ave.

Our assessment indicates that the projected canopy cover may be reached if the gap between the number of trees specified and those planted is addressed. Without reinvestment in tree planting the 30% is unlikely to be reached (noting the projected canopy cover noted is based on design potential rather than the actual outcome delivered).

EPPING NORTH EAST PRECINCT STRUCTURE PLAN: Elloura Avenue, Wollert

DESCRIPTION

Location

Wollert, 3750 | City of Whittlesea

Case Study Details

Size: 6.8ha | Private land: 4.4ha
Private lots: 101 | Average lot size: 436 m²

Overview

The subject site is within the Epping North East PSP, gazetted 26/06/2008.

Street A: Joyfields Place is a Typical Access Street.

Street B: Allumba Way is unclassified in the PSP.

Typical streetscape vegetation along Elloura Avenue (a Key Local Road). Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age varies from 2010 to 2012.

Street A: Joyfields Pl - Corymbia citriodora (Lemon-scented Gum), 8m mature canopy width, noting dwarf variety specified in landscape drawings (otherwise 12m) (currently 3 - 6m).

Street B: Allumba Way - Eucalyptus sideroxylon (Ironbark), 10m mature canopy width (currently 3m- 5m).

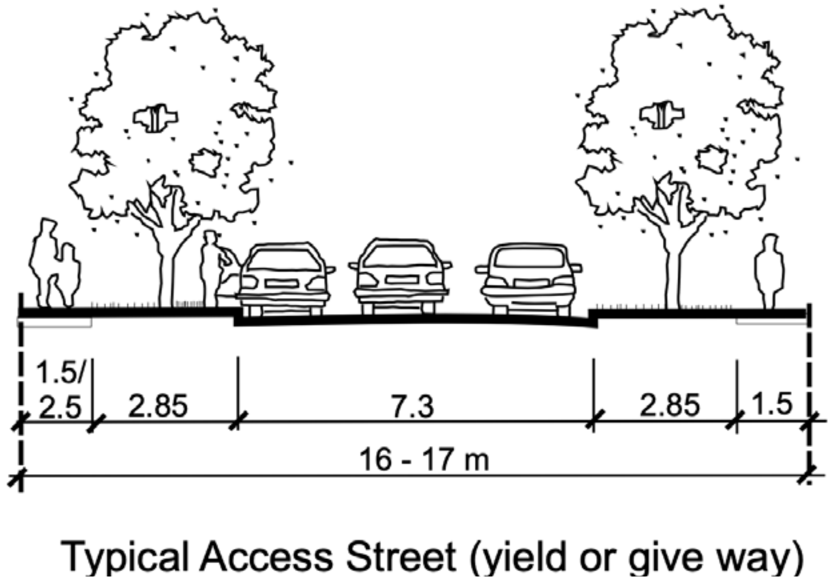
Environmental Conditions

Soil type - Basalt Plains.

The average annual rainfall is 648.4mm (Station: Epping). There appeared to be no passive irrigation integrated within the streetscape.

EPPING NORTH EAST PRECINCT STRUCTURE PLAN: Elloura Avenue, Wollert

	PSP	COUNCIL	AS BUILT
Typical Access Street – Joyfields Place	– Total reserve width: 16-17m – Road pavement width: 7.3m – Nature strip: 2.85m & 2.85m – Footpath: 1.5-2.5m & 1.5m	– Total reserve width: 16m – Road pavement width: 7.5m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 2m – 28 trees specified on landscape plan at tree frequency of 1 per 8.2m (1 tree per 131m²) – **Unsatisfactory design outcome.** – Underground servicing predominantly on west side of street - also shown on landscape drawings	– Total reserve width: 16m – Road pavement width: 7.5m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 2m – The section assessed was 230m in length, with 26 crossovers for 25 dwellings (and two laneway crossovers for the rear-loaded lots), with a tree frequency of 1 per 9.5m (1 tree per 153m²) – **Unsatisfactory as built outcome.**
– Allumba Way	– No applicable specification for this street, the closest is as per above.	– Total reserve width: 13.5m – Road pavement width: 5.5m – Nature strip: 4.8-5m & 1.8-2m – Footpath: 1.5m – 30 trees specified on landscape plan at tree frequency of 1 per 15m (1 tree per 202.5m²) – **Unsatisfactory as built outcome.** – Underground servicing predominantly on west side of street - also shown on landscape drawings	– Total reserve width: 13.5m – Road pavement width: 5.5m – Nature strip: 4.8-5m & 1.8-2m – Footpath: 1.5m – The section assessed was 450m in length, with 16 crossovers for 16 dwellings (and 18 rear-loaded dwellings), with a tree frequency of 1 per 18.75m (noting south-east side of street excluded) (1 tree per 253m²) – **Unsatisfactory as built outcome.**



A Typical Access Street as per the Epping North PSP. Image by City of Whittlesea

When two crossovers are co-located but not consolidated they consume valuable nature strip space for potential canopy cover. Image by Google Street

OTHER OBSERVATIONS

There was minimal provision of co-located crossovers with lost opportunity for additional street trees – including two full width crossovers side-by-side (11m total) to service neighbouring properties. One property in particular (10 Joyfields Place) had two crossovers, and there were various verges that had died off and/or been replaced with gravel.

While the rear-loaded townhouses reduced the need for crossovers along Allumba Way, there was a missed opportunity for more intensive street tree planting.

The health of the grass nature strips throughout was unpredictable with some areas of drying out and Allumba Way was not fully planted on the north side.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 10.5%. Slow growth took place between 2018 and 2021 resulting in a 2021 canopy cover of approximately 12%.

Projected canopy cover based on species selection in case study streets is 22% in both.

The projected canopy cover calculation in the case study area will not meet the proposed PSP Guidelines 30% target even with good ongoing tree management. The lower density of planting and specification of smaller tree species indicate the target is unachievable in this location despite healthy existing canopy coverage.

