Trees, Planning and Development

A Guide for Delivery

Section One:

Creating financial, environmental and social value into the future

Issue 1.4/2023

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Trees & Design Action Group

Primary Partners

RTPI Royal Town Planning Institute

RIBA Architecture.com

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How to use this section

Navigation

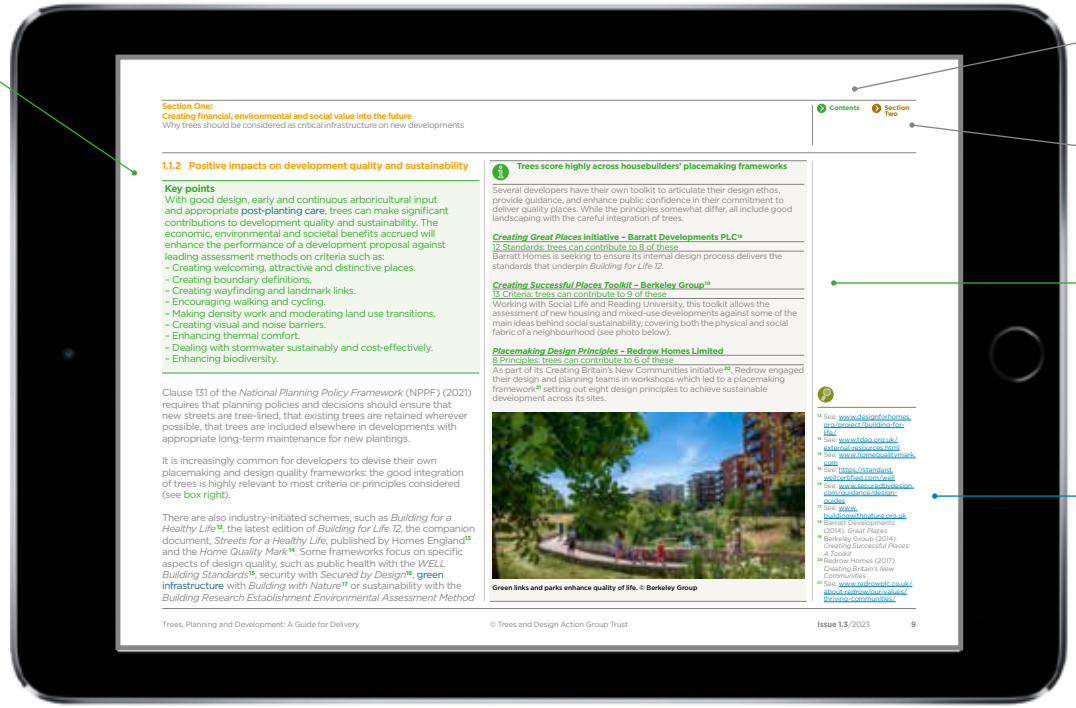
The below shows the different types/levels of content – from quick-reads such as *Key points* through to *Detailed references* hyperlinking to source material. Use the various ❯ arrows to efficiently navigate the document and go directly to the chosen page.

Key points
A quick-read box highlighting the key points discussed within the main text below.

Case Studies
Referenced in the guide and hyperlinked to our Case Study Library: tdag.org.uk/casestudies

Glossary terms
Terms are hyperlinked to the Glossary on page 49.

Briefing Notes
Detailed information and references.



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Further explanations and other supporting details.

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For original source material.

Introduction and contents

Overview

Trees Planning and Development: A Guide for Delivery covers the planning, protection, delivery and monitoring of trees in developments throughout the UK.

Purpose

All new developments should bring purpose, longevity and life enhancing qualities to places and communities.

This provides a better understanding of the many financial, social and environmental benefits trees offer new developments and how to secure them.

Audience

It is of particular interest to developers and investors, but also planners, designers, arboricultural consultants and other stakeholders

Section Two

This looks beyond new developments and focuses on developing a Strategy for a local urban forest to deliver the benefits that trees provide equitably across an urban environment.

How to use this section

1.1 Developers, local users, wider communities: all benefit from trees in new developments

"Trees form the very foundations of our developments, adding value economically, environmentally and socially. From a design perspective this is not just attractive to buyers, but also gives new places a sense of permanence and roots. For communities, they promote an engagement with green spaces by defining walking and cycling routes as well as contributing to health and wellbeing. Environmentally they are both champions of biodiversity and carbon neutrality, providing habitats, shade and filtering air. Trees are the unsung heroes of placemaking."

Paul Cutler, Head of Masterplanning and Design – Urban & Civic

1.1.1 Positive impacts on development viability

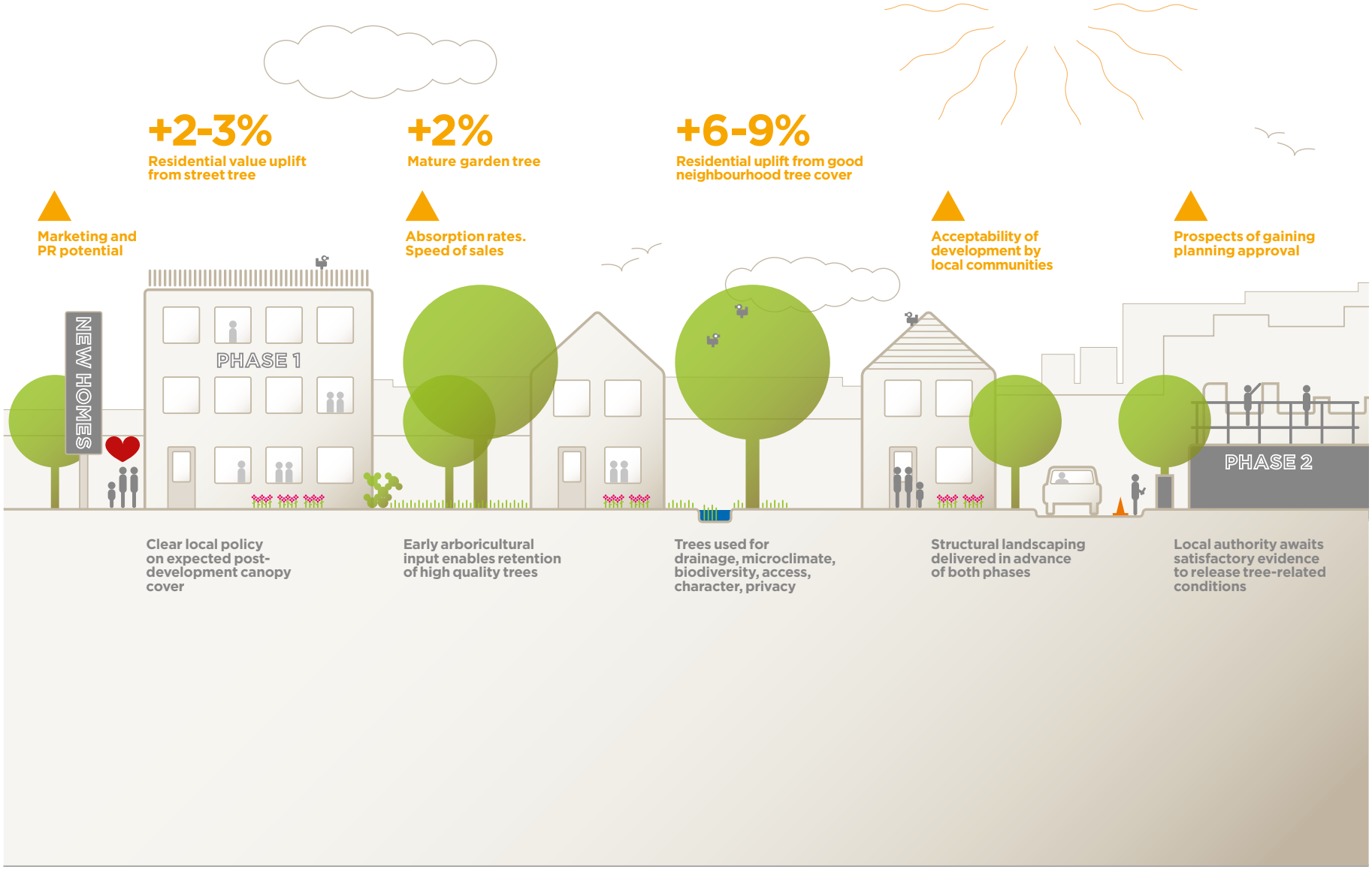
Key points
Integrating trees enhances development viability in many ways:
- Strengthening the financial value of land and property.
- Speeding and easing the sales journey.
- Reducing community opposition to development.
- Enhancing prospects of gaining planning consent.

In today's residential-led development market, it is difficult for developers to share in any uplift in property value that takes place once the build-out period is complete. Such returns are enjoyed by subsequent owners. The ability for any design to deliver both long-term and short-term gains is therefore of paramount importance. With good design skills and the necessary expertise on the project team throughout, the integration of trees into a development can be highly cost effective, even from a short-term perspective. Trees account for a very small proportion of the investment made in any scheme (see 1.1.4) and can pay dividends in added sales values, increased rates of sales and positive perceptions – which all positively impact development viability.

New play street. Unfortunately, constrained underground space limited choice to smaller species trees. King's Crescent, Hackney. Architect Karakusevic Carson; Landscape muf architecture/art; Tree planting GreenBlue Urban. © John Sturrock

The same play street (shown on the previous page) with seasonal colour in Spring 2023. © GreenBlue Urban

The measurable value that trees bring to new developments



Strengthening the financial value of land and property

International research indicates that the presence of well-maintained trees can increase land and property values. Most of the large-scale academic studies exploring this relationship come from North America, although comparable findings have been reached in research conducted in Perth, Australia, Berlin and Frankfurt, Germany and Malmö, Sweden (see box top right). A small scale, perception-based study conducted in three English towns seems to confirm that the UK conforms with these international findings (see box bottom right). The premiums observed are dependent upon several factors including the local socio-economic profile, characteristics and density of the area, and configuration of the urban forest[1].

Speeding and easing the sales journey

In the residential market, trees feature prominently in all marketing materials. Leading housing developers use good-quality, tree-rich, landscape designs to set themselves apart from their competitors. Good integration of trees provides their developments with a distinct sense of place that sell faster.

The impact of trees on absorption rates and speed of sale was a recurrent theme in the interviews conducted with large and small house builders as part of the research for this guide. Faster sales rates enable higher levels of income to be achieved sooner and, on larger sites, the development can be completed more quickly. As a result, the period until the development breaks even is shortened and the finance costs are reduced (see Alconbury Weald box top overleaf).

"We conducted some valuation work with a range of customer groups, showing them images of different developments and asking them what they like, and everybody liked the ones with trees."

Adam Tillion, Regional Technical Director – Barratt Homes

Trees enhance property values

Although there have been a few exceptions, international hedonic valuation studies using regression analysis to assess the impact of a range of urban forest conditions on single-family home sale prices show positive impacts.

Price increase	Condition
+1.9%	Street tree[2]
+2%	Mature garden tree[3]
+3%	Larger street tree[4]
+3-5%	Trees in front garden landscaping (large parcels)[5]
+6-9%	Good tree cover in the neighbourhood[6]

Investigation of perceptions of value in three West Midlands' towns found a series of strong and significant relationships between the expectation of house prices and a range of physical characteristics including the presence of street trees.[7]

First impressions matter

People make very quick judgements on the visual desirability of a place and the sample streets in the box above were subject to a property value survey, a photographic survey, mathematical image analysis of the photographs and physical character analysis. 46 people were asked to score each street in terms of their perceived levels of attractiveness, appeal and visual variety. Additionally, participants were asked to identify the physical features that influenced their decisions and the amounts that they would expect to pay for a property in each street. The results were compared to like-for-like developments in the three towns that lacked the identified features, and a series of property price uplifts and depressions were recorded, as shown below. Care must be taken in interpreting these results in isolation, as the sample size was small, and the assessment based on stated preference and willingness-to-pay rather that data arising from actual sales.[7]

Value uplift or depression	Condition
+12-18%	Views onto water
+13-21%	Views onto green areas
+18-41%	Tree-lined streets
+19-43%	Views containing listed building
+64-96%	Views containing cobbled street
-39%	Views on to multi-storey public sector apartments

[1] Terms highlighted in blue are defined in the Glossary

[2] Pandit, R, Polyakov, M, Tapsuwan, S and Moran, T (2013). *The effect of street trees on property value in Perth, Western Australia.* Landscape and Urban Planning, 110, 134-142

[3] Dombrow, J, Rodriguez, M, and Sirmans, CF (2000). *The Market Value of Mature Trees in Single-Family Housing Markets.* Appraisal Journal 68, 1:39-43

[4] Donovan, GH and Butry, DT (2010). *Trees in the City: Valuing Street Trees in Portland, Oregon.* Landscape and Urban Planning 94, 1:77-83

[5] Anderson, LM and Cordell, HK (1988). *Influence of trees on residential property values in Athens, Georgia (U.S.A.): A survey based on actual sales prices.* Landscape and Urban Planning, 15, 153-164

[6] Morales, DJ (1980). *The Contribution of Trees to Residential Property Value.* Journal of Arboriculture 6(11): 305-308

[7] Christou, K (2012). *Fractal dimensions and house values.* Unpublished M.A. thesis, Oxford, UK: Joint Centre for Urban Design, Oxford Brookes University

Reducing community opposition to development

The Housing Strategy for England (2011)[8] suggests that housing developments often fail to progress because of opposition from local communities. This was further reiterated by the Building Better, Building Beautiful Commission which stated: *"A desire to preserve greenery at all scales (from sweeping countryside to a single street tree) is a strong and consistent theme in every survey of British opposition to new developments. For example, thirty per cent of those saying they had opposed new housing gave this as a reason in a September 2017 survey"*[9]. (See box middle right).

