

URBAN FOREST TREE REPURPOSING GUIDELINES

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URBAN
FOREST
CONSULTING

Bambra Agroforestry Farm

Farm trees for conservation and profit



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Front cover: Native beehive hotel made from repurposed timber.

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INTRODUCTION

Australian Local Governments play a critical role in managing and caring for public vegetation, especially trees. This care also includes the managing the end of each tree's life. Trees in urban areas are removed for many reasons, including old age, making way for urban development or infrastructure, managing risk, conflict with infrastructure and even misdemeanour.

It is not yet a well-practiced component of sustainable urban forestry for felled trees to be managed for their whole of life-cycle to maximise the environment, social and economic returns from each tree. Tree repurposing enables opportunities to use logs for habitat or milling them into lengths of timber for furniture making or mulching them to return nutrients to the soil and create habitat.

This Urban Tree Repurposing Guideline looks at the various options and a decision-making framework for repurposing timber from trees removed in the public realm. It is aimed at urban tree managers within local government, roads agencies, major infrastructure projects and those in development. It provides an easy to use decision making hierarchy to maximise the repurposing opportunities arising from the removal of urban trees.

This guideline could easily be adapted for arborists who fell trees on private property. Although privately produced timber is less likely to have a broad public benefit, the supply may help underwrite the viability of a local urban timber industry.



Fig 1: Park bench built by Keysborough Men's Shed.

WHAT IS URBAN TREE REPURPOSING?

Urban tree repurposing is defined as reusing felled urban trees in the most sustainable way to benefit the environment and the immediate community. This process starts after all other avenues to retain the living tree are exhausted and the community has been engaged in the tree removal planning.

Some local governments have calculated that around 10% of their public tree population will need to be removed every ten years and for some Councils this can mean thousands of trees are removed every year.

Traditionally tree removal has been viewed by local government as a community engagement challenge along with a logistical and waste problem, however there is now an increasing appreciation for ways that these removed trees can be seen as a resource to be repurposed for community benefit. In Australia,

most Councils mulch removed trees and pruned branches for use in open space and revegetation. Whilst there are many positive benefits with mulch, there are other sometimes higher and better uses for some of this felled timber. One study from the US Vibrant Cities Lab has identified opportunities for urban wood ranging from carbon offsets, localised timber provision, habitat, renewable energy and even nanotechnology.

These opportunities can be environmental such as repurposing logs for habitat or conservation; community focussed such as repurposing logs for community infrastructure e.g. park benches or nature play; or as a sustainable resource for Council such as timber for park fencing or mulch for open space.

WILL ALL TREES BE SUITABLE FOR REPURPOSING?

Given that creating mulch is a repurposing of a felled tree, the answer is yes. However, it is important to apply a 'highest and best use' of the tree to ensure options for habitat provision and milling for public and community use are explored before mulch is considered.

Maximising the use of felled tree is guided by the quality of the timber. Urban trees are rarely managed for their timber and are removed because they are disease or damaged so often poorly formed or decayed rendering them unsuitable or not worthy of for milling. In addition, the diversity of species means that general maintenance is likely to yield small volumes of many different types of wood. Finally, the specialist equipment and skills required for processing timber may not be locally available.

Looking to the future, Local Government is planting thousands of trees for a wide range of amenity, environmental, cultural and social reasons. With some thought to the selection of species and their management it may be possible to build a high-quality timber resource for the future. In many cases, increasing the future timber value of trees planted for other purposes would not require any additional investment other than providing education and training for staff and being more flexible in the timing of any tree management. There is therefore a clear need for careful planning and research to support tree repurposing outcomes.

URBAN TREE REPURPOSING BENEFITS

Depending on the strategic priorities for the Tree Manager and Land Manager, there are multiple options for timber repurposing that have broad reaching benefits as outlined below.



Fig 2.

CASE STUDY:

New habitat opportunities were created in Roth Hetherington Native Park in Keysborough when felled street trees were repurposed to create a 12m 'green wall' planted out with two species of native creeper.

The felled trees were from a nearby Level Crossing Removal project.



ENVIRONMENTAL BENEFITS

Many felled urban trees can support the following environmental outcomes:

- Placement of hollow-bearing logs into areas of conservation value
- Habitat hollow carving for birds and tree dwelling mammals
- Native bee hotels, native bat habitat, stags
- Structures to grow vertical gardens
- Carbon storage by retaining carbon within hard structures
- Log placement to slow stormwater flows to support healthier riverine and aquatic habitat
- Mulch for gardens to support nutrient replenishment, habitat and water conservation

COMMUNITY BENEFITS

Repurposing timber for use in community facilities and programs also has a myriad of benefits. Examples of community uses include:

- Cultural and indigenous heritage recognition and education
- Community art by supplying local timber to men's sheds or local artisans
- Nature play and outdoor furniture at kindergartens and schools
- Community markers and signage
- Supply of mulch to community gardens/ local residents

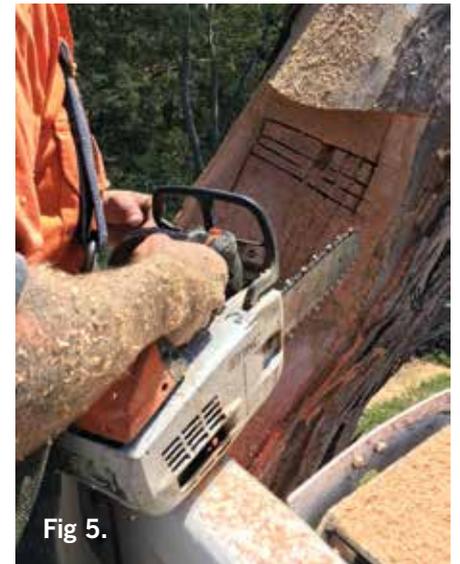


Fig 2: Felled logs from a nearby Level Crossing Removal project were repurposed and installed upright in Hetherington Park.