TRUGANINA PRECINCT STRUCTURE PLAN: Truganina

DESCRIPTION

Location

Truganina, 3029 | City of Wyndham

Case Study Details

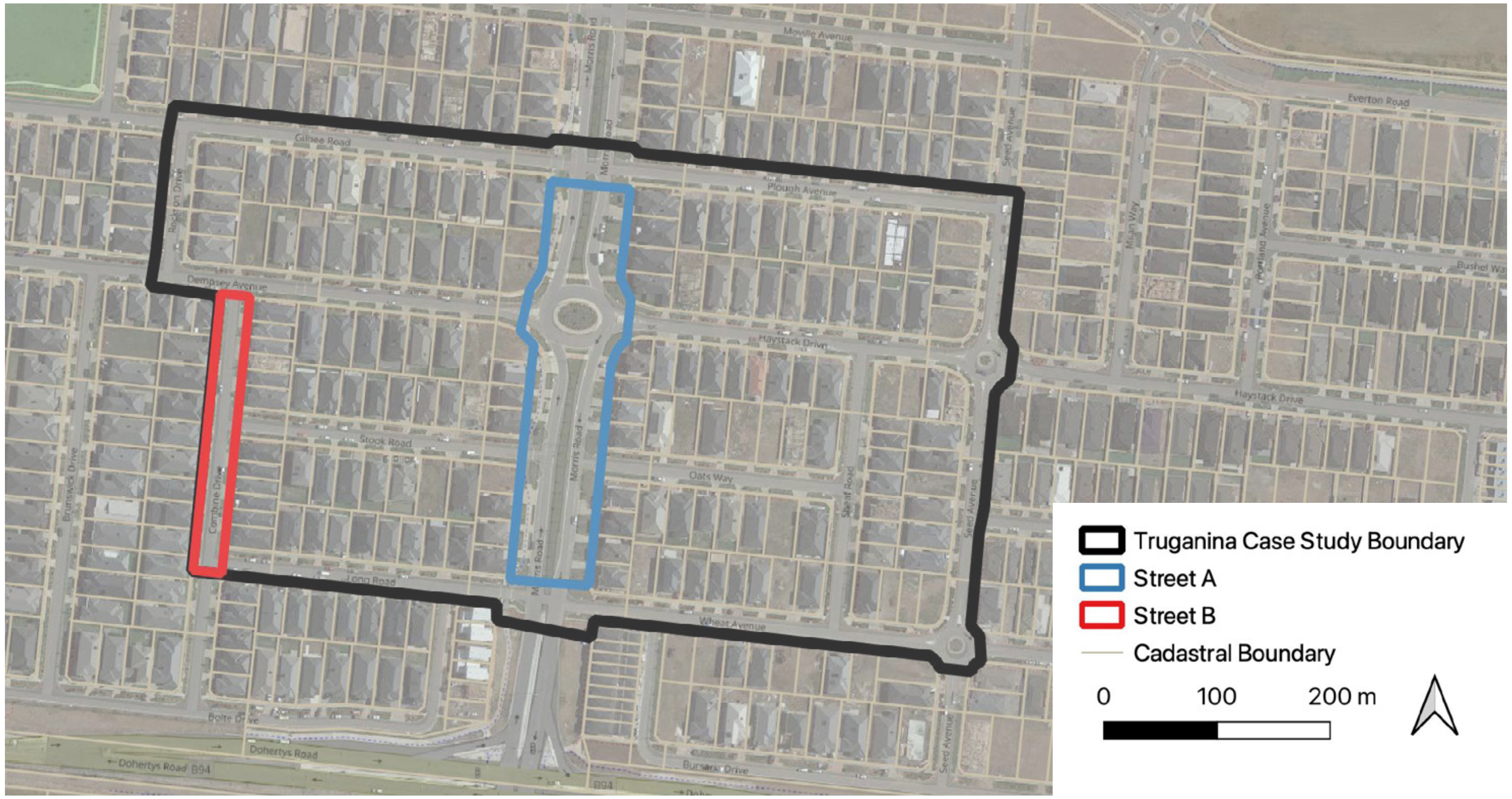
Size: 10.6ha | Private land: 6.3ha
Private lots: 167 | Average lot size: 377.2 m²

Overview

The case study area is located within the Truganina PSP, gazetted 13/11/2014.

Street A: Morris Road is a Secondary Arterial Street.

Street B: Combine Drive is a Local Access Level 1 street.



Typical streetscape vegetation within the subject area.
Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age varies from 2016 to 2017.

Street A: Morris Rd - Corymbia maculata (Spotted gum), 11m mature canopy width (currently 2m- 4m).

Street B: Combine Dr - Quercus robur (English Oak), 12m mature canopy width, (currently 2m - 4m).

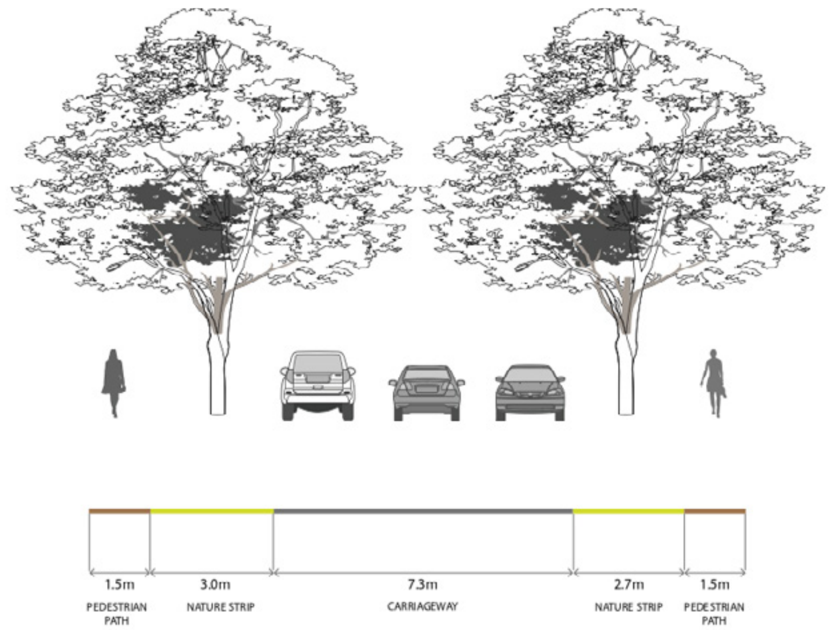
Environmental Conditions

Soil type - Basalt Plains.

The average annual rainfall is 533mm (Station: Laverton RAAF). There appeared to be no passive irrigation integrated within the streetscape.