The most popular developments are frequently the greenest, leafiest ones, with mature trees, well-designed streets and open spaces. Good integration of trees is one of the most effective ways to deliver popular neighbourhoods that endure – as they contribute strongly to creating an outcome that meets a community's desire for good quality places and green settings while also supporting developers' and landowners' objectives to create value.

Enhancing prospects of gaining planning consent

It is a duty for Local Panning Authorities (LPAs) to consider the protection or planting of trees and to secure adequate environmental quality and mitigation of potential damage to biodiversity when granting planning permission (see 1.2.1). Retaining existing mature trees within development schemes whenever possible demonstrates the protection of the local setting as well as due diligence to avoid biodiversity loss as demonstrated with the Angel Building (see Case Study). The planting of new trees should be considered from the outset and many local authorities require confirmation that new trees shown on plans are provided with adequate growing environments both above and below-ground to thrive and be viable for the long-term.

National planning policies and guidance across the UK increasingly emphasise the need for trees in new developments. Pressure to provide both housing and tree planting targets may seem daunting but the simple principles of good practice from pre- to post-planning in TDAG's First Steps guide shows how this ambition can be met.

Alconbury Weald secures strong and fast returns

For this large project, master developer Urban & Civic have prioritised investment in the public realm, with significant amounts dedicated to the planting of mature trees and to tree retention. After the first homes went to market in April 2016, Savills reported: "*Sales rates in the first two months were higher than anticipated – two per week compared to the average of one per week on an average outlet. Sales values on a per square foot level were 16% above that expected. Given that the scheme is still in it very early phases, we would anticipate further uplift*"[10]. Interviews conducted two years later with Urban & Civic have confirmed Savills' expectations.

Threat to greenery brings community opposition

A YouGov/CPRE survey[11] (2017) asked 4,931 adults a series of questions relating to the building of new homes in an area. The results showed an almost equal balance between those who supported and those who opposed new housing developments, but it also showed that a large majority of people had never engaged with the planning process in any way. Of the minority who had done so, the main reasons for opposing new housing were firstly, pressure on local infrastructure and secondly, loss of green space and the negative impact on green spaces.

Investing in green infrastructure from the outset at Alconbury Weald. © Urban & Civic

[8] HM Government (2011), *Laying the foundations: a housing strategy for England.* London, UK: Stationary Office
[9] Building Better, Building Beautiful Commission (2019), *Creating Space for Beauty: Final Report* (2020)
[10] Savills (2016), Spotlight Development: *The Value of Placemaking.* London, UK: Savills
[11] For full survey results. https://d25d2506sfb94s.cloudfront.net/cumulus_uploads/document/m722hm6rfg/CPREResults_170805_housingdevelopment_W.pdf

1.1.2 Positive impacts on development quality and sustainability

Key points
With good design, early and continuous arboricultural input and appropriate post-planting care, trees can make significant contributions to development quality and sustainability. The economic, environmental and societal benefits accrued will enhance the performance of a development proposal against leading assessment methods on criteria such as:
- Creating welcoming, attractive and distinctive places.
- Creating boundary definitions.
- Creating wayfinding and landmark links.
- Encouraging walking and cycling.
- Making density work and moderating land use transitions.
- Creating visual and noise barriers.
- Enhancing thermal comfort.
- Dealing with stormwater sustainably and cost-effectively.
- Enhancing biodiversity.

Clause 131 of the *National Planning Policy Framework* (NPPF) (2021) requires that planning policies and decisions should ensure that new streets are tree-lined, that existing trees are retained wherever possible, that trees are included elsewhere in developments with appropriate long-term maintenance for new plantings.

It is increasingly common for developers to devise their own placemaking and design quality frameworks: the good integration of trees is highly relevant to most criteria or principles considered (see box right).

There are also industry-initiated schemes, such as *Building for a Healthy Life*[12], the latest edition of *Building for Life 12*, the companion document, *Streets for a Healthy Life*, published by Homes England[13] and the *Home Quality Mark*[14]. Some frameworks focus on specific aspects of design quality, such as public health with the *WELL Building Standards*[15], security with *Secured by Design*[16], green infrastructure with *Building with Nature*[17] or sustainability with the *Building Research Establishment Environmental Assessment Method*

Trees score highly across housebuilders' placemaking frameworks

Several developers have their own toolkit to articulate their design ethos, provide guidance, and enhance public confidence in their commitment to deliver quality places. While the principles somewhat differ, all include good landscaping with the careful integration of trees.

***Creating Great Places* initiative – Barratt Developments PLC**[18]
12 Standards: trees can contribute to 8 of these
Barratt Homes is seeking to ensure its internal design process delivers the standards that underpin *Building for Life 12*.

***Creating Successful Places Toolkit* – Berkeley Group**[19]
13 Criteria: trees can contribute to 9 of these
Working with Social Life and Reading University, this toolkit allows the assessment of new housing and mixed-use developments against some of the main ideas behind social sustainability, covering both the physical and social fabric of a neighbourhood (see photo below).

***Placemaking Design Principles* – Redrow Homes Limited**
8 Principles: trees can contribute to 6 of these
As part of its Creating Britain's New Communities initiative[20], Redrow engaged their design and planning teams in workshops which led to a placemaking framework[21] setting out eight design principles to achieve sustainable development across its sites.

Green links and parks enhance quality of life. © Berkeley Group

[12] See: www.designforhomes.org/project/building-for-life/
[13] See: www.tdag.org.uk/external-resources.html
[14] See: www.homequalitymark.com
[15] See: https://standard.wellcertified.com/well
[16] See: www.securedbydesign.com/guidance/design-guides
[17] See: www.buildingwithnature.org.uk
[18] Barratt Developments (2014). *Great Places*
[19] Berkeley Group (2014). *Creating Successful Places: A Toolkit*
[20] Redrow Homes (2017). *Creating Britain's New Communities*
[21] See: www.redrowplc.co.uk/about-redrow/our-values/thriving-communities/

(BREEAM)[22]. The effective integration of trees invariably enhances a scheme's performance across a large proportion, if not a majority, of the criteria considered by all of these frameworks, often making a significant contribution towards the final score.

Creating welcoming, attractive and distinctive places

Views of nature (such as trees) from homes[23] along with good local tree cover[24] have been found to be among the best predictors of residents' satisfaction with their neighbourhood. Trees add beauty, providing unique colours, shapes, textures and light play. Their leaves can bring soothing sounds and some trees offer delightful smells. Their impact changes with the seasons, adding to our memories and sense of place. The retention of existing trees in a new development creates an instant and unique character. This ability is even greater with heritage or veteran trees, which bring additional aesthetic, cultural and historical appeal.

Warm tones of autumn leaves. © TDAG

Rich hues and texture of bark. © TDAG

Energising colour and scented blossom. © TDAG

[22] See: www.breeam.com
[23] Kearney, AR (2006). *Residential Development Patterns and Neighborhood Satisfaction: Impacts of Density and Nearby Nature.* Environment and Behavior, 38(1), 112-139
[24] Abass, ZI and Tucker, R (2018). *Residential satisfaction in low-density Australian suburbs: The impact of social and physical context on neighbourhood contentment.* Journal of Environmental Psychology 56, 36-45

Trees and hedges can contribute to the functional performance of place

Large tree signifies junction, aids wayfinding and cools hard surfaces. © TDAG

Existing mature or veteran trees provide continuity, character and enhanced value. © TDAG

Hedges delineate a boundary and reduce pollution, noise and unwanted views. © TDAG

Trees frame the view towards Bristol Cathedral. © Paul Rafferty

Creating wayfinding and landmark links

Trees can help provide structure and legibility to a scheme, which, from an end user perspective contributes to the positive experience of place, while, from a commercial standpoint enhances and extends any development's branding and visual style. Such use of vegetation, especially trees, is not just advocated by landscape design specialists, it is also championed by signage and wayfinding providers[25].

Encouraging walking and cycling

Once basic walking and cycling infrastructure is in place and provides good connectivity, the presence of nature, including street trees, can increase levels of these physical activities[26]. Trees can enhance comfort through shade, provide a barrier from vehicular traffic, add characterful markers that help navigation, and alter perceptions of distance, making routes feel shorter[27]. The Covid 19 pandemic highlighted the importance of walking and cycling for their many benefits and led to a rethink of how we use our road space – with less given to motorised vehicles. Some cities such as Milan, Barcelona, Paris, Budapest and Bogata have made significant changes to reduce car use. Low Traffic Neighbourhoods (LTNs) are becoming more widespread in the UK.[28]

Green connections between different densities and land uses

While densification can provide many benefits, there is a tension between the idea of the compact city and people's inherent need for nature, privacy, quiet and space. Research[29] has shown that the strategic use of greening enhances denser residential areas, with trees being identified as the most valued green infrastructure intervention. Covid-19 and 'lockdowns' highlighted the need for access to nature in urban environments[29,30]. Trees also have a mediating and moderating effect when there is a significant change in the land use of adjoining areas (land use transition) for example whether from rural to urban or residential to industrial (see box right).

Creating visual and noise barriers

Trees clearly have a role in overcoming visual issues, providing screening and giving residents a sense of control over boundaries. Mitigating noise is more complex. Reviewing the science, Forest

Making density work for people and place

The World Health Organisation (WHO)[31] recommends that every city should provide a minimum of 9 square metres of accessible, safe and functional urban green space for each person with an ideal amount of green space of as much as 50 square metres per person. Research has shown that urban dwellers are much happier and healthier when this minimum are exceeded.

In a recent report, *Home Comforts* (2020) by the Place Alliance[32] looked at how the design of homes and neighbourhoods affected people's experience of Covid-19 lockdowns and what can be learned for the future.

Looking at some of the issues relating to the accessibility of open space, houses were considered more comfortable than flats especially for those in buildings of more than five storeys. The highest priority for comfort was the need to access private open space. Those households with private gardens or terrace space were most comfortable. Urban living was felt to be as good as rural or suburban areas and most residents felt that their local neighbourhoods met their daily needs well although newer neighbourhoods were rated less highly.

Parks and greenery were considered to be the top neighbourhood requirement. Proximity to a park or significant green space within a five minute walk was the strongest predictor of satisfaction with neighbourhoods and even a ten minute walk was considered too far. Generally, space for walking and cycling on quieter streets was highly valued.

In *The Housing Design Handbook*[33], the point is made that since the National Planning Policy Framework (NPPF) was published in 2012, housing densities have increased well beyond the 'ceiling' of 150 dwellings per hectare (dph). Low density is now measured as 35-90 dph; medium as 90-250 dph; high as 250-350+ dph and tall (highest) as 350+ dph. High and tall can both involve housing people in tall buildings and for all developments, but especially with tall buildings, it is vital to avoid what is described as 'anti-social microclimates'. The book illustrates different ways of achieving all these densities on a one hectare plot. Designing housing layouts should also take into account the criteria set out in *Building for a Healthy Life* (2020). In the light of Covid-19 and the increased need for access to nature and open space, it is important to provide the necessary areas of open space on a site.

Overleaf are four real life examples of the different levels of density with the common thread of fostering the creation of a sense of place.

[25] See: www.asisignage.com/2010/12/23/using-nature-for-wayfinding-solutions/
[26] See paragraph 2.2.4, TDAG (2014). *Trees in Hard Landscapes: A Guide for Delivery*. www.tdag.org.uk/trees-in-hard-landscapes.html
[27] Tilt, JH, Unfried, TM, and Roca, B (2007). *Using Objective and Subjective Measures of Neighborhood Greenness and Accessible Destination...* American Journal of Health Promotion 21, 4:371-379
[28] See: https://londonlivingstreets.com/low-traffic-liveable-neighbourhoods/
[29] Buxton, JA (2018). *Attitudes toward green infrastructure strategies for more livable and sustainable communities*. Doctoral dissertation. University of Massachusetts Amherst
[30] Kaplan, R (1983). *The Role of nature in the urban context*. In Altman, I, and Wohlwill, J. F. (eds). Behavior and the natural environment (pp 127-161). New York: Plenum Press
[31] Russo, A and Cirella, GT (2018). *Modern Compact Cities – How much greenery do we need?* Int. J. Environ. Res. Public Health 2018, 15(10), 2180
[32] See: www.placealliance.org.uk/wp-content/uploads/2020/10/Place-Alliance-Homes-and-Covid-Report_2020.pdf
[33] David Levitt, Jo McCafferty (2019) *Housing Design Handbook* 2nd Edition Routledge

Making density work in new developments

Low density
(35-90 dph)

Abode, Great Kneighton
(60% private, 40% affordable)
Actual density: 35 dph
The majority of homes have some form of external private amenity space. In addition, the communal landscape areas provide about 68 square metres per dwelling.
Architect: Proctor & Matthews Architects
Landscape Architect: BBUK Studios and Townshend
Client: Countryside Properties
Completion: 2014

Countryside aims to retain existing trees and hedgerows to set a framework for their masterplans and enhance biodiversity. Here the existing shelter belt was extended with a new woodland edge bleeding into the site. There are willows in rain gardens around the access roundabout; bosquets of 14 trees at 6 metre centres adjacent to the 'great court'; mews streets and squares with groups of 2-4 trees; unadopted green lands with rain gardens and trees in small groups. Linear routes and landscape layers are designed to create wildlife corridors. The trees were chosen in accordance with the Cambridge Landscape Guidelines to provide seasonal colours and interest.