Fig 3: Hetherington Park 'Green Wall' now

Fig 4 & 5: Ecologist advice about the habitat needs of local fauna helps inform the design of hollows carved.

Fig 6: Native bee hotel created by drilling multiple small nesting cavities throughout the wall.

Fig 7: City of Greater Dandenong is now using repurposed timber for education signage in over five conservation reserves.



Fig 8.

CASE STUDY:

A local kindergarten is now home to a nature play 'crocodile' that has been repurposed from the slab top piece of a felled tree. The slab top piece is the first slice of timber cut from the log when milling.

This crocodile piece was constructed with the children on site, which required all staff to have a working with children check. Once completed, The Department of Education required an auditor to assess the structure for Occupational Health and Safety Guidelines to confirm there were no sharp line edges, that the placement was not too close to other equipment, and softfall mulch was provided below.

Council's kindergartens continue to receive repurposed trees to meet their garden edging, mulch and nature play needs.



Fig 9.

Fig 8 & 9: Nature play 'crocodile' constructed at local kindergarten.

CASE STUDY:

The Dandenong Operations Centre foyer is now home to the stunning *Eucalyptus robusta* bench shown left.

The bench has been repurposed from a tree whose trunk had grown right up against the wall of a community neighbourhood house. Care was taken when the tree was removed to ensure the timber could be repurposed for a range of community initiatives. The slab for this bench was shaped and sanded in the shed of the Neighbourhood House giving an opportunity for the community to appreciate the legacy of the tree.



Fig 10.



Fig 12A.



Fig 12B.



Fig 11.

Fig 10: Repurposed *Eucalyptus robusta* bench in the Dandenong Operations Centre foyer.

Fig 11: Repurposed trees are also used to create raised garden beds for a neighbourhood house.

Fig 12A & 12B: Outdoor table built for a local kindergarten is made from redgums felled for a nearby level crossing removal project.

CASE STUDY:

This stretch of bushland reserve fencing in Coomoora Reserve, Springvale was delivered cost efficiently by repurposing street trees removed by VicRoads for Princes Highway works. Two large logs from the felled Spotted Gums were salvaged and transported to Council depot and milled on site. The two logs created 42 posts and 84 railings. Transport and milling cost Council a total of \$1,500. A quote was sought from a hardwood supplier for same amount of timber which was valued at \$6,000. Council made a \$4,500 saving from reusing felled trees.

For Council, the move to timber fencing also sets up an ongoing demand for future felled street trees as they can be used to maintain and replace damaged parts of the fence.

OPERATIONAL

In addition to environmental and community benefits, repurposed timber provides operational benefits for Local Government by reusing an underutilised resource for municipal operations. This can create cost efficiencies and demonstrate Council leadership in resource recovery.

Examples of timber reuse for municipal operations include:

- Park infrastructure e.g. fencing, benches, picnic tables, boardwalks, railings
- Internal 'feature furniture' in Council offices and community centres
- Dog play obstacles in off-leash areas
- Renewing timber assets: timber paths, garden
- Mulch



Fig 13 & 14: Fence constructed from felled spotted gums (right) in Coomoora Reserve.

Fig 15: Logs used as obstacles in dogs off leash area

CASE STUDY:

River Redgums removed at the Thompson Road extension have been used to replace parts of a decayed wooden boarded walkway in Keysborough.

It is intended that all of the walkway will be progressively replaced with repurposed redgum. Many previous boardwalks have been built from soft timber and a progressive replacement with redgum will extend the life of these boardwalks.



Fig 16: Recovered redgum walkway

TIPS FOR TREE REPURPOSING

Whilst the benefits of tree repurposing are clear, there are some considerations and challenges that need to be taken into account. The checklist in Section 6 will prompt you to consider these issues.

COMMUNITY BENEFIT

Council-owned trees are a community asset and any timber repurposed from the tree must be for community benefit, though this might include reducing the costs of Council purchasing timber. This includes using the timber for public furniture or community groups. A possible alternative to explore is the option of selling a portion of timber logs (for example 25%) to help fund the costs of supporting the remainder to be repurposed for community benefit. Ideally, sales should be to certified social traders.

DEAD TREES VS RISK

There is ample evidence that dead and dying trees, also known as stag trees provide much needed hollows and habitat for many animals. However, in urban areas, the perception of stag trees is that they are unstable, unsightly and a safety risk to buildings and human life.

Keeping a stag tree is most beneficial when in a native park or bushland area, away from buildings and heavy pedestrian activity. When retaining stag trees, an ongoing risk inspection program will be required to monitor potential root decay, limb failure and root stability.

TIMBER FOR HABITAT ASSESSMENT

It is important that qualified ecologists are employed to determine what sort of timber will be suitable for habitat. Design of insect and bee hotels, bat hollows etc requires very specific knowledge and if not done properly can render the repurpose project ineffective.

The cutting of such habitat timber is also a specialist skill requiring someone who knows how to properly use a chainsaw to specifically cut hollows. Unfortunately, many arborists do not have this skill so employing the right expertise is crucial.

THE QUESTION OF FIREWOOD

Firewood is considered by some to be a repurposing of trees because if managed well this can help prevent the public from picking up firewood that is actually habitat for ground dwelling fauna. In reality, however, in urban areas, the need for wood in heating homes is becoming less prominent as more efficient technologies are available. Added to this, the smoke created from wood burning actually increases air pollution so timber for firewood is not seen as a sustainable re-use of urban trees.