TRUGANINA PRECINCT STRUCTURE PLAN: Truganina

	PSP	COUNCIL	AS BUILT
Secondary Arterial – Morris Road	– Total reserve width: 39.5mRoad pavement width: 6.5m & 6.5m – Nature strip: 5.3m & 5.3m + 9.2m median strip – Footpath: 1.5m & 1.5m + bicycle path 3m (x2)	– Total reserve width: 41.8m – Road pavement width: 7m & 7m – Nature strip: Varied + 7-8.5m median strip – Footpath: 1.5m & 1.5m – Other: 3m shared path on west – Varied servicing arrangements (both east and west) – 46 trees, for a tree frequency of 1 per 4.5m (1 tree per 182m²)– **Unsatisfactory design outcome.**	– Total reserve width: 39.5-41m – Road pavement width: 7m & 7m – Nature strip: 5m & 7.5m + 7-8.5m median strip – Footpath: 1.5m & 1.5m – Other: 3m shared path – The section assessed was 210m in length, with 17 crossovers for 22 dwellings (with numerous dual-crossovers), and a tree frequency of 1 per 5.25m (1 tree per 210m²) – **Unsatisfactory as built outcome.**
Local Access Level 1 – Combine Drive	– Total reserve width: 16m – Road pavement width: 7.3m – Nature strip: 3m & 2.7m – Footpath: 1.5m & 1.5m	– Total reserve width: 16m – Road pavement width: 7.5m – Nature strip: 2.7m & 2.7m – Footpath: 1.5m & 1.5m – Other: 3m shared path on west – Varied servicing arrangements (both east and west) – 14 trees, for a tree frequency of 1 per 10.3m (1 tree per 165m²)– **Satisfactory design outcome.**	– Total reserve width: 16m – Road pavement width: 8m – Nature strip: 2.5m & 2.5m – Footpath: 1.5m & 1.5m – The section assessed was 145m in length, with 14 crossovers for 21 dwellings, and a tree frequency of 1 per 6.6m (1 tree per 105.5m²) – **Satisfactory as built outcome.**



Local Access Street - Level 1.

Excessive hardscaped areas along Morris Road.
Image by Google Street

OTHER OBSERVATIONS

Despite the reasonable tree frequency evident along Morris Road, the dual provision of a footpath and shared path within the nature strip replaced valuable tree provision space with concrete (as per image below). While Morris Rd matched most of the PSP specifications, it only contained one 3m two-way bicycle path.

Combine Drive had a total of 22 trees, however 15 of these were on the western side, indicating a sporadic and uneven distribution throughout the streetscape.

Nature strip health was generally good, and plants were neatly mulched and protected where needed.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 1%, representative of only 1 - 2 years of growth.

Good growth took place between 2018 and 2021 resulting in a 2021 canopy cover of approximately 3 - 4%.

Projected canopy cover based on species selection in case study streets is 38% in Combine Dr and 25% in Morris Rd.

Despite very low existing canopy cover due to recent establishment, the species selection and spacing indicates that in the fullness of time the case study area will potentially meet the PSP Guidelines 30% canopy tree cover target if the trees grow to their full potential.

ESTABLISHED AREA EXAMPLE: West Footscray

DESCRIPTION

Location

West Footscray, 3012 | City of Maribyrnong

Case Study Details

Size: 12.6ha | Private land + Open Space: 9ha
Private lots: 233 | Average lot size: 386.2 m²