Drawing: © Proctor & Matthews Architects

Photos: © Countryside Properties

Making density work in new developments

Medium density
(90-250 dph)

Harvard Gardens, Walworth, London
(48% private, 52% affordable)
Actual density: 167 dph
Each dwelling has some private open space, with gardens for family homes and balconies for flats. The public and communal open space provides about 14 square metres of open space per dwelling. In total 58% of the open space is public and 42% is private.
Architect: Pollard Thomas Edwards
Landscape Architect: AREA
Client: L & Q
Completion: 2017

As part of the Aylesbury Estate regeneration, Harvard Gardens knits this part of the estate back into the physical fabric of the area. A pedestrian mews street separates two urban blocks which are centred around private gardens leading to a shared open space.

Retention of the three highest quality existing trees was considered essential and included the only tree on-site to pre-date the original estate. These three large London Planes were given prominent gateway locations within the new development layout set in generous beds planted using hand-dig methods with low growing shade-tolerant perennials and grasses. A new bridging walkway was introduced to take pedestrians on a desire line under the canopy of two of these key trees, avoiding future compaction.

Selection criteria for the 12 species of new trees included resilience to climate change and pests and diseases, tolerance of pruning, clay soils and pollution, and variety of form, colour and seasonal characteristics, including flowering and fruiting.

All new tree pits were designed with a generous (or continuous in the case of street tree planting) rooting zone through use of soil vaults. The base of these pits was excavated to the natural gravel formation level beneath the London Clay sub soil and made up with gravel where required to ensure good drainage. Permeable paving was specified to support irrigation and ventilation. All trees were maintained for 24 months post-planting by the installing contractor.

Drawing: © AREA
Photo: © Tim Crocker

Making density work in new developments

High density
(250-350+ dph)

Camden Courtyards
(50% private, 50% affordable)
Actual density: 400 dph
The total open space on the site provides approximately 15 square metres per dwelling.
Architect: Sheppard Robson
Landscape Architects: Exterior Architecture
Client: Barratt Homes
Completion: 2017

The buildings reach a maximum of seven storeys with dual aspect apartments each with a private balcony. There are two tranquil courtyards at the heart of the scheme and two large landscaped roof terraces.

The general landscape approach was to retain existing trees as they offer maturity to any site. New tree planting focused on species diversity, increasing canopy cover where possible and creating seasonal variations.

The retention of the trees on the front of the site supported the continuous planting along Camden Road, buffering the buildings against the effects of traffic and providing the respite of canopy cover in a hard urban environment. Additional new planting of London Plane trees, filled the gaps and created continuity with the existing species.

In the courtyards, conditions for trees were heavily constrained by light levels and so suitable species selection and placement was vital. Each courtyard is identified with a feature tree. The planting specification was designed with root cells and sufficient soil volumes to ensure longevity.

On the terraces, smaller tree species are planted on raised beds to provide compact lower-level screening, framing views and creating seasonal changes to all the key roof spaces.

Drawing: © Sheppard Robson
Photo: © TDAG

Making density work in new developments

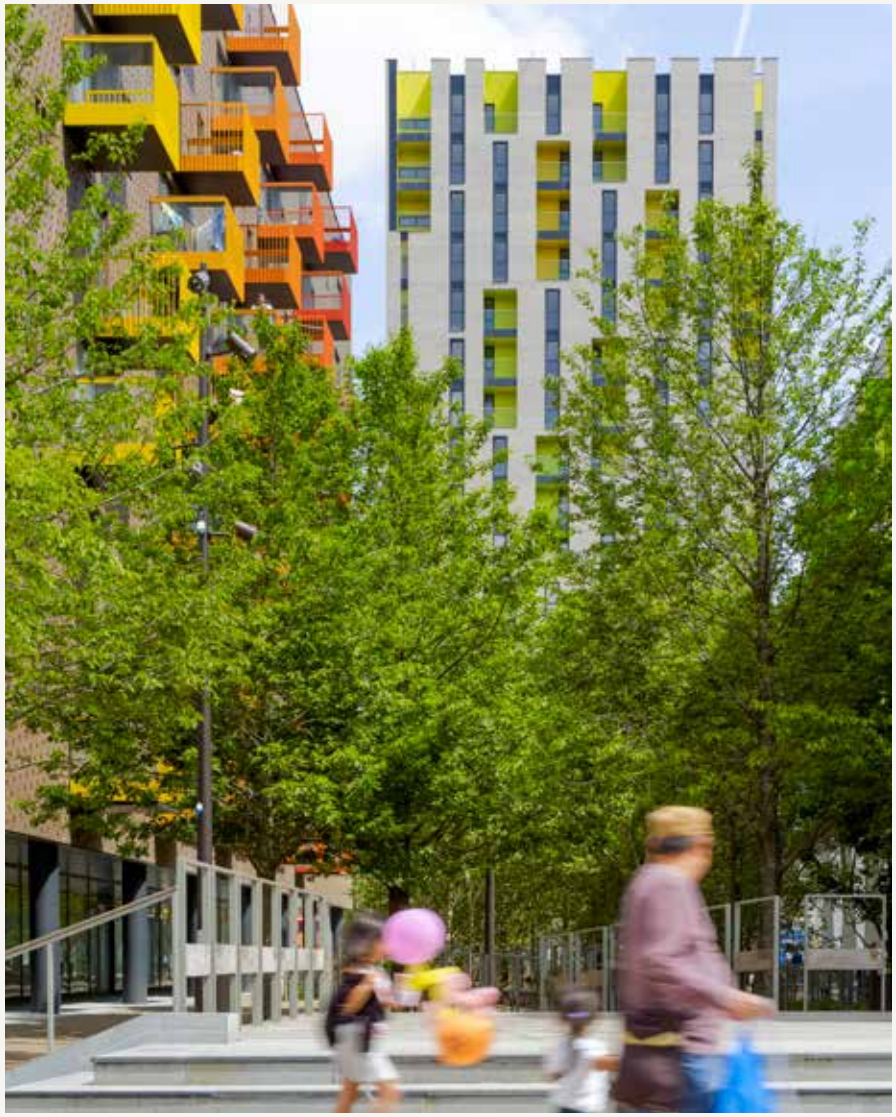
Highest density
(350+ dph)

Barking Central Phase Two
(44% owner-occupiers, 48% private tenants, 8% social tenants)
Actual Density: 403 dph
The buildings enclose a linear 'arboretum'. There is new town square in front of the existing town hall. Each flat has a private balcony or terrace.
Architects: Allford Hall Monaghan Morris
Public space and arboretum: muf architecture/art
Client: Redrow Regeneration and LB Barking & Dagenham
Completion: 2010

Barking Central is a mixed-use regeneration project adjacent to the existing town hall.

The second phase includes residential buildings, the tallest of which is 17 storeys, a hotel, a shed for 250 bikes plus retail units and a café.

Civic engagement is an important part of the scheme with an extensive new town square and an arboretum taking trees into the heart of the development.



Derbyshire, B, Goulcher, M, Beharrell, A and von Bradsky, A (2015). *Superdensity: The Sequel*. London, UK: HTA/Levitt Bernstein/ Pollard Thomas Edwards/ PRP Architects. www.pollardthomasedwards.co.uk/download/SUPERDENSITY_2015_download.pdf

Photos: © Timothy Soar

Research indicates that urban greenspace can mitigate noise marginally by planting trees and shrubs as 'noise buffers' (see box top right).

Enhancing thermal comfort

Trees can affect all four environmental factors impacting human comfort: air temperature, radiant temperature, air velocity and humidity[34]. As a result, trees can modify local climate conditions at macro- (eg city/neighbourhood) and micro- (eg site) scales[35], with associated impacts being felt both outdoors and indoors[36].

While trees have commonly been used on farmlands across the UK to provide wind breaks, they are increasingly valued in built-up settings to reduce wind chill and help mitigate funnelling, vortexes, downdraughts and other adverse wind effects associated with high-rise buildings. Trees alone cannot be expected to compensate for poor building design and layout, but they can offer a good additional solution to help break up airflow and address outstanding wind issues once all other architectural and composition options have been exhausted.

A lot more demand is to be expected in the future in respect to cooling. In South East England especially, one of the most significant design challenges posed by climate changes is excessive indoor temperatures. This concern led to the introduction in the 2016 revision of the London Plan for major development proposals to demonstrate how they will reduce the potential for overheating and reliance on air conditioning systems. This requirement has been retained in the 2021 London Plan[37]. Trees provide an effective solution towards reducing excess heat in both low-rise buildings and open space via shading and evapotranspiration (see box bottom right). Trees have a role in climate-based masterplanning.

Trees and noise mitigation and attenuation

The contribution of trees for urban noise reduction is through the scattering and absorption of sound waves by the leaves, branches and trunks, thus obstructing the pathway between the noise and the receiver. Woodland can additionally attenuate noise, particularly low frequency noise, through its generally soft and porous ground cover which can absorb sound waves. The visual barriers provided by trees and woodland can also reduce the perceived volume and psychological impact of noise. Specifically, trees with broad leaves and/or high leaf surface can attenuate noise more effectively than narrow-leaved species. The trunk diameter of large trees can attenuate more noise as can densely planted and deeper tree belts. If roads carrying fast moving traffic and heavy vehicles are within 100 metres of housing, the belts must be tall and wide (eg 30 metres) to reduce sound to an acceptable level and noise barriers should be located close to the source of the noise, not half way between the source and the receiver. Widely spaced trees along streets (ie more than 3 metres apart) do not absorb noise but their presence may improve tolerance to noise.[38]

Climate-based spatial planning can use trees to influence building performance and save energy

Climate change means that the UK's climate zones are moving south. Nature-based solutions and climate-based spatial planning are becoming central to decision-making for the design and performance of buildings and the quality of place. In the northern hemisphere tree shading alone has been found to reduce the energy use up to 24% for a single-storey building with 30% increase in tree cover, corresponding to three trees per house[39]. In winter shading can increase heating demand requiring the choice of deciduous trees. Reductions in electricity demand for cooling resulting from tree shade during the summer usually far outweigh any increase in demand for winter heating.

Well-placed trees can both enhance outdoor shading to counter solar radiation reflected by low-rise buildings in summer and some reduction in wind speed. Street orientation influences the best positioning for street trees, eg for an east-west street, planting trees on the 'sunny' north side is the most useful. A north-south running street will be mostly in shade except near noon and so the positions for tree planting can be more flexible.[40]

Wind can come from any direction, but the prevailing wind usually dominates. Sheltering of buildings from the wind can reduce winter heating costs. Vegetation with 50% porosity will slow wind speeds. Wind-tolerant species must be selected as most plants tend to respond to persistent windy by closing their leaf pores (stomata) to reduce water loss. This action also limits the plants' ability to breath and therefore grow.

[34] Armson, D, Stringer, P, and Ennos, AR (2012). *The effect of tree shade and grass on surface and globe temperatures in an urban area*. Urban Forestry and Urban Greening 11, 245-255
[35] Rahman, MA and Ennos, AR (2016) *What we know and don't know about the cooling benefits of urban trees*. London, UK: TDAG
[36] Mavrogianni, A, Davies, M, Taylor, J, Chalabi, Z, Biddulph, P, Oikonomou, E, et al. (2014). *The impact of occupancy patterns, occupant-controlled ventilation and shading on indoor overheating risk in domestic environments*. Build Environ. 78:183–98
[37] See: www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf
[38] See: https://www.forestresearch.gov.uk/publications/delivery-of-ecosystem-services-by-urban-forests/
[39] Akbari, H and Taha, H (1992). *The impact of trees and white surfaces on residential heating and cooling energy use in 4 Canadian cities*. Energy 17, 141-149
[40] Chatzidimitrou, A and Yannas, S (2017). *Street canyon design and improvement potential for urban open spaces; the influence of canyon aspect ratio and orientation on microclimate and outdoor comfort*. Sustainable Cities and Society 33, 85-101

Dealing with stormwater sustainably and cost-effectively

In January 2023 the government decision to implement Schedule 3 of the Flood and Water Management Act 2010 making it mandatory for all new developments in England to incorporate Sustainable Drainage Systems (SuDS) was announced. This is expected to be implemented in 2024, following Wales which did so in 2019[41]. Where possible trees should be combined with SuDS. Trees also contribute to surface water management through canopy interception, evapotranspiration, infiltration and bioretention[42] and appropriately designed tree rooting environments also provide water retention and pollutant removal. Incorporating trees in the drainage strategy offers a cost-effective solution towards attenuation and water quality management, while also enhancing the chances of survival of the trees themselves as lack of accessible water resources is a major challenge for young urban trees.

Enhancing biodiversity

The presence of trees provides a significant boost for wildlife and enhances biodiversity and ecological health. The retention of existing trees and hedges, and the associated soil resources, is a particularly effective strategy for optimising these biodiversity benefits. See Biodiversity Net Gain (BNG) and ecology, page 25.