OWNERSHIP OF LOGS

The asset owner of the tree that is felled is the legal owner of the timber to be repurposed. Local Government is able to use its felled timber; however, trees owned by VicRoads, Department of Education or VicTrack, as examples, must have permission from the owning agency for it to be repurposed.

Standard contracts used for tree removals may be set up for the ownership to be transferred to the tree removal contractor who may sell it as mulch. Variation to this arrangement will need to be clear to contractors.

TIMBER FOR MILLING

Not all trees are worth milling and a tree assessment is required to determine suitability based on species, log diameter, straightness and the existence of defects such as knots, bends or decay. Once the tree has been felled, contractors must take steps to preserve the timber for milling; such as ensure clean cuts at each end that must then be coated with end sealer to retain moisture. Each log should also be tagged so that information about the tree can be obtained at any point.

Even experienced arborists take some time to develop an eye for which trees will ultimately provide quality millable timber. Again, the employment of specialist may prove beneficial in the early stages. Further details in consideration of milling are included in Appendix A.

A recent project by City of Greater Dandenong assessed 300 felled street trees to find only 25 logs considered to be of a quality suitable for milling. This ratio is likely to improve in future years as land managers increasingly apply best practice urban tree management such as formative pruning.

COSTS OF MILLING, TRANSPORT AND STORAGE OF LOGS

Milling logs is an additional cost to consider. Mobile milling machines have made milling a more viable option in recent years. Transporting both logs and milled timber, given their long lengths can also be an expensive challenge. Availability of storage for felled logs and milled timber must also be considered. To achieve the highest quality, the timber may need to be dried to a consistent moisture content of between 10% to 14% which represents an additional cost. Full details and requirements for milling can be found in Appendix A.

A more detailed cost benefit analysis, however can show that when systems are set up, tree repurposing for milling can actually save costs. For example, the business case needs to factor in the reduced costs from managing and distributing mulch; and for using the felled trees on core operational needs such as fencing, signage and furniture instead of buying in hardwood timber.

CONTRACTORS

Even with clear specifications in a tree removal contract, it can be difficult to rely on contractors to deviate from standard practice.

The development of a checklist and project plan is a step towards bridging this gap as is regular and transparent communication. This needs to be supported by new standard contractual conditions, and information sessions with contract bidders to help them understand and value the new processes.



Fig 17 & 18: Portable milling has increased the feasibility of tree repurposing for Local Government. Be prepared with contractual agreements; ensure storage, transport and milling is organised before tree removal date; and find end uses for the felled trees by matching with different needs and opportunities.

DECISION MAKING FRAMEWORK

This step by step Decision Making Framework has been developed to help public land managers make decisions about timber repurposing from felled trees and understand the various decision making points.

This Framework must be applied *well before* any tree is removed.



STEP 1: EARLY CONSIDERATION OF POTENTIAL TREE REPURPOSING PROJECTS

- Find out which trees are forecast to be removed by Council in the coming year. Use these guidelines to broadly consider which 'tree removals' would be most suitable for tree repurposing in terms of timing, location, and tree suitability.
- Develop a list of appropriate tree repurposing projects. If this is your first tree repurposing project to manage, we recommend starting with a small project. See example Prioritisation Matrix in Appendix B and adapt as needed.
- Confirm who will own the logs once removed. Will it be Council or another land owner? Check there will be no contractual agreements vest the ownership of the felled timber to a removalist contractor.
- For trees identified as potential habitat logs, discuss with Council's parks and gardens staff to determine if there is a potential place for the logs can be used. If no, offer to other local land managers for habitat.
- For trees identified as potential milling logs, discuss with Council's community development staff to
- determine if there are groups such as Men's Shed, community houses, libraries, community gardens and kindergartens who would like the timber for community purposes.
- For any milling options, list the desirable log or timber specifications for each purpose and the required volume. Specifications include wood durability, piece size and length and whether the timber needs to be dried.
- Once the preferred tree repurposing project is chosen, confirm Council (or supporting partners) have operational budget to support the milling, storage and transport of repurposed trees.



STEP 2: ENGAGE WITH COMMUNITY AND STAKEHOLDERS

- Consult with relevant community and stakeholders about the repurpose project before the tree is removed.
- Make variations to the tree repurposing project to respond to any opportunities or concerns raised.
- Ensure tree has been assessed against Tree Removal Policy and cannot be retained. For significant trees, undertake propagation or seed collection to support reproduction of the specimen.
- If tree to be removed has Aboriginal cultural significance, such as scar tree or birthing tree, offer to make the tree available for ceremony, bark collection, scar practice. Offer return of logs to Traditional Owners
- Seek specialist advice from ecologists or milling operators to understand all opportunities that can be achieved from the felled tree. This advice will need to be included in conditions of contract. See example checklist in Appendix C and adapt as needed.
- Meet onsite with the future receiver of the repurposed tree (for example parks staff, men's shed, school principal, etc). Discuss the logistical matters that are likely to arise to ensure they will be addressed in Step 3.
- Work with communications staff to advise the community members affected by the tree removals that the tree will have a second life. Explain where the timber will be used, and ways that they could be involved (visit the park or contact the Men's Group etc).