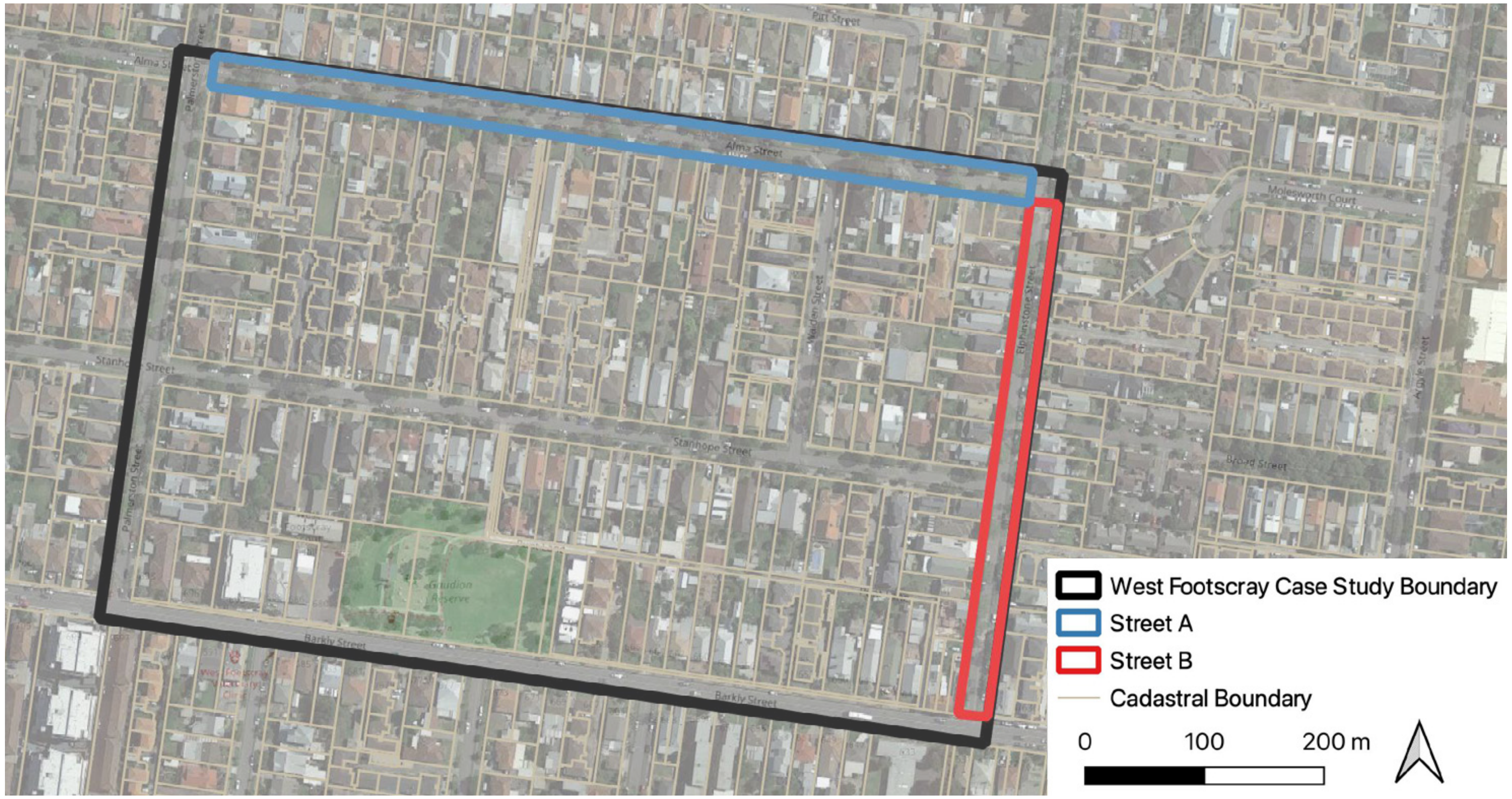
Overview

The case study is within an established area of West Footscray, with a mix of single storey residential and unit developments.

Street A: Alma Street is a Local Access Street (equivalent).

Street B: Elphinstone Street is a Connector Street (equivalent).

Typical streetscape vegetation within the subject area.
Image by Google Street



VEGETATION CHARACTERISTICS

Vegetation age is undetermined.

Street A: Alma St - Melaleuca styphelioides (Prickly-leaved Paperbark). (currently mature at 7m)

Street B: Elphingstone St - Melia azedarach (White cedar) (currently mature at 7 - 9m)

Environmental Conditions

Soil type - Basalt Plains.

The annual mean rainfall for the area is 589.6mm (Station: Flemington Racecourse). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

ESTABLISHED AREA EXAMPLE: West Footscray

Canopy potential has been reduced due to overhead power lines.
Image by Google Street

AS BUILT	
Street A – Alma Street (Local Street)	– Total reserve width: 15m – Road pavement width: 8m – Nature strip: 1.5-2m & 1.5-2m – Footpath: 1.5m & 1.5m – The section assessed was 408m in length, with 41 crossovers for 86 dwellings (with 9 dual-crossovers and a number of unit developments), and a tree frequency of approx. 1 per 8.16m (1 tree per 122m²).
Street B – Elphinstone Street (Connector Street)	– Total reserve width: 15.5m – Road pavement width: 8m – Nature strip: 1.5m & 3m – Footpath: 1.5m & 1.5m – The section assessed was 255m in length, with 24 crossovers for 55 dwellings (with a number of unit developments), and a tree frequency of approx. 1 per 5.9m (1 tree per 92m²).

An example of consolidated dual-crossovers within the case study area.
Image by Google Street

An example where consolidation hasn't occurred, resulting in less space for canopy plantings.
Image by Google Street

OTHER OBSERVATIONS

While the case study area performs well in terms of canopy provision, there were still a number of instances where crossovers were not consolidated (as per image below), or nature strip health was struggling.

There were however other example where nature strips had been planted-out to support ground cover and shrubs around trees – something that was not evident in the newer growth-area examples.

Power lines were evident above ground and Dial before you dig indicated most services were located under road pavement rather than under landscape strip.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 40%. No discernable growth took place between 2018 and 2021 resulting in a 2021 canopy cover of approximately 40%.

Full projected canopy cover has likely been reached already for this location, although limited further growth may occur. Comparing with growth area communities, the key differences appear to be related to growing conditions (potentially a combination of less conflict with underground servicing and reduced compaction and other disturbance during construction). Both of these factors can be improved in growth area communities.

The location has already significantly exceeded the proposed canopy cover target of PSP Guidelines 30% indicating that although a constraint, underlying soil types and slightly lower rainfall can be overcome to deliver a very positive canopy cover outcome.

ESTABLISHED AREA EXAMPLE: Malvern East

DESCRIPTION

Location

Malvern East, 3145 | City of Stonnington

Case Study Details

Size: 11.4ha | Private land: 7.5ha
Private lots: 129 | Average lot size: 581.4 m²