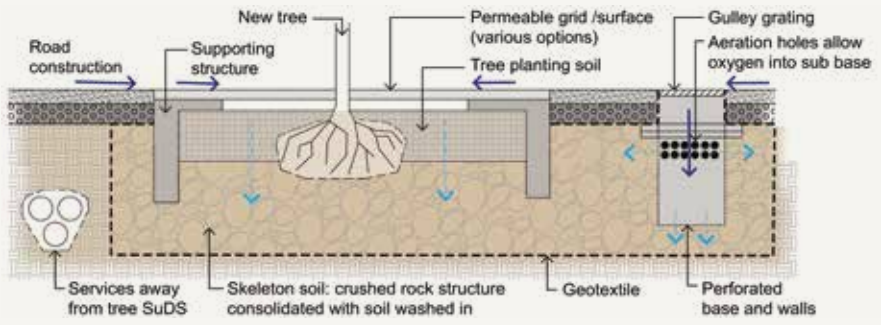
1.1.3 Positive impacts on wider policy objectives

Key points

Trees should be considered as part of the basic infrastructure and therefore a considered approach to their integration in the built environment is an effective mechanism to create places that perform above and beyond average, with stronger outcomes across some of the most important agendas driving national and local policies, including:

- Economic growth.
- Health, wellbeing and community cohesion.
- Safe and sustainable transport.
- Climate resilience.
- Biodiversity net gain and ecology.
- Culture, heritage and identity.

Trees and SuDS to reduce peak flows[43]



The skeleton soil system integrating trees and SuDS for combined benefits for new developments. © CIRIA C768

DeepRoot SilvaCells used for retrofitting tree planting in Howard Street Salford, where three years of monitoring rainfall events by the University of Manchester showed an average reduction of 85% in peak and 80% in volume, with a peak-to-peak delay of 118 minutes. © DeepRoot

[41] See: https://www.gov.uk/government/news/new-approach-to-sustainable-drainage-set-to-reduce-flood-risk-and-clean-up-rivers#:~:text=Schedule%203%20provides%20a%20framework,the%20lifetime%20of%20the%20development

[42] See pp 59-60, TDAG (2014). *Trees in Hard Landscapes: A Guide for Delivery.* London: TDAG. www.tdag.org.uk/trees-in-hard-landscapes.html

[43] Illman, S and Wilson, S (2017). *Guidance on the construction of SuDS, C768*, London, UK: CIRIA

Economic growth

Trees affect a local economy in more ways than are immediately obvious. Research indicates that trees in retail areas have an impact on consumer behaviour: shoppers are willing to travel farther, stay longer, visit more frequently and pay more[44] (see box top right). Visual access to greenery, such as simple views onto trees in office environments has been shown to enhance workers' performance[45] (see box middle right). As an important component of high-quality public realm, trees are also a valuable factor in strategies aiming at attracting inward investment, supporting job creation[46] and making attractive places to work.

"Retail marketers use 'atmospherics' to set the stage for shopper behaviours. Trees are an outdoor atmospheric that set up favourable impressions, including cues about social interactions. Shoppers buy things to satisfy needs, and also to enjoy positive experiences with friends and family. The streetscape can be a welcoming place, and shape consumer expectations before even entering a store."

Dr Kathleen Wolf, lead researcher on trees and successful retail environments

Health, wellbeing and community cohesion

Evidence pointing to the association between exposure to trees and a wide range of beneficial public health outcomes (see box overleaf) is growing at a very fast pace (see box bottom right).

Why might views onto trees or green roofs increase performance at work?

Providing office workers with views of urban nature – as can be created by street tree canopies surrounding a building – seems to have significant impact on work productivity. A team of researchers led by Kate Lee at University of Melbourne gave 150 subjects a menial, computer-based task that required a high level of sustained attention. After five minutes the subjects were given a 40-second break, and an image of a rooftop surrounded by tall buildings appeared on their screens. Half the subjects saw a plain concrete roof; the others saw a roof covered with a green, flowering meadow. After the break, concentration levels fell by 8% among the people who saw the concrete roof, whose performance grew less consistent. But among those who saw the green roof, concentration levels rose by 6% and performance held steady. To explain their findings, Kate Lee and her team drew on attention restoration theory: *"The theory is that because nature is effortlessly fascinating, it captures your attention without you having to consciously focus on it. It doesn't draw on your attention control, which you use for all these daily tasks that require you to focus. So, gazing at natural environments provides you with an opportunity to replenish your stores of attention control."*[47]

What can nature-based solutions tell us about urban trees and their benefits to public health?

Few studies to date have compared the impacts of different types of urban vegetation, but those that have provide interesting insights. For example, one study conducted in New York City found beneficial health associations of trees to be somewhat stronger and more consistent than those for grass, the other most prevalent type of vegetation in urban areas. In addition, exposure to trees (and, to a lesser extent, grass) showed positive associations with better self-reported health when maintaining a constant exposure to parks and open spaces[48]. This points to the special role that trees have in enhancing any community, bringing nature closer to where people live, work and shop, even in the densest urban neighbourhood.

[44] Wolf, KL (2005), *Business district streetscapes, trees, and consumer response.* Journal of Forestry, vol. 103, issue 8, pp. 396-400
[45] Lee, KE, Williams, KJ, Sargent, LD, Williams, NS, and Johnson, KA (2015). *40-second green roof views sustain attention: The role of micro-breaks in attention restoration.* Journal of Environmental Psychology, 42(6), 182-189
[46] Gore, T, Eadson, W, Ozdemiroglu, E, Gianferrara, E and Phang, Z (2013). *Green Infrastructure's contribution to economic growth: a review.* DEFRA Project Report WC0820. London: Eftec
[47] Torres, N (2015). *Gazing at Nature Makes You More Productive: An Interview with Kate Lee.* Harvard Business Review, September 2015, pp. 32-33
[48] Reid, C, Clougherty, J, Shmool, J, Kubzansky, L (2017). *Is all urban green space the same? A comparison of the health benefits of trees and grass in New York City.* Int. J. Environ. Res. Public Health.14:1411

The value of trees to promote health for people and place in urban environments

Healthy people

High birth weight for infants and reduced levels of toddler obesity – forest schools, play spaces shaded by trees and more activity

Students have reduced stress levels, improved concentration and learning. Schools should have views of trees and landscapes

Inviting environments for adults to embrace active travel – walking, cycling with tree canopy cover in hot weather, and protection from vehicles

Urban woodlands help contribute towards a sense of self-worth

Encourage the less-able to be outside – pedestrian friendly walkways, tree cover, places to rest and socialise

Engagement with trees and nature reduces stress and improves mental health for everyone, with positive impacts on non-communicable diseases

Increase summer cooling, reduce peak-flow rainfall, and reduce heating and cooling costs for buildings

Create seasonal interest throughout the year. Support biodiversity and provide green links

Tree-lined streets promote calmer driving. Trees can separate transport modes to encourage both walking and cycling

Trees help create a sense of place, encourage social activities and build stronger, friendlier communities

Contribute to improved urban air quality

Support retail by increasing dwell-time and higher spend

Having nearby nature improves job satisfaction, reduces job related stress, and promotes creativity

Lower levels of violence and crimes

Healthy places

Having nearby trees supports people's health in two general ways: the urban forest promotes and protects good health, helping people to be at their best, but, should they become ill, trees provide healing and therapy benefits.

Wolf, KL, Lam, ST, McKeen, JK, Richardson, GRA, van den Bosch, M, & Bardekjian, AC (2020). *Urban Trees and Human Health: A Scoping Review.* Int J Environ Res Public Health, 17(12), 4371

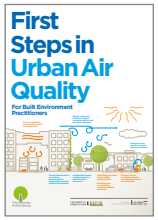
Green Cities: Good Health. www.depts.washington.edu/hhwb/
Human Dimensions of Urban Forestry and Urban Greening. www.naturewithin.info

The health benefits of trees are felt throughout our lives (see page 20). For example, the proximity of trees (urban forest canopy) to households has been associated with higher birth weights[49], lower prevalence of obesity among pre-schoolers[50], enhanced academic performance among primary school children[51] and enhanced overall adult health[52]. Access to tree-rich environments, such as urban woodlands, has also been associated with enhanced wellbeing and sense of self-worth[53] together with a lower need for medication among people with early stage dementia.

Importantly, evidence shows strong positive impacts on some of the most challenging health issues the UK is facing today: particularly chronic non-communicable diseases such as heart disease, diabetes, respiratory disease and mental illness, all of which may have also contributed to increased deaths from Covid-19.

It is also important to recognise that trees can also have a negative impact on human health for some people through adverse effects on air pollution as well as asthma and allergenic sensitisation[54]. An informed approach to design and tree species selection can prevent most of these occurrences which can be overcome by avoiding:

- Planting patterns likely to generate a continuous canopy in street canyon environments with high levels of pollution emission at ground level can prevent pollution dispersion.
- Creating concentrations of allergenic tree species in the built environment, especially in proximity to buildings hosting potentially sensitive users (eg nurseries, schools, hospitals and carehomes). An informed approach to tree species selection can enhance benefits and reduce any adverse health effects.



TDAG's guide compiles the basics built environment professionals need to know about urban air quality and how design of our urban infrastructure – including green infrastructure – determines where air pollution is produced, and how it disperses.

Visual access to greenery in New Street Square, City of London. © TDAG

[49] Donovan, GH, Michael, YL, Butry, DT, Sullivan, AD and Chase, JM (2011). *Urban trees and the risk of poor birth outcomes.* Health Place. 17:390–393
[50] Lovasi, GS, Schwartz-Soicher, O, Quinn, JW, Berger, DK, Neckerman, KM, Jaslow, R, Lee, KK, Rundle, *A Neighborhood safety and green space as predictors of obesity among preschool children from low-income families in NYC.* Prev. Med. 2013;57:189–193
[51] Sivarajah, S, Smith, SM and Thomas, SC (2018). *Tree cover and species composition effects on academic performance of primary school students.* PLoS ONE 13(2): e0193254
[52] Ulmer, JM, Wolf, KL, Backman, DR, Tretheway, RL, Blain, CJA, O'Neil-Dunne, JPM and Frank, LD (2016). *Multiple health benefits of urban tree canopy: The mounting evidence for a green prescription.* Health Place. 42:54–62
[53] Cook, M (2015). Research Note: *Forests as places of mental well-being for people with dementia.* Forest Research, UK
[54] Lovasi, GS, O'Neil-Dunne, JP, Lu, JW, Sheehan, D, Perzanowski, MS, Macfaden, SW, King, KL, Matte, T, Miller, RL, Hoepner, LA, et al. (2013) *Urban tree canopy and asthma, wheeze, rhinitis, and allergic sensitization to tree pollen in a New York City birth cohort.* Environ. Health Perspect. 121:494–500

Safe and sustainable transport

Potential housing developments and economic opportunities must be linked to an effective urban transport system – one that supports multi-modal use and active travel in particular. Trees can make a significant contribution to the environmental and placemaking qualities and effectiveness of these transport systems. This is one of the central themes explored in TDAG's *Trees in Hard Landscapes: A Guide for Delivery*[55]. Trees can slow-down motorised traffic and help drivers better read key changes such as approaches to intersections and built-up areas. Trees also help to make streets attractive for walking, cycling and using public transport. Research conducted for Caltrans[56] has shown that street trees and similar landscape features are among the top five factors determining people's choice of walking route and length of walk to a bus stop or train station. Looking at housing/community development going forward it is essential that these are linked to sustainable transport systems and are not car dependent developments. The work of Transport for New Homes[57], Connected Cities[58] and the 15 Minute City[59] offer insights into these issues.

Climate resilience

The top two climate risks for the UK are excess heat and increased flood risks[60]. Trees can contribute to mitigating both. The Planning and Compulsory Purchase Act (2004) includes a duty on plan making to mitigate and adapt to climate change.[61]

Handling excess heat

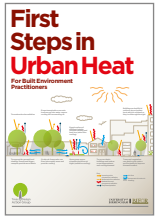
Trees have a key role to play in reducing urban temperatures by providing shade to both public space and low-rise buildings and by the process of evapotranspiration which provides a cooling effect on the surrounding area. Trees also contribute to creating cooler urban environments by reflecting heat away and storing less heat than most artificial materials (see box overleaf and box page 24). This is important given that climate predictions suggest that we will experience hotter summer temperatures with temperatures reaching 30+°C and research has shown that there is an increase of 3% in deaths in London, for example, for every one degree over 21°C increase in temperature[62].

Rethinking transport to reclaim streets from traffic domination to social places for people, applies to new developments as well as existing streets. Sauciehall Street, Glasgow, Urban Movement and Civic Engineers. © Urban Movement

"Urban places are inherently social places... streets must nurture this conviviality... the challenge is to ensure that this is built deep into new streets, because this is how to make successful places for all involved."