STEP 3: FINALISE LOGISTICS OF TREE REMOVAL AND REPURPOSING

- Ensure the tree removal contractor is fully committed to felling the tree for desired output. e.g. log lengths, style of cuts etc to suit milling or hollows or habitat. Note logs longer than 4m are more challenging to transport. This should already be in the contract following advice from Step 2 however it will need reinforcing.
- Identify type of machinery and transport required to move logs, milled timber or mulch to depot, storage facility or location of re-use. The tree removal contractor may meet these requirements, otherwise find alternative arrangements. Use milling advice in Appendix A to help make suitable arrangements.
- Ensure the transport contractor will undertake the movement of any logs for habitat repurposing in accordance with ecologists advice to ensure minimal impacts are made on the receiving environment.
- Confirm allocated area for log storage and portable milling has been made available and Worksafe arrangements are in place.
- Confirm post cutting care requirements for timber such as end-sealing, storage needs etc. Use advice in Appendix A to help make suitable arrangement.
- Confirm requirement for branding/tagging/dating/grading of timber and make suitable arrangements.
- From storage site, identify who and when the timber will be delivered to its final destination.



STEP 4: REMOVE AND REPURPOSE TREE

- Ensure that tree removal/milling contractors have the above checklist and confirm logistics for each step.
- Include hold points if necessary.
- Implement necessary Council protocols for fauna management including relocation of impacted fauna.
- Remove tree as per work order and tree protection protocols for adjoining vegetation.
- Document works completed



STEP 5: MONITORING AND EVALUATION

- Capture tree removal and repurpose information in an internal database.
- Establish an annual review and monitoring program to determine diversity and effectiveness of outcomes.

Review all documented repurposing projects to learn from challenges and opportunities.

Please note, this checklist will need to be trialled several times before refining. Practical application of the checklist will increase its useability for future users.

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APPENDIX A:

MILLING SUITABILITY GUIDANCE

MANAGING TREES IN THE URBAN FOREST FOR FUTURE TIMBER QUALITY

Every tree has a limited useful lifespan expectancy and will, eventually, die or need to be removed. Anticipating this, councils can choose to preference species that might be expected to have a greater wood value and manage them during their lifespan so as to enhance future log quality for milling.

Although timber production will always be a secondary consideration, it is likely that, for many applications, the species and management options that enhance future timber value will complement, or at least not undermine, their primary values. In many cases the management required for timber, such as pruning and spacing, will not represent any additional cost, although the timing and methods may vary from those currently employed by Councils.

SPECIES CHOICE

There are many factors that Local Government must take into consideration when selecting species for planting in urban areas. The Urban environment usually has a high level of disturbance and achieving best tree function now and for the future will need to be carefully assessed. In some cases, council is also responsible for native trees that naturally regenerate. As discussed above, in both cases there is an opportunity to preference species that are likely to have a high future value for timber.

Within each species there is a high degree of genetic variability which can manifest itself in tree growth rate, disease resistance, stem form, branching habit, disease resistance and wood quality. The approach to genetic selection will vary depending on the species:

1. **Local native species:** To enhance the prospects for the trees developing well for timber production the aim should be to collect seed from many (at least 10) trees with good form (tall and straight) and to avoid any stunted or malformed trees, particularly where this cannot be directly attributed to their past management.
2. **Australian native species (non-indigenous):** Because these species are not native to the local area there is greater opportunity to select 'improved' genetic material without the risk of affecting the integrity of the local gene pool. In some cases there has been research on the 'best' provenances for timber production and there are even seed orchards of some of these species where the best performing individuals are crossed to produce improved seed stock (e.g. Red Ironbark and Spotted Gum). As the priority for selection is on tree health, form and wood quality there is unlikely to be any reason why this genetic material would not also be suitable for the primary purposes.
3. **Exotic species:** Cultivars that display straight growth and horizontal branching would be preferred for timber production. Many exotics are grown from seed including the Oaks. The same principles discussed above for seed collection particularly the importance of avoiding collecting seed from isolated or related individuals to reduce the risk of inbreeding.

MANAGING TREE FORM AND LOG QUALITY

Whatever the purpose, timely tree management and care can influence the growth and form of a tree thereby increasing its future wood quality. The focus should be on ensuring that there is one single leader that is straight (resulting in a straight trunk) and that the branches are removed from the lower trunk to control the location and size of the knots in the log. In almost all cases, this management is likely to complement the amenity and shade value of the trees by reducing the risk of tree failure (double leaders) and removing the lower branches (access and safety).

For timber production, the timing of pruning is critical. Whilst there is some degree of flexibility in the timing this pruning the most important thing is that it is done regularly over a number of years. This will be particularly important in the urban setting where trees are planted more widely apart than in a forest plantation (increasing exposure), the risk of damage to the leader and branches is greater (vehicles, vandals etc) and there is less opportunity to cull mal-formed trees. Guidelines for pruning for milling are available in Appendix D.

TREE SPACING

Tree diameter growth is directly related to the leaf area of the canopy. Sawlog growers generally plant trees close together and thin their plantations to give selected trees more space as they get larger and thereby encourage diameter growth on the pruned trunk. In an urban setting there may be some plantings, or natural forest areas, that could follow the same pattern and where thinning is undertaken to enhance non-timber benefits such as:

- the removal of dangerous or diseased trees;
- improving the diversity by reducing the number of any dominant species;
- improving access for the public and maintenance crews (ease of mowing and weed control);
- improving the aesthetics by creating a more open woodland of larger diameter trees; and,
- improving the habitat value of the forest by increasing light levels for the understorey and providing more dead wood on the ground (there may also be an opportunity to kill trees standing to create vertical habitat).

SHORT ROTATION FORESTRY OPTIONS

In our environment, the production of sawn timber is a long-term project. In the native forests, it takes more than 50-60 years to produce a sawlog from eucalypts. By pruning and spacing the trees, this can be reduced to about 25 years. In urban forest, the long rotation length may not be a problem. In fact, increasing the time that the trees are present in the community, providing their other values, is likely to be preferred over more intensive short-rotation forestry options.