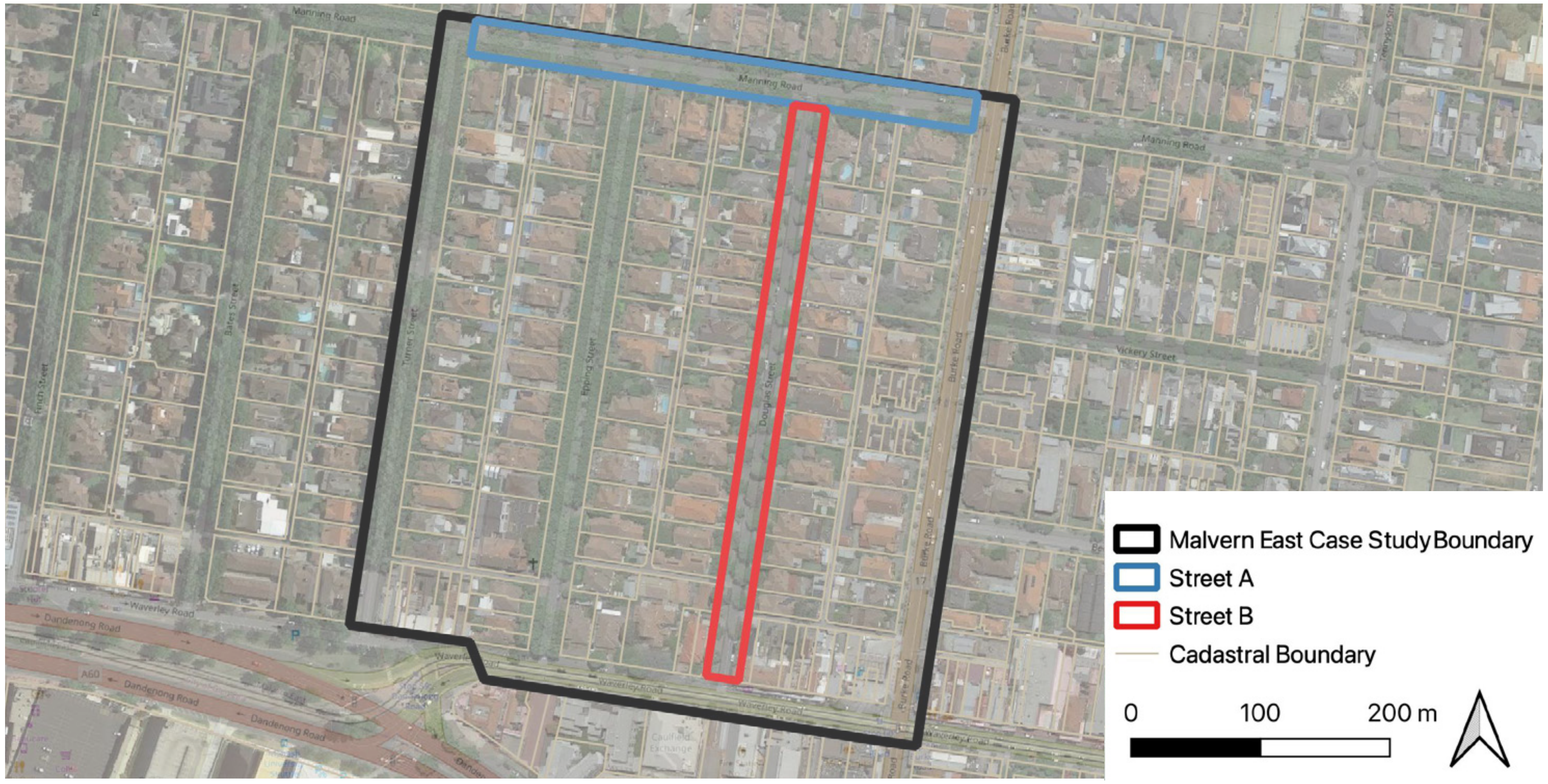
Overview

An established middle-suburb approximately 13km south-east of Melbourne's CBD – established at the turn of the twentieth century with the first post-office opening in 1914.

Street A: Manning Road is a local connector (equivalent)

Street B: Douglas Street is a local access street (equivalent).

Typical streetscape vegetation within the subject area.
Image by Google Street



VEGETATION CHARACTERISTICS

Vegetation age is undetermined.

Street A: Manning Rd - Platanus x acerifolia (London Plane). (currently mature at up to 15m)

Street B: Douglas St - Lophostemon confertus (Queensland Brush Box) and Quercus palustrias (Pin Oak) (currently mature at 7 - 10m)

Environmental Conditions

Soil type - Tertiary Sands.

The annual mean rainfall for the area is 720.7mm (Station: Caulfield Racecourse). Within the subject site there appeared to be no provision of WSUD features to support passive irrigation.

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ESTABLISHED AREA EXAMPLE: Malvern East

Canopy diameter within the case study area reaches 15+m.
Image by Google Street

AS BUILT	
Street A – Manning Road	– Total reserve width: 20m – Road pavement width: 10m – Nature strip: 3.5m & 3.5m – Footpath: 1.5m & 1.5m – The section assessed was 280m in length, with 17 crossovers for 21 dwellings (many serviced by rear lanes), and a tree frequency of approx. 1 per 7.3m (1 tree per 147m²).
Street B – Douglas Street	– Total reserve width: 18m – Road pavement width: 8m – Nature strip: 3.5m & 3.5m – Footpath: 1.5m & 1.5m – The section assessed was 320m in length, with 29 crossovers for 29 dwellings, and a tree frequency of approx. 1 per 7.8m (1 tree per 140m²).

OTHER OBSERVATIONS

Unlike Footscray West which had a number of consolidated dual-crossovers, these case study streets appeared to benefit from larger lots, and rear lane access and/or the initial non-provision of driveways, which resulted in larger areas of non-interrupted nature strips.

Nature strip health was consistently good throughout – with a number of new tree plantings mixed in-between the established canopy.

From the aerial view, there was also a higher provision of private lot canopy vegetation, which would be unattainable with the smaller lots provided in growth areas (with dwellings built to boundary and reduced front setbacks).

Larger lots and less crossovers (with rear lane servicing) has allowed larger tree canopies to establish.
Image by Google Street

An example of non-consolidated dual-crossovers, resulting in less space for canopy tree plantings.
Image by Google Street

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover is 60%. No discernable growth took place between 2018 and 2021 resulting in a 2021, maintaining canopy cover of approximately 60%. Projected canopy cover has likely been reached already for this location.

Species selection is varied and is supported by higher levels of rainfall and good underlying soil conditions. We note that London Plane Trees are no longer recommended due to reduced adaptability to climate change.

This location is the benchmark for canopy tree cover in Melbourne, indicating the potential outcomes which are achievable over time with the right conditions. Reduced servicing conflicts underground may have assisted growth as have reduced number of crossovers allowing for uninterupted landscape verges.

ESTABLISHED AREA EXAMPLE: Fitzroy

DESCRIPTION

Location

Fitzroy, 3065 | City of Yarra

Case Study Details

Size: 5ha | Private land: 2.6ha
Private lots: 124 | Average lot size: 209.6 m²

Overview

An established inner-suburb approximately 3km north-east of Melbourne's CBD – crowned Melbourne's first suburb, Fitzroy was established in 1858[1].

Street A: Westgarth Street is a local access street (equivalent).

Street B: Rose Street is also a local access street (equivalent).

Typical streetscape vegetation within the subject area.
Image by Google Street

VEGETATION CHARACTERISTICS

Vegetation age is undetermined.

Street A: Westgarth St - Platanus x acerifolia (London Plane). (currently mature at up to 15m)

Street B: Rose St - Pyrus calleryana (Callery's Pear) (currently approximately 2m – mature at up to 8m, assume 6m in this location)

Environmental Conditions

Soil type - Silurian sand.

The annual mean rainfall for the area is 659.5 mm (Station: Melbourne Botanical Gardens). Within the subject site there appeared to be moderate application of WSUD in the form of exposed areas around trees to allow pavement run-off and passive irrigation.