Christopher Martin, Urban Movement

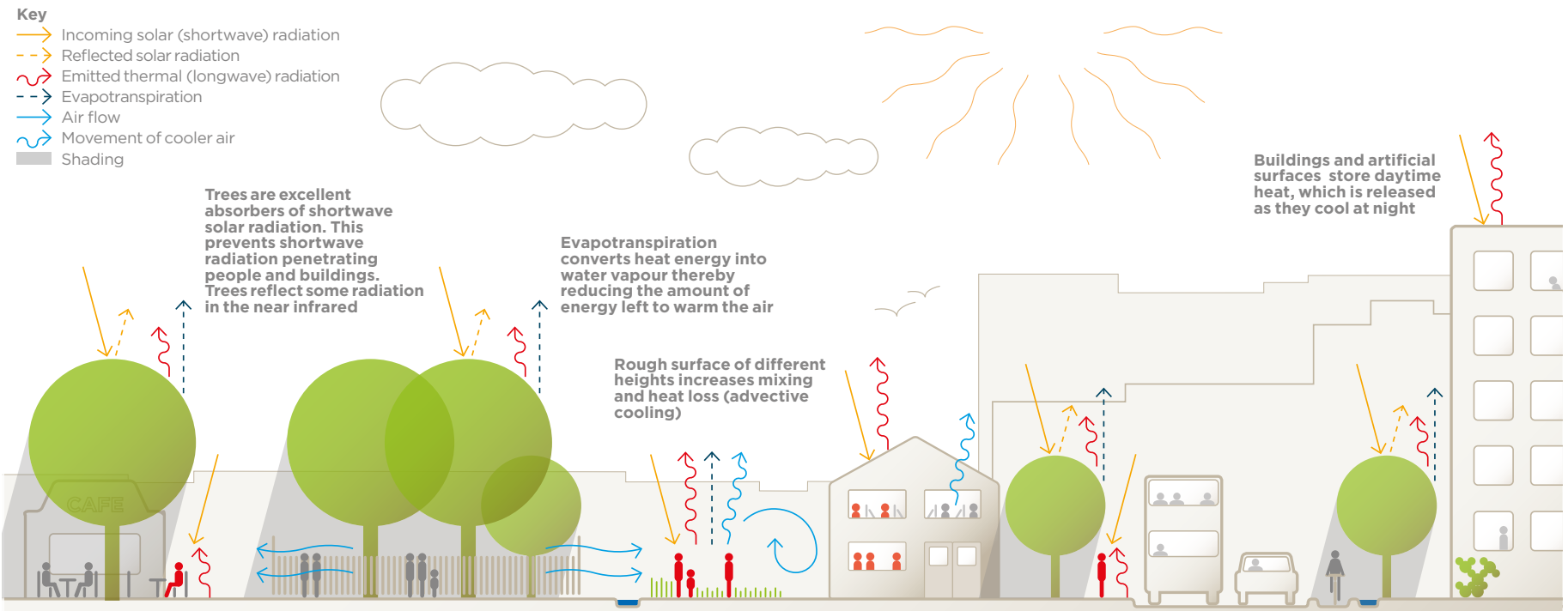
TDAG's guide explores the key four building blocks to success – collaborative process, designing with trees, technical design solutions and species specific criteria.



TDAG's guide overviews the sources and circulation of heat within our urban areas, including the cooling benefits provided by green infrastructure, and other cooling solutions.

[55] See pp. 55-57. www.tdag.org.uk/trees-in-hard-landscapes.html
[56] The agency responsible for highway, bridge, and rail transportation planning, construction, and maintenance in the State of California in the US
[57] See: www.transportfornewhomes.org.uk/
[58] See: https://www.connectedcities.org/
[59] See: https://www.15minutecity.com/about
[60] UK Climate Change Risk Assessment Evidence Report. www.theccc.org.uk/uk-climate-change-risk-assessment-2017/
[61] See: www.legislation.gov.uk/ukpga/2004/5/section/19
[62] Hajat, S, Kovats, RS, Atkinson, RW, Haines, A, (2002). *Impact of hot temperatures on death in London: a time series approach.* Journal of epidemiology and community health, 56 (5). pp. 367-372

The role of trees and other vegetation in urban cooling – four key mechanisms: Evapotranspiration, shading, reflecting solar radiation and storing less heat



Urban trees
Trees provide ground-level cooling by blocking solar radiation. Denser and bigger canopies provide more shade

Trees typically store less heat than artificial materials, and therefore emit less heat at night

Urban park
Urban parks or canopy cover with a density >40% can be up to 1.5°C cooler than surrounding areas[63]

The cooler air from urban parks can provide cooling in leeside areas via plumes of cool air passing through

Open greenspace
Parks, gardens and other open spaces with more sky visible help cool the surface by facilitating the loss of long-wave radiation at night (radiative cooling)

Shaded building
Suitably positioned trees can provide shading to low rise builds to reduce room temperatures and reduce the need for air-conditioning

Shading transport routes
Trees can improve the thermal comfort of transport corridors such as cycle lanes by shading and evapotranspiration*

*When there is sufficient water availability

Urban areas are often warmer than surrounding rural areas, particularly at night. This is the Urban Heat Island (UHI) effect. Artificial surfaces, that typically absorb and store more heat contribute to the UHI, whereas trees and vegetation provide cooling. Summer days could be up to 5.8°C warmer by 2070, with heatwaves and hotter summers becoming more common.[64]

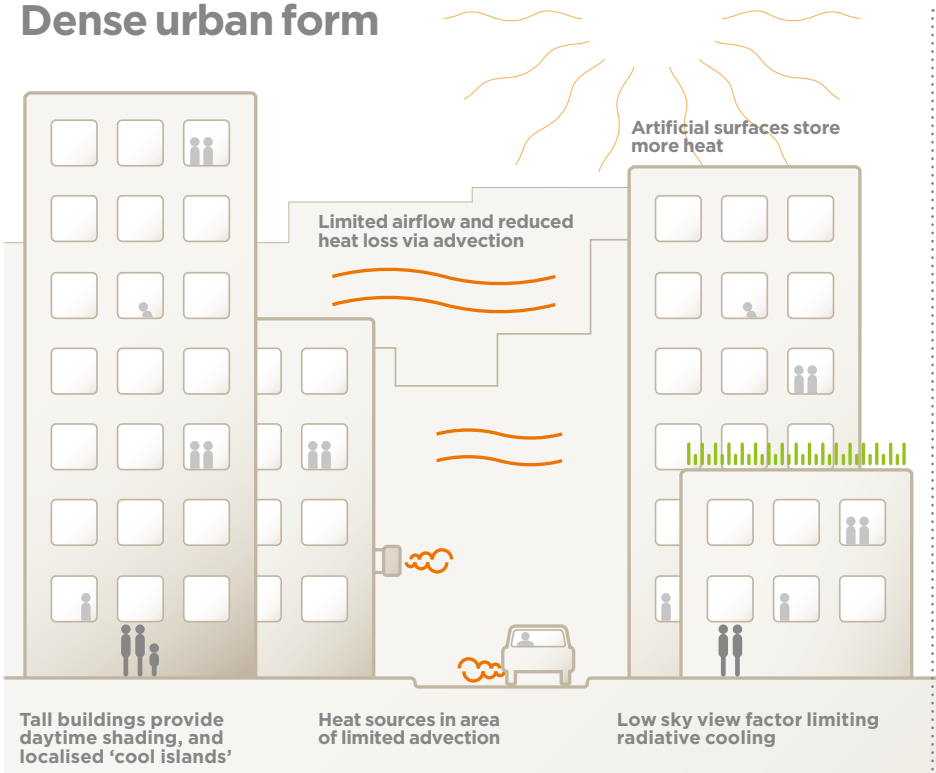
[63] Ziter, CD, Pedersen, EJ, Kucharik, CJ and Turner, MG (2019). *Scale-dependent interactions between tree canopy cover and impervious surfaces reduce daytime urban heat during summer.* Proceedings of the National Academy of Sciences, 116(15), pp.7575-7580

[64] Met Office (2019) *UKCP18 Science Overview – Executive Summary*

Ferranti, EJS, Futcher, J, Salter, K, Hodgkinson, SPB, and Chapman L (2021). *First Steps in Urban Heat for Built Environment Practitioners.* London, UK: TDAG

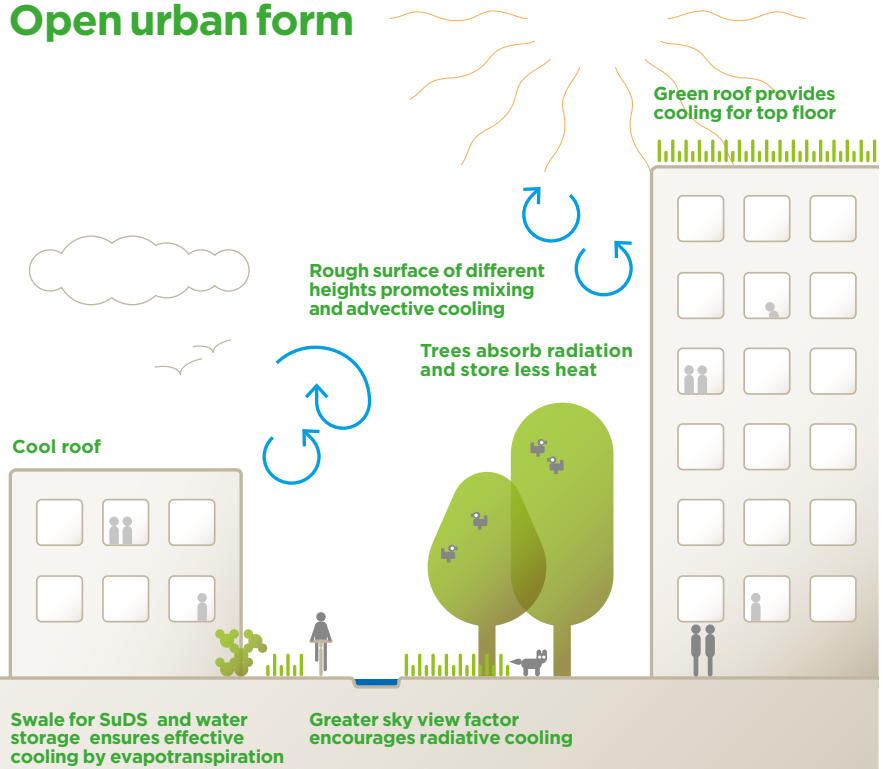
Overheating risk is seasonal (ie more common on hot days), and is driven by urban form, building function and vegetation

Dense urban form



Dense urban form with little vegetation has a high night time overheating risk. This is of low importance for daytime offices, but important in residential settings

Open urban form



Open urban form with more vegetation has lower night time overheating risk suiting residential land use

Dense urban areas are warmer during the day, and cool more slowly at night. Open form and more vegetated areas are often less warm during the day and cool more quickly at night. Built environment practitioners should consider urban form and building function to understand overheating risk to avoid placing vulnerable communities in areas of high overheating risk.

Ferranti, EJS, Futcher, J, Salter, K, Hodgkinson, SPB, and Chapman L (2021). *First Steps in Urban Heat for Built Environment Practitioners.* London, UK: TDAG

Handling excess stormwater

The UK is experiencing an increasing number of heavy rainfall events. Trees are powerful assets to help manage stormwater runoffs with their ability to:

- **Intercept rainwater**. Trees catch rain in their foliage and branches, some of which evaporates while the remainder is slowly released back on the ground. This reduces demands on surface drainage, thereby reducing the risk of flooding and erosion.
- **Facilitate stormwater infiltration and attenuation**. Tree root growth and decomposition increase soil infiltration rates and overall infiltration capacity. Designing tree rooting environments to help reduce the volume and rate of surface water runoff entering the drainage system is an important component of well-designed SuDS, while also providing trees with a better chance to thrive[65].
- **Remove stormwater runoffs pollutants**. Pollutants removal mechanisms include filtration, absorption and uptake, and sequestration in plant material.

Biodiversity net gain and ecology

The 'Dasgupta Review' showed our lives and livelihoods depend on nature[66]. The UK is one of the most nature depleted countries in the world and so increasing biodiversity in urban as well as rural environments is critical. Paragraph 179 and 180 of the NPPF (2021) relates to biodiversity. The Environment Act requires a minimum 10% Biodiversity Net Gain and it is understood that this will come into effect for larger sites in November 2023 and small sites in April 2024. Off-site provision is considered to be a last resort. Defra has developed a biodiversity metric version 4.0[67] which can be used for calculating biodiversity net gain.

Street trees can contribute to an increase in the number of bird species present, especially when connected to 'blocks' of greening such as parks or squares, because, with their landscape layers, they offer greater support for birdlife and biodiversity generally.[68]

The larger a tree, the more likely it is to operate as a keystone species[69] which is critical for the survival of countless other species including invertebrates, lichens and fungi, providing the basis of a healthy food chain that is a vital life support resource for birds and mammals.

Trees play a critical role in managing surface water runoffs and enhancing biodiversity in the Lyon Confluence development. © TDAG

[65] See sections 2.4 and 3.5 in *Trees in Hard Landscapes: A Guide for Delivery* (2014). London, UK: TDAG. www.tdag.org.uk/trees-in-hard-landscapes

[66] *The Economics of Biodiversity: The Dasgupta Review. Final Report*. HM Treasury (2021)

[67] Version 4.0. https://publications.naturalengland.org.uk/publication/6049804846366720

[68] Fernández-Juricic, E (2000). *Avifaunal Use of Wooded Streets in an Urban Landscape*. Conservation Biology 14(2):513 – 521. https://www.bio.purdue.edu/People/faculty/faculty_files/publications/36207_118867181.PDF

[69] Stagoll, K, Lindenmayer, DB, Knight, E, Fischer, J and Manning AD (2012). *Large trees are keystone structures in urban parks*. Conservation Letters 5, 115–122

Culture, heritage and identity

Trees can connect us with local history and culture. Their longevity, sometimes measured in centuries are a tangible living link with the past and connection to the future. This can have a significant psychological benefit to people who value this sense of continuity and place. The heritage value of trees is recognised in statutory approaches to heritage conservation whether in local designations, such as conservation areas or on an international scale with World Heritage Sites.