However, there are cases where council have responsibility to manage land for a defined period of time such as where there are planned to develop a freeway or future housing development. In this case there may be interest in exploring multipurpose forestry options that can be liquidated in 10 to 15 years.

Short rotations invariably mean smaller diameter trees. In which case they are unlikely to be suitable for sawlogs. There are small diameter timber options that may be suitable including roundwood products such as posts and poles, and firewood. For Councils requiring posts and poles for fencing, outdoor structures, playgrounds and bollards, roundwood production may be an attractive option.

TREE SPECIES FOR TIMBER MILLING

Across Victoria there are hundreds of indigenous, native and exotic tree species within our urban forests. Some, such as the European Oak or the Australian Red Ironbark, have well established timber markets and a lot is known about their processing and utilisation. Others, such as the Paperbarks (*Melaleuca* species) or Lilly Pilly (*Syzygium* species), aren't well known for their timber.



Native Beehive at local kindergarten

EXAMPLE OF SOME HIGH VALUE URBAN TREE SPECIES FOR PROCESSING INTO SOLID TIMBER

Common Name (Species)	Wood characteristics	Notes on processing options and possible products	Minimum characteristics of a high quality log worth of value adding
The White Oaks <i>Quercus robur</i> <i>Q. bicolor</i> , <i>Q. alba</i> etc.	Sapwood: very wide in open grown trees, susceptible to <i>Lyctus</i> , Heartwood: Brown, relatively durable (Class 2) Density: 700 kg/m ³ Shrinkage: 3% radial, 6% tangential Grain: prominent ray cells.	Large diameter logs required in order to avoid sapwood. Sapwood can be treated for internal use with Boron salts. Most likely product options include furniture and crafts.	Clean of defects, straight logs over 2m long with a diameter over 45cm (for quartersawing). Could be air dried, kiln drying preferred
Silky Oak <i>Grevillea robusta</i>	Sapwood: susceptible to <i>Lyctus</i> , Heartwood: pink to light brown, not durable (Class 4) Density: 620 kg/m ³ Shrinkage: 2% radial, 5% tangential Grain: Prominent ray cells	Large diameter logs required in order to avoid sapwood. Sapwood can be treated for internal use with Boron salts. Most likely product options include furniture and crafts.	Clean of defects, straight logs over 2m long with a diameter over 45cm (for quartersawing). Could be air dried
<i>Lophostemon confertus</i> (Queensland Brush Box)	Sapwood: <i>Lyctus</i> not susceptible Heartwood: pinkish grey to reddish brown: Not durable (Class 3), Termite resistant, Density: 900kg/m ³ Shrinkage: 5% Radial, 10% Tangential Grain: clean and straight, waxy texture.	Once commonly available for flooring. Most likely product options include furniture and crafts.	Clean of defects, straight logs over 2m long with a diameter over 45cm (for quartersawing). Could be air dried, kiln drying preferred
Spotted Gum <i>Corymbia maculata</i>	Sapwood: wide sapwood in open grown trees, <i>Lyctus</i> susceptible Heartwood: brown to reddish brown, semi durable (Class 2), Termite resistant, Density: 950kg/m ³ Shrinkage: 4.5% Radial, 6% Tangential Grain: clean and straight	Commonly available high quality native timber. Ideal for use in decking or other external applications above ground. Dried timber can be used for flooring and furniture. Exclude all sapwood for external uses. Treat sapwood with boron for internal uses.	Clean of defects, straight logs over 2m long with a diameter over 45cm (suitable for backsawing).
Red Ironbark <i>Eucalyptus sideroxylon</i> <i>Eucalyptus tricarpa</i>	Sapwood: <i>Lyctus</i> susceptible Heartwood: brown to dark red, very durable (Class 1), Termite resistant, Density: 950kg/m ³ Shrinkage: 3.5% Radial, 7% Tangential Grain: clean and straight	Very high quality native timber. Ideal for use in all external applications. Dried timber can be used for furniture. Generally discard all sapwood due to colour and susceptibility to <i>Lyctus</i> .	Clean of defects, straight logs over 2m long with a diameter over 40cm (suitable for backsawing).
River Red Gum <i>Eucalyptus camaldulensis</i>	Sapwood: Wide sapwood band, <i>Lyctus</i> susceptible Heartwood: dark red: Very durable (Class 1) Termite resistant Grain often interlocked (fiddleback) ADD = about 900kg/m ³ Shrinkage: Radial = 4% Tangential = 8%	Usually sourced from native trees rather than planted trees. Logs often have a very large diameter which may affect mill options. Uses: flooring, heavy furniture, posts, construction	Clean of defects, straight logs over 2m long with a diameter over 50cm. Prefer to quartersawn which should be possible given the large diameter of the logs.
Sheoaks <i>Casuarina cunninghamiana</i> <i>Allocasuarina verticillata</i>	Sapwood: not susceptible to <i>Lyctus</i> , Heartwood: pink to dark red, durable (Class 2) Density: 750+ kg/m ³ Shrinkage: 3% radial, 8% tangential Grain: Prominent ray cells	Most likely product options include furniture and crafts. Often used in restoration projects for timber shingles.	Clean of defects, straight logs over 2m long with a diameter over 40cm (for quartersawing). Could be air dried.
Callery's Pear <i>Pyrus calleryana</i>	Sapwood: not susceptible to <i>Lyctus</i> Heartwood dark red: pale pink/brown, not durable (Class 4) ADD = about 900kg/m ³ Shrinkage: Radial = 4% Tangential = 7%	Widely planted as ornamental pears. Some are reaching a size suitable for milling on a bandsaw. Timber is favoured for caving and wood turning with larger boards being suitable for furniture	Clean of defects, straight logs over 1.5m long with a diameter over 20cm could be sawn on a bandsaw.