1. The Fitzroy History Society (2021) History of Fitzroy

ESTABLISHED AREA EXAMPLE: Fitzroy

WSUD features in the form of exposed planting areas for passive irrigation. Image by Google Street

Narrow streets such as Rose Street, where car parking is still allowed on both sides, had new plantings cut out into the road pavement.
Image by Google Street

AS BUILT	
Street A – Westgarth Street	– Total reserve width: 20m – Road pavement width: 14m – Nature strip: 0m – Footpath: 3.5m & 3.5m – The section assessed was 230m in length, with 9 crossovers for 20 dwellings (many serviced by rear lanes), and a tree frequency of approx. 1 per 10.4m (1 tree per 209m²).
Street B – Rose Street	– Total reserve width: 10m – Road pavement width: 7.6m – Nature strip: 0m – Footpath: 1.2m & 1.2m – The section assessed was 230m in length, with 15 crossovers for 20 dwellings (many apartments), and a tree frequency of approx. 1 per 28.75m (1 tree per 287.5m²).

Most lots have no on-site parking or were serviced by rear lanes, with only a handful of crossovers within the study area.
Image by Google Street

OTHER OBSERVATIONS

The case study areas has a mix of attached terrace-style housing and converted warehouse apartments, resulting in generally fewer crossovers, with rear-access lots or basement car parking.

The consolidated urban form is evident with the absence of consistent nature strips (occasional plantings near roundabouts), with mature trees located within the road reserve (as evident left).

The vegetation on Rose Street was relatively immature and presenting very little canopy cover, while the vegetation along Westgarth, while not presenting as high tree frequency as Malvern East or Footscray West, exhibited exceptional cover due to mature canopy growth.

CASE STUDY SUMMARY

Based on point sampling of 2018 imagery the actual canopy cover within the study area is 61.5%. No discernible growth took place between 2018 and 2021 resulting in a 2021, maintaining canopy cover of approximately 62%. Projected canopy cover has likely been reached already for this location, with the exception of Rose St.

Species selection is predominantly Plane Trees and is supported by higher levels of rainfall and good underlying soil conditions. We note that London Plane Trees are no longer recommended due to reduced adaptability to climate change.

This location is amongst the higher canopy tree cover in Melbourne, indicating that with species selections with larger canopies exceptional outcomes can be delivered. Reduced servicing conflicts underground may have assisted growth, a number of services seem to be located under footpath or in the middle of the streets (therefore avoiding conflicts with trees).

Findings Summary

This section of the report summarises key findings. The findings are structured according to the relevant development stages as per the Overview table on p. 6 of this report. Each stage of development has critical success factors, barriers and potential solutions.

The analysis found that the ability to deliver a good canopy tree cover outcome is dependent on a range of design, construction and occupancy phase factors. Design factors contribute to the potential canopy tree coverage outcome dictated by factors such as space allocation, tree planting frequency and density and species selection. Construction factors can limit the ability for projected tree canopy to be reached by compomising growing conditions and the occupancy stage recognises that ongoing management is essential to reach successful projected mature canopy size.

PRECINCT STRUCTURE PLANNING

Our analysis highlighted key regulatory influences as Precinct Structure Plans and stakeholders involved in this phase as the VPA, developers, VicRoads and Councils.

The analysis of the PSP's indicated that for the most part, the PSP's provided limited direction beyond cross sections that has a bearing on canopy tree cover outcomes. Only the Cranbourne East PSP had any detailed species guidance (which was followed), but did not dictate planting frequency / density or canopy tree coverage targets. Generally speaking the PSP's followed the cross section guidance contained in the PSP's, with the exception of Cardinia Road PSP, where some planning was completed prior to the PSP being developed for the wider precinct.

The analysis also noted the VicRoads Tree Policy as a constraint (barrier protection or a principles based alternative is required when road speeds are above 70km/h, restricting the ability for higher canopy tree coverage outcomes to be achieved on arterial roads). Further work is required to develop safe, cost effective, median canopy tree planting solutions for this road classification.

The case studies demonstrate a wide range of outcomes are being delivered through PSP processes and that the cross sections are insufficient on their own to deliver positive canopy tree coverage outcomes. Additional guidance within PSP's is required to ensure that outcomes are consistently positive (canopy cover targets, planting frequency, species selection, passive irrigation guidance etc.).

The analysis found that the canopy tree coverage target proposed in the updated Guidelines is appropriate, but the flexibility to adopt a different canopy tree coverage target (higher or lower) based on local conditions will ensure that the targets developed through PSP processes are site responsive.

Separate targets for road reserves and other open space will improve accountability in future development stages. This is because depending on the programming of public open space (active / passive etc.) significantly different canopy tree coverage outcomes will be sought.

Whilst analysis at the subdivision and detailed design stage of projected canopy tree cover within road reserves is able to demonstrate consistency fairly with a target, analysis on public open space should be demonstrated at the PSP scale to account for the differing roles and functions of open space (active open space has much lower canopy coverage than passive open space).

Our analysis recommends that the term 'potential canopy cover' in Target 13 be replaced with the term projected canopy cover, recognising that in most circumstances the potential or optimal canopy cover (the term used in this report) exceeds the practically achieved outcome.

The additional target to use stormwater to support canopy trees is strongly supported by analysis, however we do note that during establishment phases and extended periods of lower than average rainfall that passive irrigation alone will not be sufficient to ensure canopy tree health.

The PSP Guidelines will need to be supported by further guidance (in the form of Guidance note) to clarify methods of calculating projected canopy cover and provide accountability for future stages against the PSP targets. PSP Guidance Notes such as the proposed Movement and Place can also support improved urban design objectives and principles to improve outcomes in subsequent stages.

Subject to further stakeholder consultation unable to take place within this project timeframe, the recommended guidance notes could also address a number of other barriers highlighted within this report. The case study analysis and the review of literature and relevant studies all highlighted the need for future development stages to support targets set through the PSP stage.

SUBDIVISION PLANNING

Within the subdivision stage, outcomes for canopy trees have in many cases been ‘let down’ by urban design layouts which simply do not support the space requirements of a medium to large canopy tree, due to constraints relating to vehicle access (cross overs) to private lots and reducing frontage widths in response to higher density targets. The subdivision planning stage locks in several aspects related to planting frequency or density, in particular road pavement widths, verge widths, lot frontage widths and sometimes cross over location. Given landscape plans are often submitted as a condition on permit this can limit tree planting opportunities during the detailed design stage.