Whether in an urban or rural context, trees often provide a living legacy of older patterns of land use, ownership and practices, and as such help to inform local identity and the particularities of a place. In the urban fringe for example, it is common for new developments to take place on sites featuring hedgerows associated with former farm field patterns, enclosures of former mines, or demarcation of old lanes and routes through former countryside. Cultural and historic interest in such a context is not just the planting pattern but also the species and shape of the trees, which may reflect the former contribution of trees as part of a wider productive landscape. Old pollards, formerly used for animal fodder, timber or firewood production, are a great example of this.

The cultural associations between species and places have sometimes been strong enough to influence the common names for some trees such as the London Plane, Plymouth Pear, Lucombe Oak, Manchester Black Poplar and the Torbay Palm. Trees also play a role in culture and identity in today's public realm design and 'future' heritage buildings.

Victorian landscaping of the conduit, Brookside 'new town', Cambridge[70]. © Historic England

Potential 'future' heritage building example, St John's College, Oxford. © TDAG

[70] See: www.capturingcambridge.org/wp-content/uploads/2015/12/Newtown.-Cambridge-New-Town-A-Victorian-Microcosm.-PCAS.-XCIV.-2005.-P-Bryan-and-N-Wise.pdf

1.1.4 Understanding costs

Key points
- Concerns about the costs of tree planting and the ongoing responsibilities and costs of maintenance are one of the recognised barriers to achieving tree planting especially in adopted streets and the public realm (see box right).
- As with any investment, sound decision-making on tree-related expenditure requires an asset management perspective, taking into consideration the whole life of the tree.
- Early consideration and adequate arboricultural input throughout project conception, design and delivery will go a long way to reducing on-going costs.

Realising best value requires a whole life perspective

The natural life of trees can vary from several decades to several centuries and there will be ongoing maintenance and management costs. However, these costs are also investments as the bigger the tree, the greater the benefits and public goods delivered. Unlike many other elements of urban infrastructure, the asset value of trees and the benefits that they deliver increase over time. The early loss of a healthy semi-mature or mature tree which is relatively young in terms of its life cycle potential is a loss of current and future benefits as well as the actual costs incurred to date and cost of removal. There is also a likely cost if replacement and potential compensation claims are considered.

Tree lifecycle costs: CAPEX (capital) vs OPEX (operational)

The timing of the expenditure supporting such investments matters: to yield maximum returns investing more at the design, planting and establishment phases will reduce management and maintenance costs as the tree ages.

The initial capital investment cost of the trees should include the trees, the planting, and at least 5-10 years post-planting care so that the trees gain independence in the landscape. The nature of the planting site makes a big difference on the costs associated with planting itself as well as with post-planting care. Long-term success

Comparative costs for tree planting in new developments

This is an indicative cost comparison only, based on general costs and not taking into account economies of scale, changes in material or labour costs. Key requirements include: maximising rooting volume by utilising shared rooting space and break out zones wherever possible, with the isolated tree pits as a last resort.

Cost of establishment: Aftercare practices – watering, mulching (where possible) and, depending on the structure of the tree and the planting site, formative pruning and raising of the tree's crown to accommodate both pedestrians on footways and high-sided vehicles may be necessary.

General inspection and ongoing maintenance: After 5-10 years of establishment, any planting infrastructure no longer required should be removed, tree guards and grilles should be adjusted or removed (see page 38) and thereafter critical 'maintenance' should only require an annual safety inspection for trees on public land.

Costs for skeleton/structural soil for trees in hard landscapes: An appropriate tree base, surrounds and sturdier guard to suit location similar to the crate system below. NB. Must be integrated with sustainable drainage systems including rainwater harvesting.

Costs for crate system for trees in hard landscapes: Below-ground anchoring, sturdy metal guard, watering tube, aeration system, load-bearing cellular system complete with soil and a surface opening with tree grate for inner city conditions.

Costs for street trees in soft verges: Tree protection, stakes and mulch.

Costs for trees in green spaces: Similar to planting in soft verges.

For further information see:
www.tdag.org.uk/trees-in-hard-landscapes.html

Location/ Item	Skeleton/ structural soil on street	Crate system in street or on podium	Soft verge in street	Parkland and green space
Average cost of a 12-14cm trunk diameter Lime tree	£110	£110	£110	£110
Cost of planting the tree itself	£8,085	£10,965	£135	£135
Cost of establishment	£375	£375	£325	£325
Total planting cost	£8,570	£11,450	£570	£570
Annual inspection, general maintenance	£10	£10	£10	£10

requires investing in the correct tree rooting environment and planting costs for the specific location, the species and size of tree, and the degree of tree protection or surface finish required. The ultimate investment return will be reduced if ill-considered, under financed design and delivery leads to conflicts and poor tree performance or failure.

Once trees are independent in the landscape, the annual cost should be that of inspecting the trees at a cost of £10s not £100s. This apportioning of future investment matters when it comes to identifying which organisation will adopt the tree and be responsible for its operation or maintenance, especially as it seems to be easier to establish capital budgets (CAPEX) than operational ones (OPEX) (see box right). Overall, barring unforeseen circumstances such as disease, the next major cost for the tree will be an end-of-life cost.

Implications for project sponsors and their design teams

There are several critical junctures on the path to optimising the benefits from trees in new developments. Key levers to optimise project costs and achieve best value include:

- Procuring input from an arboriculturist to secure a reliable understanding of the impact of trees on the developable area, ahead of any site layout decisions or even simple estimates being made. This, together with early consultation with the local planning authority on arboricultural constraints, will always prove worth the time and expense incurred.
- Treating trees as a design matter, maintaining qualified arboricultural input throughout the design phase to allow for timely advice as design iterations are produced, to achieve best overall project outcomes.
- Establishing the right place for the right tree (see box overleaf).

Street tree maintenance – recommendations for addressing funding gaps in new developments in England and Wales

One of the key recommendations for Government featured in the UCL's Housing Audit 2020 (England) is the issuance of "*national guidance on what it is reasonable to charge for adopting trees and other landscape elements*". In the absence of national guidance on this matter, here are some simple rules of thumb:

- Post-planting management falls unarguably within the developer's remit. It is a direct continuation of design and planting, and requires dedicated attention and resources. BS8545:2014 is explicit on this: "*Post-planting management and maintenance is critical. Landscapes, particularly urban landscapes, are littered with young trees, which, although alive, do not grow. Trees in this condition never realize their genetic potential or deliver the benefits for which they were planted. The young nursery tree, once transplanted, has only partially completed its development. It has been carefully nurtured on the nursery and this nurturing needs to continue for several years after transplanting before the tree can be considered fully independent*". In practice, this can vary from a minimum of 5 years to about 10 years for street trees.
- Although it is widespread and legal in England and Wales, there are serious grounds to question the practice of requiring developers to cover for routine maintenance of trees over their whole life. Trees provide widespread public benefits that reach beyond the community that lives in direct proximity to them. Evidence of the critical impacts which adequate tree canopy cover can make towards enhancing public health and creating climate-resilient communities is accumulating, and at a time when many communities are asked to cope with higher densities to meet the housing shortage, street trees can hardly be considered as 'extra over'. Government formulas in England and Wales for determining highways' funding allocations need to be revised to reflect this reality. Some form of 'pump priming' might be required in the meantime, and this guide recommends that calculations are made over no more than 15 years.

"Landscape, especially tree retention, is a great way to get instant distinctive character. With low value developments, spending a few pounds on trees has much more impact than spending a similar amount on elevations."

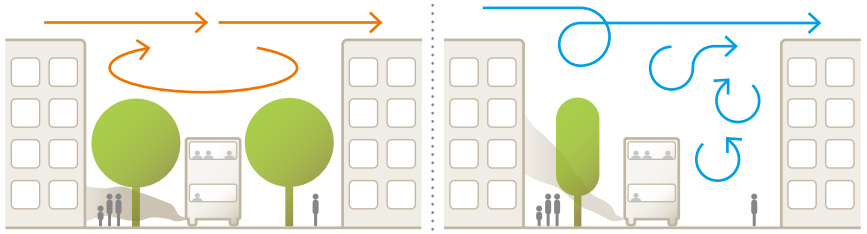
Stefan Kruczkowski, co-author of *Building for Life*

The impact of trees on use value – what does it mean to plant the 'right tree in the right place' or, ideally, to provide the 'right place for the right tree'

Some common issues are shown below. Other issues include damage to footways, too much overshadowing and droppings from trees.

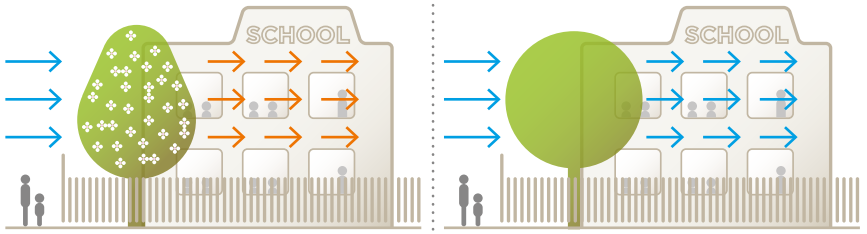
Wrong Street canyons trap pollutants creating poor air quality and less dispersion

Right Only suitable for trees on one side or occasional trees eg crossings and landmarks



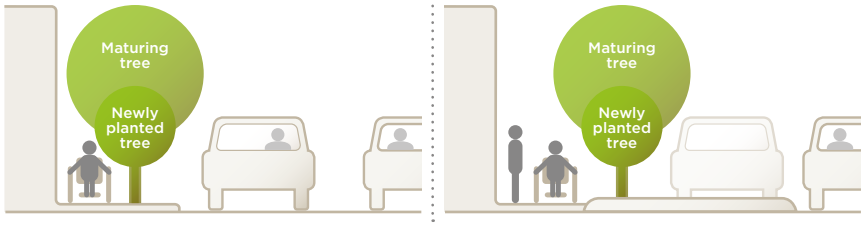
Wrong Allergenic tree species close to buildings eg schools and hospitals

Right Right species is the first decision if tree cover is desirable in that location



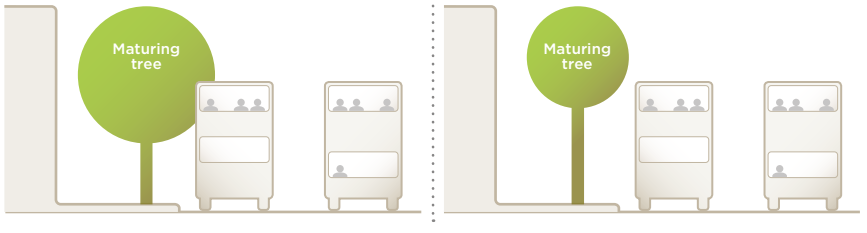
Wrong Footway width reduced as trees grow eg wheelchair and pushchair access

Right Create build-outs into road which can also calm traffic and create parking places



Wrong Street tree planting not taking into account high sided vehicles

Right Raise canopy cover by post-planting formative pruning



Wrong Restricting canopy by planting too close to buildings

Right Allow space for natural canopy growth and shape over time

Wrong Tree root damage to low-rise buildings with inadequate foundations

Right Provide resilient foundations to accommodate tree roots in shrinkable soils

TDAG's guide provides clear information with a decision-making tool for appropriate tree species selection.

1.2 Trees in development management and delivery: key legislation, policy, guidance and standards

1.2.1 Tree-related responsibilities imposed by law on those pursuing development

Key points

Across the UK, the law places a range of responsibilities upon landowners, developers or agents which may affect what they can, cannot or must do in respect to trees on or around land earmarked for development. These responsibilities cover three broad areas (tree retention, tree planting, and tree establishment and maintenance), and unless otherwise noted (see Briefing Note 01), they apply across England, Wales, Scotland and Northern Ireland:

- For example with respect to securing a felling licence for felling trees with a timber volume of more than 5 cubic metres in any one three-month period on sites that do not yet have full planning consent, unless an exemption applies (see box bottom overleaf).
- Seek consent from the local planning authority (LPA) prior to conducting works or felling any tree(s) protected by a Tree Preservation Order, unless an exemption applies.
- Notify the LPA of intention to carry out tree works to trees in a Conservation Area, unless an exemption applies.
- Avoid or delay tree works that could injure or destroy wild birds' active nests or the nesting or roosting sites of other protected wild animals, such as bats, unless an exemption applies.
- Notify the LPA prior to removing hedgerows, unless an exemption applies (England and Wales only).

Across the UK, the primary legislation places a number of responsibilities upon landowners when it comes to trees found on their land. The following focuses on the requirements most likely to affect land earmarked for development, and the way in which landowners, developers and their agents finalise it. This does not cover issues related to the general duty of care, which are outside the scope of this guide.

Avoid using netting when birds nest between March and August. © Bav Media

Tree retention in a residential square in Derwenthorpe, York. © Amy Burbidge

The law can impose three types of responsibilities on landowners, developers or their agents in respect to trees when pursuing development:

- **Tree retention:** may affect the ability, the extent and/or the construction techniques used for developing the land, or the timing of the works.
- **Tree planting (as a mitigation to trees lost to development, and/or as new infrastructure provision):** may affect design choices and will require thoughtful staging of works for best results.
- **Tree establishment and maintenance:** will require adequate design, may require short- and long-term planning for the care of trees and stewardship arrangements to cover for all or part of these needs.