SPECIES SELECTION FOR ROUNDWOOD

In most cases roundwood posts and poles are used outside so the species should have Class 1 or Class 2 durable heartwood which is also termite resistant. The best poles for most uses are those that are straight, branch-free and have an even diameter (little taper up the stem). Although the sapwood of all timber species is not durable in the weather, preference should be given to those species which have sapwood that is non-susceptible to *Lyctus*, and management options that are likely to result in a narrow sapwood band.

In trees, the width of the sapwood band relates to the size and health of the canopy. To reduce the width, the trees can be grown very close together (e.g. 3m apart) so that competition for light reduces the effective leaf area on each tree. In eucalypts, this competition will also lead to self-pruning of the lower branches and a more cylindrical trunk. All the species listed in Table 2 coppice strongly after cutting and can be repeatedly harvested for post, poles and firewood while the site is available.

Table 2 possible species for durable posts and poles

Species	Heartwood Durability	Sapwood Lyctus susceptibility	Comments
Yellow Box <i>E. melliodora</i>	Class 1, Termite resistant	Not susceptible	Grow in tight plantation and prune to a single stem
Red Ironbark	Class 1, Termite resistant	Susceptible	If grown in very tight plantations the sapwood band can be very thin. Bark often retained as a feature for some applications.
Sugar Gum <i>E. cladocaylx</i>	Class 1, Termite resistant	Susceptible	If grown in very tight plantations the sapwood band can be thin. Easy to remove bark of tree at time of harvest
Spotted Gum <i>C. maculata</i>	Class 2, Termite resistant	Susceptible	Thick bark and wide sapwood band

MILLING OPTIONS

- The cheapest option is a portable chainsaw mill. A conventional chainsaw cuts a very rough kerf that is nearly twice that of a regular circular saw blade and much more than a band saw. They are useful where the log cannot be removed from the site due to access problems. In this case the logs can be rough sawn into boards that can be carried out.
- The most common portable mill in Australia is the circular swing-blade portable sawmill e.g. The Lucas Mill. Once the log is positioned underneath the mill the operator can cut final dimension timber in a series of back and forth passes. There is a limit to the width of board that the circular saw can cut although for very wide boards or slabs a chainsaw-type bar can be added.
- Portable bandsaw mills usually have a log deck which doubles as a trailer. The advantage of the deck is that the log can be rotated easily and held in place for each successive cut. The wider girth of the band saw also allows the operator to cut right through the centre of a relatively large log in order to follow a quartersawing pattern.

POST CUTTING CARE

- The ends of the log must be cut clean and coated with an appropriate end-sealer to reduce moisture loss from the end grain. Without this sealer the ends will begin to split.
- Logs can be stored for a short time outside. In summer the logs should be held in the shade. If kept too long the sapwood will begin to degrade (discolouration and rot) It is best to mill log green before they begin to dry out.

DRYING SAWN TIMBER

- There is a long list of defects that can arise during the drying process: end splitting, cupping, warping, surface and internal checking, collapse etc.
- In Victoria, timber moisture content of around twelve per cent is generally seen as desirable
- The key is to remove the water slowly whilst maintaining a gentle and even moisture gradient from the centre of the board out to the surface thereby allowing the cells to shrink evenly. Milling should be done under cover out of direct sunlight. If this is not possible avoid working on hot sunny days or have a spray system available to keep the freshly sawn timber wet.

- Within a few hours of milling all the green timber should be stickered out using timber spaces between the boards in the stack and protected from the sun and drying winds.
- Air drying down to a moisture content of below 20% might take as long as six months or more than a year.
- For higher quality end uses the timber will need to be 'finished' to an even moisture content of between 8 and 14 percent. In most cases this will require a kiln to heat the timber and extract the moisture. Because of the costs and skills required to install and operate a timber drying kiln the most likely scenario is that councils will begin by selecting boards of green sawn timber required for a particular job and having them contract dried prior to use.

STORAGE OF DRY TIMBER

- Timber will reabsorb moisture from the ambient environment and move accordingly.
- If the timber has been dried down to a moisture content fit for furniture or building applications it must be stored well out of the weather, preferably inside a building.
- Timber intended for external use should be covered to protect it from rain and direct sunlight.
- Unequal drying and wetting, where one side of a piece is exposed to the elements, can cause twisting, bowing or cupping in a board that was once square and straight.

STRUCTURAL AND APPEARANCE GRADING

- Timber used for structural purposes must be graded and marked accordingly with a stress grade (ranging from F5 to F27). This may be an essential requirement for many structures in which council intend to use any timber they recover from their trees.
- Commercial sawmills that produce structural timber generally have a machine that tests the bending strength of each piece of timber and marks it accordingly. Machine testing is unlikely to be an option for small producers, particularly those with timber from a range of different species.

TAGGING LOGS AND TIMBER

- Given the milled timber produced is likely to be highly variable it will help to know the origin of each board.
- From the point of harvesting and through milling and drying some form of tagging process such as a log and tree number should be adopted that allows anyone to determine the following features of each piece:
 - » species (including the Latin name).
 - » location of the tree (address or GPS)
 - » date of harvest
 - » log diameter
 - » date of milling and mill type
 - » whether it has been kiln dried

APPENDIX B: EXAMPLE MATRIX TO PRIORITISE TREE REPURPOSING END USER OPTIONS

List out potential timber repurposing projects and prioritise them.