The analysis of the subdivision planning stage indicated that there was no obvious evidence that regulatory processes had not been followed. The poor outcomes within subdivision were driven not so much by regulation that was not followed, rather that regulation as it currently standards does not sufficiently restrict poor urban design and street tree outcomes and does not adequately support positive outcomes. The most influential factor in canopy tree coverage from a design perspective is planting frequency or density and to a lesser extent species selection, but more support could be provided in planning schemes for the retention of healthy non-native vegetation. The former is heavily influenced by urban design factors such as crossover location, road pavement and frontage width, but no State policy sets a target for street tree planting frequency or density.

Clause 56 is the major regulatory influence during this stage and requires review with a view to elevating the importance of canopy tree coverage in decision making elevating the role of DELWP as a key stakeholder, alongside developers (and their teams) and Councils. This report (p. 22) outlines some potential solutions for improvements to Clause 56 and the Small Lot Housing Code, including urban design responses, the staging of landscape planning, improved retention of canopy trees and discretion for reduced road pavement widths based on lower target speeds and vehicle volumes (allowing reallocation for landscaping).

DETAILED DESIGN

At the detailed design stage, the critical issue highlighted through the analysis was poor integration between engineering and landscape design. Improvements to the EDCM offers opportunity for reinforcing good canopy tree coverage through reduction in conflicts between services and soil volumes capable of supporting large trees and better integration of design documentation and assessment. The role of VPA, Council and development teams (engineering and landscape) are critical.

Our analysis of the detailed design stage indicates that the guidance in the EDCM and local Landscape or Street Tree Guidelines was followed with respect to servicing locations, landscape and engineering documentation and species selection, but that the EDCM and Council landscape guidelines can be improved to provide for improved outcomes in relation to canopy tree coverage.

High-level analysis of Council species lists indicated that whilst there were opportunities for improvement to refocus on canopy width and climate adaptability, in general terms, lists contained a variety of species which were capable of delivering the projected tree canopy targets, subject to good construction and environmental conditions, and preferencing selection of medium or large trees rather than smaller species.

We recommend to improve consistency, guidance related to species and project canopy cover be elevated to the metropolitan level (still accounting for local variations) in the interests of standardising assumptions. At the same time a broad review of appropriateness of species selections with a view to climate change adaptability would be beneficial.

CONSTRUCTION

Both the literature review and the case studies highlighted the importance of the construction stage in implementing landscape designs and setting up the growing conditions for successful canopy trees. Civil and landscape teams become important during this implementation phase. The study found major barriers including poor soil conditions, poor water regimes during the establishment phase, poor planting technique and stock and tree damage were all influential in limiting the ability for canopy tree coverage to be practically delivered in line with projected (modelled) canopy cover.

It was not within the scope of this project to review the extent to which the construction phase delivered against regulation, however there was evidence that the construction phase did not fully implement landscape plans. Generally speaking there was attrition between the designed landscape plan and what was actually delivered. Sometimes this was a result of conflict with other infrastructure (signage, bus stops etc.), however on other occasions the reason for the gap between designed and delivered is unclear.

Whilst it was not possible to analyse elements such as construction and soil preparation techniques it was apparent in some of the case study areas that trees had been lost or were struggling because of construction related issues. Opportunities for improving construction related practices rest mostly on evidence of compliance with good practice.

Solutions to improve construction outcomes centred on education and compliance, which Council may need to modify practices to willingly support. There is opportunity to improve accountability of landscape / horticultural construction teams, requiring demonstration that adequate soil volumes, tillage and organic matter, topsoil replacement etc. are all occurring through evidence provision (photos etc.) or improved compliance checks. Use of financial mechanisms such as tree bonds may support reduced damage during dwelling construction phases.

OCCUPANCY AND TREE GROWTH

The occupancy phase commences when local Councils take over management of street trees. Our analysis found limited regulatory influences, but highlighted the importance of community values and programs in shaping stewardship of street trees as valuable community assets.

It was not within the scope of this project to analyse the extent to which management of canopy tree coverage by Councils conformed with local guidelines for tree management. The evidence reviewed did not extend to pruning, pest management techniques, watering regimes etc. The literature review highlighted a number of contributing factors to a successful occupancy or tree growth phase however and a number of barriers.

Barriers include a lack of community support, funding and organisational priority as well as management regimes which don't deliver required water supply or tree maintenance, noting that case study evidence of poor maintenance regimes were not investigated during this study and this finding is related to academic literature only. Additionally, a lack of longer term monitoring and evaluation relating to street tree success has hampered understanding. Whilst we know that barriers exist there is limited research which demonstrates the relative importance of each construction and occupancy related factor or influence on successful canopy tree outcomes.

Recommended solutions centre on the role of Council in delivering community programs and elevating the role of street trees as capable of delivering a range of community (ecosystem service) benefits. Further improvements to watering and maintenance regimes are recommended.

Additionally, to further improve understanding, improved monitoring and evaluation will enable evidence-based decision making for design and operational improvements. This rapid research project is a foundation only and further research and stakeholder engagement is required to build a more detailed understanding of the most effective measures. The literature review highlighted a range of research projects the outcomes of which are yet to be published. VPA is recommended to maintain a watching brief on this research.

CASE STUDY FINDINGS

The table on the following page outlines the high level results from the case studies. The findings are mixed, but clearly demonstrate with regulatory improvement, good design, establishment and growing support that canopy tree coverage in excess of 30% is practically achievable in road reserves in a growth area context.

The case studies examined the potential for the PSP areas to deliver street canopy tree coverage outcomes in excess of 30%. The analysis undertaken assumed that the trees in the ground (noting some are as young as two years old) will grow to 75% of their optimal canopy width, for example a species with an optimal canopy width (according to a range of landscape guidelines) of 8m will provide 100% canopy coverage equating to a 6m diameter.

In practice, poor construction techniques may already have limited this (for example, inadequate soil volumes are not necessarily apparent in the first few years of growth) and occupancy phase tree management may further limit potential. Due to this uncertainty, the case studies examine the realistic potential of delivering canopy tree coverage based on the first three stages of the development process and unless it is obvious through examination of the growth rates that trees will not reach projected canopy maturity we have assumed they will.

Applying this method, two of the PSP case study areas will likely reach a canopy tree coverage in excess of 30% if construction practices have not limited potential and best practice tree management is applied. Best practice tree management includes formative and maintenance pruning: to ensure good canopy development, removal of damaged or diseased growth; regular monitoring of street trees to check for healthy condition and replanting dead or damaged trees. A third case study has a reasonable likelihood of reaching the canopy cover target (the projected canopy cover is almost exactly 30% across case study streets).