Tree owners also need to be aware of the certain requirements and legal implications of:

- **Tree felling licences** (see box right)
  "Do I need a felling licence?" should always be the first question considered by landowners contemplating the felling of trees on their land. Many mistakenly believe that if a site has been allocated for development in the local plan, or if it has secured outline permission, then tree felling is exempt from the need to be authorised by a felling licence. This is not the case. Felling licences are managed by the Forestry Commission in England[71], Natural Resources Wales in Wales[72], Scottish Forestry in Scotland[73] and Daera's Forest Service in Northern Ireland[74].
- **Tree Preservation Orders (TPOs)** (see box top overleaf)
  A TPO is made by a local planning authority in England to protect specific trees, groups of trees or woodlands in the interests of amenity, which may be present today or in the future (eg conditional TPO). It is the landowner's responsibility to seek consent from the LPA prior to conducting works or felling any tree(s) protected by a TPO, unless an exemption applies[75]. A breach is a criminal offence and the courts have shown that they will not allow a party to benefit from their crime[76].
- **Trees in conservation areas** (see box middle overleaf)
  The landowner, agent or other party has a responsibility to give notice to the LPA of any works to trees in conservation areas unless an exemption applies.

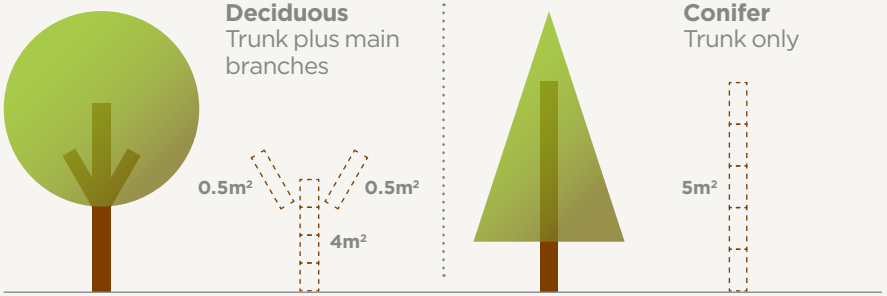
Further useful things to know about tree felling licences

Pre-emptive felling, ie the practice of clear felling all or part of a site for the purpose of turning it into potentially buildable land without having previously secured either a felling licence or full planning consent, is an offence[77] where trees are covered by statutory protection, unless an exemption applies such as full planning permission, emergency works for utilities/statutory undertakers or government requirements on disease control grounds.

Once the need to apply for a felling licence has been identified, it is important, as a second step, to check whether there are any Tree Preservation Orders (TPOs) or conservation areas covering the trees which will be subject to the felling licence request. At the point of applying for a felling licence, this will need to be stated on the application, and getting this wrong – deliberately or otherwise – can lead to prosecution.

Failure to comply with the requirement to secure a felling licence for non-exempt trees is increasingly severely punished by law, and associated enforcement mechanisms are becoming stricter. For example, in England, under the Environment Act[78], fines will be unlimited, giving the courts discretion to punish offenders in proportion to the potential gains from development. A restocking notice served by the Forestry Commission following failure to secure a felling licence prior to felling will become a charge on the land, so it will appear on the local land charge register – visible to any prospective buyer and binding on them if they bought the land. The courts will be given the power to order landowners to replant trees on land where the Forestry Commission's replanting directions following an illegal felling had been ignored – on pain of a further fine and/or a custodial sentence.

A rough guide for calculating the volume of timber in a tree (volume is calculated as Pi x radius² x height)



[71] See: www.gov.uk/guidance/tree-felling-licence-when-you-need-to-apply
[72] See: www.naturalresources.wales/permits-and-permissions/tree-felling-and-other-regulations/public-register/felling-licence-register/?lang=en
[73] See: www.forestry.gov.scot/support-regulations/felling-permissions
[74] See: www.daera-ni.gov.uk/publications/applying-felling-licence
[75] England and Wales: Sections 198-210 of The Town and Country Planning Act 1990 (as amended); Scotland: Section 160-171 of the Town and Country Planning (Scotland) Act 1997; Northern Ireland: Sections 122-126 of the Planning Act (Northern Ireland) 2011 (as amended)
[76] In the Canford Cliffs case, Poole Borough Council successfully prosecuted Mr Samuel Wilson for cutting back an oak tree, under the terms of the Proceeds of Crime Act. www.natlawreview.com/article/money-grows-trees-local-council-pursuing-home-improvement-enthusiasts-and-local
[77] England and Wales: Sections 9-17 of the Forestry Act 1967 (as amended); Scotland: Part 4 of the Forestry and Land Management (Scotland) Act 2018; Section 15 of the Forestry Act (Northern Ireland) 2010
[78] See: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted

- **Nesting and roosting site protection** (see box bottom right)
  Works to trees, hedges or woodland must be carefully timed. Causing injury to or destroying wild birds' active nests or the nesting or roosting sites of other protected wild animals, such as bats, is an offence – unless an exemption applies.
- **Hedgerow retention (England and Wales only)** (see box top right overleaf)
  In England and Wales, protection is afforded to hedgerows which are over 30 years old or more than 20 metres in length or join other hedgerows, provided they adjoin agricultural land, forestry, paddocks, common land, village greens, a site of special scientific interest (SSSI) or a local nature reserve. It is a criminal offence to remove a hedgerow without permission.
- **Scheduled Monument Consent** (see box middle right overleaf)
  Scheduled monuments have statutory protection through their inclusion in the schedule of monuments maintained under section 1 of the Ancient Monuments and Archaeological Areas Act 1979.
- **Trees in Special Sites of Scientific Interest (SSSIs)** (see box bottom right overleaf)
  An SSSI is a formal conservation designation for an area of particular interest to science due to the presence of certain flora, fauna, geological or physiological features within its boundaries.

Conservation areas have certain requirements and legal implications. © Barrell Tree Consultancy

Further useful things to know about Tree Preservation Orders (TPOs)

There are four types of TPOs. Any one order can contain more than one type:
- **Individual:** can be applied to an individual tree.
- **Group:** can be applied to a group of individual trees which, together, make up a feature of amenity value but which separately might not.
- **Area:** covers all trees in a defined area at the time the order was made.
- **Woodland:** covers all trees within a woodland area regardless of age.

A TPO may be placed on a tree or set of trees that have not yet been planted but have been agreed upon in the planning application process. This is a conditional TPO and is a means to secure long-term protection for new planting that is deemed critical. It is common to apply conditional TPOs to replacement plantings agreed in mitigation for on-site tree loss.

Information about TPOs on a site can be obtained from the LPA. If the aspiration is to fell, rather than works to the protected tree(s), the first question is whether a felling licence is required. If it is, both applications (ie felling licence and application to fell a TPO tree) will need to be coordinated by the responsible authorities, and the felling licence legislation takes precedence.

Further useful things to know about trees in conservation areas

The landowner is required to give written notice of proposed tree works to the LPA at least six weeks before the work starts, unless an exemption applies[79]. This enables the LPA to consider protecting the tree with a TPO. Failure to comply with this requirement on non-exempt trees can lead to prosecution.

Further useful things to know about protecting nesting and roosting sites

The presence of birds and protected wildlife can delay, but not prevent, the felling of trees, hedgerows and woodlands. The statutory nature conservation organisation (SNCO) for each country of the United Kingdom[80] is the regulatory body overseeing the implementation of wildlife protection and may issue licences relating to wildlife disturbance in appropriate circumstances.

Both the contractor and the landowner can be prosecuted and fined in case of a breach. Netting over vegetation, denying access to birds and other wildlife, enabling works to take place at any time[81], is technically legal if done with care so that no animal is trapped or injured. This approach is not recommended by wildlife protection organisations or professional bodies such as the Chartered Institute of Ecology and Environmental Management (CIEEM)[82].

[79] England and Wales: Section 211 of the Town and Country Planning Act 1990 (as amended); Scotland: Section 172 of the Town and Country Planning (Scotland) Act 1997; Northern Ireland: Section 127 of the Planning Act (Northern Ireland) 2011 (as amended)

[80] Natural England, in England; Natural Resources Wales in Wales; Scottish Natural Heritage in Scotland and the Northern Ireland Environment Agency in Northern Ireland

[81] See: www.theguardian.com/environment/2019/apr/05/use-of-netting-to-stop-birds-nesting-before-housebuilding-rebuked

[82] See the April 2019 CIEEM/RSPB joint statement on netting on hedges and trees. www.cieem.net/cieem-and-rspb-advise-against-netting-on-hedges-and-trees/

Planning consent, and implications for trees

The law requires that planning decisions are taken in accordance with the local development plan and any other relevant material consideration. Trees, protected or not, are a material consideration (see 1.2.2) and LPAs have an express duty (ie not just a power) to ensure that adequate provision is made for the preservation or planting of trees when granting planning permission[83]. To exercise this duty, LPAs have the powers to use planning conditions and TPOs.

To fulfil this and other duties, notably the biodiversity duty, as well as a wide range of national planning policy objectives (see 1.2.3), LPAs should write into their development plans specific policies articulating local tree retention, tree planting and tree maintenance requirements. These are often informed by British Standards (see 1.2.4) and other existing good practice guidance to define expected practices. These requirements should be reflected in the level and type of information to be submitted with a planning application.

It is the developer's responsibility to seek planning consent when required and to assemble and submit the information needed for the LPA to assess the impact of the proposed development, including its impact on trees. Also to demonstrate that the proposal meets relevant local plan policies, including those related to tree retention, tree planting and tree maintenance, and to wider objectives including quality of place, economic growth, public health, sustainable transport, climate resilience, biodiversity, landscape and heritage – to all of which trees can make a significant contribution (see 1.1.3 and 1.2.3).

Further useful things to know about hedgerow retention in England and Wales

Landowners are required to notify the LPA of any proposed work to such hedges at least six weeks before the work starts, unless an exemption applies. This gives the LPA an opportunity to consider whether the hedgerow is 'important' (in line with criteria defined in the Hedgerow Regulations[84]) and if so, to protect it by issuing a hedgerow retention notice.

It is a criminal offence to remove an important hedgerow without permission. In these circumstances, if the landowner is found guilty by a magistrate's court, they could be fined up to £5,000. If tried in a Crown Court, the fine is unlimited. The landowner may also be required to plant a replacement hedgerow and the LPA has legal powers to ensure this happens. The replacement hedgerow is automatically considered important for 30 years after it has been planted.

Further useful things to know about Scheduled Monument Consent

Trees can be vital to the character of an area and important features of historic or architectural sites. Large or interesting trees, sometimes many centuries old, are often embedded in a sense of place for communities and part of their history[85] and culture, so, apart from TPOs and Felling Licences, works to trees on a scheduled monument may need Scheduled Monument Consent before works begin.[86]

Further useful things to know about trees in Sites of Special Scientific Interest (SSSIs)

These sites are classified as SSSIs in England, Wales and Scotland and Areas of Special Scientific Interest (ASSIs) in Northern Ireland. SSSIs and ASSIs are protected by law and designated by the statutory nature conservation organisation (SNCO) for each country of the United Kingdom[87]. Each SSSI or ASSI has a management plan and a list of operations requiring the SNCO's consent prior to carrying out works, which might include tree works. Should tree felling be envisioned and a felling license required, the application will be processed by the relevant agency (see the paragraph dedicated to felling licenses on page 31), in coordination with the appropriate SNCO.

[83] England and Wales: Section 197 of The Town and Country Planning Act 1990 (as amended); Scotland: Section 159 of the Town and Country Planning (Scotland) Act 1997; Northern Ireland: Section 121 of the Planning Act (Northern Ireland) 2011 (as amended)
[84] Hedgerow Regulation 1997: www.legislation.gov.uk/uksi/1997/1160/contents/made
[85] See: www.historicengland.org.uk/advice/technical-advice/parks-gardens-and-landscapes/tree-management-consents-and-controls/
[86] See: www.historicengland.org.uk/advice/planning/consents/tree/
[87] Natural England, in England; Natural Resources Wales in Wales; NatureScot in Scotland and the Northern Ireland Environment Agency in Northern Ireland

1.2.2 Key duties, national policies and guidance weighing on local planning authorities

Key points
Across the UK, there are strong commonalities in how primary legislation and the national planning policies and guidance shape local planning authorities' (LPAs) responsibilities in respect to trees, planning development. To fulfil these responsibilities, it is recommended that LPAs act diligently in six key areas:

1. **Develop a strategic framework for the development and management of the urban forest.**
2. **Secure adequate tree-related information from applicants.**
3. **Secure adequate tree protection.**
4. **Secure mitigation of unavoidable tree loss.**
5. **Seek adequate new tree planting and aftercare.**
6. **Enforce tree-related planning decisions.**

Strong commonalities across the UK

There are strong commonalities across the UK in the tree related duties weighing over LPAs when dealing with planning and development management (see boxes top and middle right).

There are also many similarities in national policies and guidance. This includes largely shared expectations in respect to the planning, design and management of trees and wider green infrastructure provision in development (see box bottom right). It also includes the way in which the good integration of trees is likely to have a meaningful impact on many of the wider objectives pursued.

What does this mean for LPAs?