Project Name, Location & Reuse Type	Key stakeholders	Timber types/Species	Milling Specifications	Storage & transport arrangements	Predicted complexity/ costs (low, med or high)
Habitat	For (a) tree removal stage and (b) tree repurposing stage.				
Milling – gifted to community	eg: land owner, land manager, adjacent community, tree removal contract manager, community beneficiaries				
Milling – used for Council operations					
Other					

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APPENDIX C: EXAMPLE CHECKLIST TO CONSIDER TREE REPURPOSING POTENTIAL

Example Tree Repurposing checklist. To be accompanied by Tree Removal Report of tree.

Criteria	Status
Tree ID	
Tree to be removed (id/species/owner)	
Healthy or decayed?	
Recommended repurpose	
Stakeholders/recipients	
Felling style (one log, small pieces)	

Onsite milling or mulching?

Ecologist employed?

Transport from site – where to and how?

If stored, how long and where?

Timber tagging/branding needed?

When and how will timber be delivered to final destination?

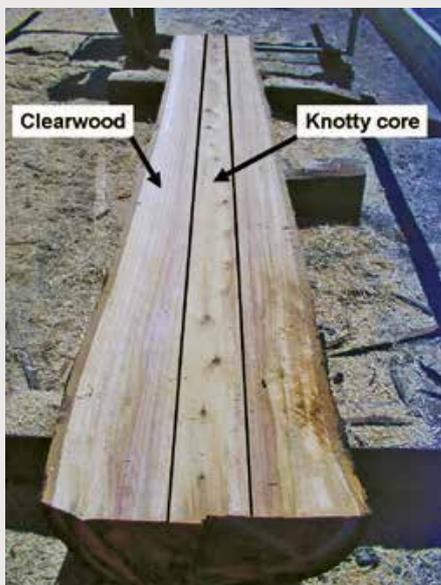
Other comments?

APPENDIX D: PRUNING URBAN TREES FOR TIMBER PRODUCTION

Pruning trees for sawlogs

The main purpose of pruning is to increase the proportion of knot-free clearwood in the lower log. The aim is to create a slender branch-free trunk, the scaffold, over which knot-free wood can be laid down with each year's growth.

Here I present my standard approach to pruning for clearwood timber. Of course, in practice I do vary this a little to suit different species and product options but these notes provide a good starting point for growers.



My regular pruning of this Shining Gum confined the branch knots to an even core running up the centre of the log allowing clearwood to be cut from the surrounding clearwood zone.

When to start pruning

Visit every tree every winter to determine if it needs pruning. Check them again around Christmas time to remove any epicormic shoots or correct double leaders before the stems become too large.



Epicormic shoots often develop on the pruned stems of many hardwoods (top: Northern Red Oak) and softwoods (bottom: Hoop Pine). Cut them off close to the trunk as shown.

Which trees to prune

Don't prune trees that have a lean of more than about ten percent, bends or kinks that deviate outside the central axis, or show signs of disease or severe borer damage. Have a clear idea of the final stocking rate you plan to retain to avoid high-pruning trees that will ultimately be too close together. For eucalypts, I suggest not pruning two trees within a distance less than the height you are pruning to at the time. For example, if pruning a eucalypt to about four metres in a block plantation then do not prune another within four metres as the competition will reduce the diameter growth and the benefits of your pruning work. I thin any unpruned trees immediately after I have completed the pruning to ensure they do not dominate the pruned trees.

Double leaders

It is critical to remove double leaders early. A double leader can be identified by the lack of a branch collar. On a normal branch, the swelling at the base of the branch is an indication that the stemwood is overgrowing the branchwood. In a double leader, there are no interlocking wood fibres so there is a greater risk of the trunk splitting.



Pre-emptive form pruning

Each winter remove any branch on the stem, up to the anticipated pruned height, that is over about 2.5 centimetres in diameter. This measurement is taken a little out from the stem away from the swollen collar.



This Red Ironbark branch has a diameter greater than 2.5 cm so I removed it even though the main trunk at that point was less than 8 centimetres in diameter. If left to grow for another year, dominant branches like this can grow very large, increasing the workload later and affecting the shape of the main trunk.

A double leader in a young Tallowwood (*Eucalyptus microcorys*). Note how there is no swelling at the base of either stem. I have cut the weaker stem off perpendicular to the stem to minimise the area of exposed wood. In a year or two, the main stem will envelop the stub.

Stem pruning

Each winter remove every branch on the stem, up to a point where the trunk diameter is 8 centimetres. Stem pruning stops when you have reached the desired height. I make my own pruning gauge that has an 8-centimetre mouth on one side for stem pruning and a 2.5-centimetre mouth on the back for pre-emptive pruning.



Before and after I pruned a Coast Redwood up to a trunk diameter of 8 cm using a plywood gauge to determine where to stop. I then check for a double leader or any large branches (over 2.5 cm) above that point.

How high to prune

For special timbers like Blackwood, a pruned log of just 2 or 3 metres would be acceptable. For eucalypts, I tend to go to 6.5 metres to ensure I can produce one 6.1-metre-long log (the longest length I can mill on my bandsaw and fit in my kiln) or two 3.1 metre logs (close to the shortest practical length for most eucalypt timbers). The only species I prune higher is the Coast Redwood. I prune them to 8 metres because they are easy to prune and grow tall.

Where to cut

Remove the branch close to the trunk without cutting into the branch collar. The branch collar is the swelling at the base of the branch where the fibres in the trunk overlap with the branch fibres. If the collar is damaged, sugars flowing down the trunk cannot feed the cells that form the callus to overgrow the wound. Do not apply any coatings over the wound. A healthy tree will confine any decay to the branch stub and central core.



Before and after pruning a River Sheoak. Note how I have not damaged the branch collar.



The recovery one and two years after pruning a Black Walnut (not the same branch). If the collar is not damaged the callus growth will be shaped like a doughnut, evenly overgrowing the stub from all sides.