A further PSP case study area will potentially reach 30% canopy tree coverage if the gap between what was designed and what has been delivered to date are addressed with reinvestment in street tree planting (we note that a number of case study areas have opportunities for re-investment in street trees - additional rows of planting, tree outstands etc.).

The other three PSP case study areas will likely not reach 30% canopy tree coverage even with the best practice tree management. The limiting factors in these examples are varied, but insufficient planting frequency or density is a key factor, with species selection, infrastructure conflicts (both below and above ground) and construction related issues all contributing to the outcome.

Findings Summary

CASE STUDY AREA	IMAGE FILE NAME	SPECIES	OPTIMAL WIDTH (M)	PROJECTED CANOPY	ACTUAL CANOPY (OVERALL CASE STUDY AREA FROM POINT SAMPLING)	ASSESSMENT
Cardinia (Pakenham)	Cardinia 1 - Shearwater Drive	Platanus orientalis (Cyprian Plane)	11	37%	17.5%	The combination of already high existing canopy cover and a high projected canopy cover based on case study streets indicates that the case study area will likely meet the new PSP Guidelines 30% canopy tree cover target when fully mature.
	Cardinia 3 - Paperback Drive	Corymbia citriodora (Lemon-scented Gum)	12	56%		
Truganina	Truganina 6 - Combine Drive	Quercus robur (English Oak)	12	38%	0.5%	Despite very low existing canopy cover due to recent establishment, the species selection and spacing indicates that in the fullness of time the case study area will potentially meet the PSP Guidelines 30% canopy tree cover target if the trees grow to their full potential.
	Truganina 9 - Morris Road	Corymbia maculata (Spotted gum)	11	25%		
Cranbourne East	Cranbourne 2 - Casey Fields Boulevard	Corymbia maculata (Spotted gum)	11	41%	9%	Despite very low existing canopy cover due to recent establishment, the species selection and spacing indicates that in the fullness of time the case study area will likely meet the PSP Guidelines 30% canopy tree cover target if the trees grow to their full potential.
	Cranbourne 6 - Heales Road	Eucalyptus leucoxylon (Red Flowering Yellow Gum)	9	29%		
Craigieburn	Craigieburn 3 - Ocean Way	Banksia integrifolia (Coastal Banksia)	7	21%	2.5%	The analysis indicates that the case study area will not meet the proposed PSP Guidelines 30% target even with best practice ongoing tree management. The lower density of planting and specification of smaller tree species in some streets indicate the target is unachievable in this location.
	Craigieburn 8 - Highlander Drive	Corymbia maculata (Spotted gum)	11	25%		
Taylors Hill (Frasers Rise)	Taylors Hill 3 - Concorde Avenue	Ulmus parvifolia (Chinese Elm)	11	25%	1.2%	The projected canopy cover indicates that the case study area will definitely not meet the proposed PSP Guidelines 30% target even with good ongoing tree management. The lower density of planting and the challenging soil and lower rainfall indicates the target is unachievable in this location without extensive reinvestment in street trees.
	Taylors Hill 4 - City Vista Court	Corymbia maculata (Spotted gum)	11	24%		
Lockerbie	Lockerbie 2 - Dwyer Street	Quercus lucitinica (Portugese Oak)	12	39%	4%	Our assessment indicates that the projected canopy cover may be reached if the gap between the number of trees specified and those planted is addressed. Without reinvestment in tree planting the proposed PSP Guidelines 30% is unlikely to be reached (noting the projected canopy cover figure is based on design potential rather than the actual outcome delivered).
	Lockerbie 5 - Dianella Avenue	Melia azedarach (White cedar)	7	27%		
Epping North	Epping 2 - Allumba Way	Eucalyptus sideroxylon (Ironbark)	10	22%	10.5%	The projected canopy cover calculation in the case study area will not meet the proposed PSP Guidelines 30% target even with good ongoing tree management. The lower density of planting and specification of smaller tree species indicate the target is unachievable in this location despite healthy existing canopy coverage.
	Epping 5 - Joyfields Place	Corymbia citriodora (Lemon-scented Gum)	8	22%		

Findings Summary

CASE STUDY AREA	IMAGE FILE NAME	SPECIES	OPTIMAL WIDTH (M)	PROJECTED CANOPY	ACTUAL CANOPY (OVERALL CASE STUDY AREA FROM POINT SAMPLING)	ASSESSMENT
West Footscray	West Footscray 1 - Alma Street	Melaleuca styphelioides (Prickly-leaved Paperbark)	7	31%	40%	The location has already significantly exceeded the proposed canopy cover target of 30% indicating that although a constraint, underlying soil conditions and slightly lower rainfall can be overcome to deliver a very positive canopy cover outcome.
	West Footscray 2 - Elphingstone Street	Elphingstone St - Melia azedarach (White cedar)	8	55%		
Malvern East	Malvern East 1 - Manning Road	Platanus x acerifolia (London Plane)	13	90%	60.5%	This location is the benchmark for canopy tree cover in Melbourne, indicating the potential outcomes which are achievable over time with the right conditions. Reduced servicing conflicts underground may have assisted growth as have reduced number of crossovers allowing for uninterrupted landscape verges.
	Malvern East 4 - Douglas Street	Quercus palustrias (Pin Oak)	8.5	40%		
Fitzroy	Fitzroy - Westgarth Street	Platanus x acerifolia (London Plane). (currently mature at up to 15m)	13	63%	61.5%	This location is amongst the higher canopy tree cover in Melbourne, indicating that with species selections with larger canopies exceptional outcomes can be delivered. Reduced servicing conflicts underground may have assisted growth, a number of services seem to be located under footpath or in the middle of the streets (therefore avoiding conflicts with trees).
	Fitzroy - Rose Street	Rose St - Pyrus calleryana (Callery's Pear) (currently approximately 2m – mature at up to 8m, assume 6m in this location)	8	10%		

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We respectfully acknowledge that every project enabled or assisted by HIP V. HYPE in Australia exists on traditional Aboriginal lands which have been sustained for thousands of years.

We honour their ongoing connection to these lands, and seek to respectfully acknowledge the Traditional Custodians in our work.

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