A section of Black Walnut (top) and Shining Gum (bottom) showing how the clearwood grows over the pruned stub. Note how any decay that enters the stub is confined to the branch and does not affect the new wood. The Shining Gum also shows how fiddleback can be initiated by pruning live branches and can continue to develop in the new wood.

Pruning tools

I use secateurs, long-handled loppers and a hand-saw. To work at height I use a vertical ladder and harness. The ladder is specially made to fit against the tree and is tied off to provide a firm footing. I fit the pole belt around the tree before I leave the ground. Rules regarding working at heights vary in different states.

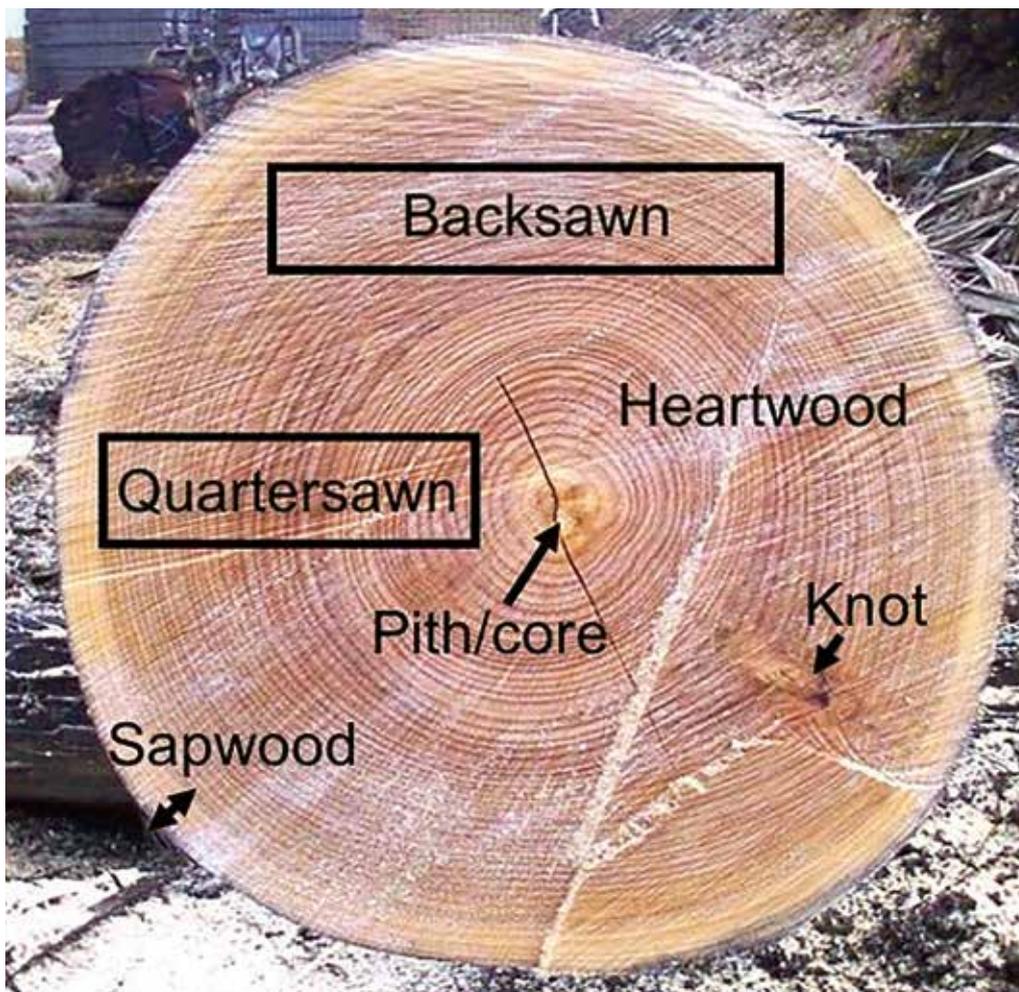
Occasionally I use a pole saw instead of a ladder but only on species with small, horizontal branches, like Australian Silky Oak. Recently I purchased electric pole secateurs that can reach about 5.5 metres. These are ideal for double leaders and pre-emptive pruning. I do not use, nor recommend, a chainsaw. If you prune on time, every year, the branches should not get too large for hand tools.



High pruning a Shining Gum with a harness and ladder (left) and a Black Walnut with electric pole secateurs (right). Note, these are demonstration photos. When high pruning I do wear a helmet to protect myself from falling branches.

NOTES ON WOOD CHARACTERISTICS

- Sapwood: The sapwood of all species is not durable outside. In most, the sapwood is also susceptible to the *Lyctus* borer which can attack dry timber including in furniture.
- Heartwood: Extractives laid down in the sapwood when it is converted to heartwood affect wood colour, durability, ease of drying and performance.
- Durability: Class 1 = inground uses, Class 2 = outside, above ground, Class 3 & 4 = inside or undercover.
- Air-dried Density (at 12% m.c.): Wood density affect timber strength, ease of drying and use (weight, ease of nailing, drilling, gluing, etc.). Most tree species produce wood within a relatively narrow density range although the wood produced in the early years (near the core) may be significantly lower in wood density. High density timbers (over 750kg/m³) have a higher fire resistance rating.
- Shrinkage: All wood shrinks as it dries although the extent and pattern of shrinkage varies. Where the tangential shrinkage is much greater than the radial shrinkage the logs may be to be quartersawn.
- Grain: Some species have prominent ray cells that make quartersawn timber more highly valued. Other valuable grain characteristics include fiddleback and bird's-eye, although these are more difficult to predict as they do not occur in all logs.







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