To best fulfil the tree-related duties they face, produce local plans that deliver outcomes aligned to national planning policy and guidance, and achieve integration of trees in developments, it is recommended that LPAs act diligently in the following six key areas:

Trees and green infrastructure (GI) in national planning policies across the UK: key commonalities

In all four nations' national policy and guidance:
- GI, which includes trees, is identified as critical to deliver high-quality, sustainable development – ie the primary stated goal of the planning systems in England, Wales, Scotland and Northern Ireland. As a result, LPAs are expected to identify and promote GI in their local plans.
- GI or natural capital, or environmental quality (terminology varies across countries) is widely recognised as contributing to many other national policy objectives, such as creating healthy living conditions, supporting economic growth, enhancing biodiversity and adapting to climate change.
- For benefits to materialise, it is highlighted that GI requires adequate design, planting and management as well as some form of strategic planning. LPAs are strongly encouraged or required to produce a local assessment and plan dedicated to GI, including trees, and/or to forests and woodlands.
- Developments need to strive to protect existing trees where appropriate. Individual aged or veteran trees and ancient woodlands are deemed irreplaceable habitats, and as such are expected to be shielded from the impacts of development.
- Developments also need to strive to provide adequate GI, including trees, and should consider GI provision at an early stage of a planning proposal.

Key tree-related duties: taking into consideration the adequacy of provisions

Primary legislation across the UK[88] places a specific duty on LPAs to ensure, when granting planning permission for any development, that adequate provision is made for the preservation or planting of trees. The potential effect of development on trees, whether statutorily protected (eg through a Tree Preservation Order, or inclusion within a conservation area) or not, is a material consideration taken into account in dealing with planning applications.

Key tree-related duties: enhancing and restoring biodiversity

The planning systems[89] across the UK countries also place a duty on all public bodies, including LPAs, to pursue the restoration and enhancement of biodiversity in policy and all aspects of decision-making. This duty is reinforced in the Environment Act which will require, as a condition for the granting of planning permission, a minimum 10% Biodiversity Net Gain (BNG) for larger developments from November 2023 and smaller sites from April 2024.

[88] England and Wales: Section 197 of the Town and Country Planning Act 1990; Scotland: Section 159 of the Town and Country Planning (Scotland) Act 1997 as amended; Northern Ireland: Section 121 of the Planning Act (Northern Ireland) 2011

[89] England and Wales: Section 40 of the Natural Environment and Rural Communities Act (2006); Wales: Section 6 of the Environment (Wales) Act 2016; Scotland: Section 1(1) of the Nature Conservation (Scotland) Act 2004; Northern Ireland: Section 1 of the Wildlife and Natural Environment Act (Northern Ireland) 2011

1. Develop a strategic framework for the development and management of the urban forest

Veteran or heritage trees and trees that are protected by TPOs or are in conservation areas, provide widely recognised benefits on an individual basis. However, many of the benefits trees bring to the built environment stem from the local tree population as a whole, where positive impacts are cumulative.

Giving adequate consideration to the retention and planting of trees for individual development proposals (as required by law) is greatly facilitated by having an understanding of the characteristics of the whole tree population in the area and a local tree strategy prioritising the outcomes that will best suit local needs[90].

Having such a strategic framework, developed from a robust understanding of the strength and weaknesses of existing provisions (*What do we have? What do we want? How do we get what we want? Are we getting what we want?*), will also provide the evidence base needed for policies identifying local standards of planting, retention, replacement and management to be included in the local plan (see box right).

Section Two provides details for developing a tree strategy that delivers. TDAG recommends that this should be an adopted strategy.[91]

2. Secure adequate tree-related information from applicants

The amount and nature of information required will vary between stages and in relation to what is proposed. This might include information on individual trees such as:

- The location and quality of existing trees (a tree survey).
- The identification of trees to be retained and trees to be felled (tree retention/removal plan).
- The identification of the constraints (canopy spread shade, root protection area) created by each of the trees to be retained (tree constraint plan).
- An assessment of the impact of the proposal on trees and equally of trees on the proposal (arboricultural impact assessment).
- Written description (arboricultural method statement) and plan

Evidence-based adopted tree and woodland strategy embedded in local plans

Step one: *What do we have?*
A good evidence base is needed on:
- the spatial distribution and the characteristics of the urban forest – tree canopy cover, species, age and condition.
- current and anticipated needs for trees based on information such as urban heat island/microclimate data, ecological networks data, local communities' health profiles, transport and mobility provisions, as well as community perceptions.

Step two: *What do we want?*
This provides a shared vision for the future of the urban forest, whether public or private, and its contribution to the prosperity and wellbeing of local communities.

Step three: *How do we get what we want?*
This is the comprehensive **SMART** action plan identifying the changes and interventions needed to realise the agreed vision.

This will include establishing a coherent policy framework for the planting and management of trees. Policies could include:

Targets: – Canopy cover – Tree species diversification – Carbon sequestration – Biosecurity	Tree retention policies and TPOs	Tree planting and post-planting care, including pruning policies	Tree replacement policies	Risk management policy

This will also include the preparation of management plan(s) translating into operational practice the range of policy objectives and principles identified.

It will also address how to engage with and involve local communities around trees.

It will need to identify the resources to be used for delivery.

Step four: *Are we getting what we want?*
This is the ongoing monitoring approach to ensure that delivery is taking place and that what has been delivered is retained in order to gain the wide range of tree benefits over time.

NB: The above outlines what every LPA should include in its suite of policy and delivery documents. However, this process can apply at all scales, including individual development sites.

[90] See Principles 1 and 2 in TDAG's *Trees in the Townscape: A Guide for Delivery* (2012), London, UK: TDAG. www.tdag.org.uk/trees-in-the-townscape

[91] Following the publication of the *England Trees Action Plan* in May 2021, Defra is also developing guidance on local tree strategies

(tree protection plan) identifying the site-specific tree protection measures and tree works to be implemented during the construction process.
- Hard and soft landscape design proposal, including species and location of new tree planting (this might include a site-specific tree strategy for larger sites).
- Landscape maintenance schedule.

The information required might also cover wider parameters that will affect prospects of successful tree retention and planting such as:
- Environmental information on topography, ecology and soils.
- Information on buildings and structures such as the location of utilities and types of foundations.

The information provided will need to meet clearly defined standards. It is the LPA's responsibility to be explicit about expectations and demand compliance with British Standards (an overview of which can be found in 1.2.3, page 39).

3. Secure adequate tree protection

Planning permission may be refused if it results in the loss of trees deemed to be of high value from an amenity, townscape or biodiversity perspective. The law provides LPAs with two further complementary tools to exercise their duty to protect trees: TPOs and planning conditions.

TPOs are used to protect trees worthy of retention for their public amenity value, whether they are already planted or to be planted as part of a development scheme (Conditional TPO).

Planning conditions, subject to the outcome of the current proposed planning changes, can require a developer seeking planning permission to abide by the tree protection measures needed to achieve the successful retention of trees that have been identified to make the development acceptable.

During construction: The Connaught Hotel, London. © Barrell Tree Consultancy

After construction: The Connaught Hotel, London. © Barrell Tree Consultancy

4. Secure mitigation of unavoidable tree loss

As with other natural assets contributing to biodiversity, trees are subject to the planning system's mitigation hierarchy[92] whereby, any loss or deterioration of trees resulting from development should, firstly, be avoided. If this is not possible, negative impacts should be minimised, or, as a last resort, compensation for any unavoidable loss should be provided. If none of these are possible, then planning permission should be refused. When the need for compensation occurs, it is to all parties' advantage that local policy or guidance provides a clear framework on how to do so. This includes defining a tree loss replacement standard.

A tree loss replacement approach may be based on equivalence of ecosystem services delivery (see box right). Other approaches include replacement based upon tree canopy cover or CAVAT value (Capital Asset Valuation for Amenity Trees), updated in March 2023[93].

Associated benefits include:
- Upfront certainty for developers on the tree-related costs associated with making a property developable.
- Adequate levels of compensation secured with greater consistency and on a 'transparent' basis that has been submitted to public consultation giving local communities a voice in defining the threshold of environmental trade-offs they are willing to accept.
- Time saved by avoiding lengthy debates and negotiations and reducing the risks of tree-motivated opposition from local communities.

Such compensation measures might be secured and/or supported via:
- Planning conditions, to secure compensatory planting conducted on-site.
- TPOs placed upon the compensatory planting on-site.
- Planning obligations which can currently be used to secure a financial contribution or establish contractual requirements for the management and maintenance of open spaces including trees and other landscape elements (this may change in England in the near future).
- Financial and legal incentives, such as bonds, to encourage compliance.

Tree loss replacement standard – decision-making: a worked example

Assuming that all possible avenues have been explored for a particular development site or location and, in this example, the outcome is that a healthy ca. 60-year-old beech tree will have to be felled, replacement tree planting should be the first requirement. The number of replacement trees required will depend on a length of time to reach the equivalent of each felled tree. For example, this could be 10 years after planting. This worked example based on a publication by Forest Research and on work by arboriculturists Sharon Durdant-Hollamby and Luke Fay[94] demonstrates how this could be assessed in practice. The service provision of the felled tree is determined from published datasets[95]. Canopy cover is calculated from published crown width formula[94]. A species or multiple species are then selected for replacement planting and their service provision at ten-years post-planting is read from the tables or calculated from the stem growth rate and crown extent formulae. The number of trees required to provide equivalent provision of benefit is calculated as provision by felled tree divided by provision by the planted tree species. In the example below this may range from 1 to 29 replacement individuals depending on which service is selected as the basis for replacement. Here, the felled tree is a 60-year-old beech with a diameter at breast height (DBH) of 60cm and a crown radius of 6m, growing in a semi-open location (ie with three sides of crown exposed to light). The replacement trees are assumed to be 7 years old at planting, and planted in the same conditions. Benefit provision is calculated at 10 years post-planting, when the replacement trees are 17 years old.

Service/ Benefit	Felled tree: Beech tree (DBH 60cm)	**Replacement option: 17-year-old Norway maple (DBH 30cm)**		**Replacement option: 17-year-old Callery pear (DBH 16cm)**	
		Service provision at planting + 10 years	Number of trees required	**Service provision at planting + 10 years**	Number of trees required
Carbon stored (kg)	1,473	245	7	51	29
Carbon sequestered (kg/year)	22	27	1	5	5
Air pollution removal (kg/year)	0.8	0.3	3	0.04	20
Rainfall interception (litres/year)	2,400	900	3	100	24
Amenity/ CAVAT (£)	82,269	19,693	5	5,899	14
Canopy cover (m^2)	113	42	3	29	4

[92] England: National Planning Policy Framework (2019) paragraph 175; Wales: Planning Policy Wales 10th edition paragraph 6.4.21; Scotland: Scottish Planning Policy (December 2020 revision) paragraphs 216 and 217; Northern Ireland Strategic Planning Policy Framework (2015) paragraphs 6.192 and 6.193

[93] See: https://www.ltoa.org.uk/documents-1/capital-asset-value-for-amenity-trees-cavat

[94] Hand, K. and Doick, KJ (2021). *Ecosystem service provision by urban trees: informing species selection*. Farnham, UK: Forest Research

[95] Datasets used for service provision estimates: Vaz Monteiro, M, Levanič, T, and Doick, KJ (2017). *Growth rates of common urban trees in five cities in Great Britain: A dendrochronological evaluation with an emphasis on the impact of climate*. Urban Forestry & Urban Greening, 22, 11-23. Vaz Monteiro, M, Doick, KJ, and Handley, P (2016). *Allometric relationships for urban trees in Great Britain*. Urban Forestry & Urban Greening, 19, 223-236

5. Seek adequate new tree planting and aftercare

As when dealing with tree loss replacement, it is to all parties' advantage that local policy and guidance clearly sets out tree planting targets for new developments, both in terms of the amount and quality of planting and the required aftercare. This guide explores several options on how to set and implement such targets, suitable for different contexts, which have been shown to be expedient for both applicants and LPAs (see box top overleaf).

In addition to clear policy and guidance on new planting and aftercare, LPAs are also able to use:

- Planning conditions, including post-completion conditions. This is used to require a period of maintenance to ensure establishment and to secure details of long-term management proposals for communal or other special areas that include trees (see box right).
- Planning obligations which can currently be used to secure a financial contribution or establish contractual requirements for the management and maintenance of open spaces including trees and other landscape elements (this may change in England in the near future).
- Financial and legal incentives, such as bonds, to encourage compliance.

6. Enforce tree-related planning decisions

Tree enforcement is important to secure the adequate protection and planting of trees in new developments. Tree enforcement requires diligent consideration within each LPAs' enforcement plan (England[96]), policy (Wales[97]) or charter (Scotland and Northern Ireland)[98] or to ensure:

- Sufficient monitoring is conducted.
- Effective action is taken should any tree-related breach identified be likely to result in unacceptable impacts.

Surface opening treatments in hard landscapes – good and bad aftercare

Tree trunks grow over time. Good aftercare will adjust and remove surface opening systems as required. Failure to do so has obvious long-term consequences for tree health and resilience[99].

Good aftercare: tree grille rings and surround can be removed as the trunk grows. © Michael Sankus

Bad aftercare: failure to remove this grille in time has caused permanent damage. © John Parker

[96] In England, enforcement plans are not a statutory function, but paragraph 58 of the National Planning Policy Framework (2019) encourages their use to facilitate proactive, consistent and locally appropriate enforcement action

[97] Legislation, national policy or guidance in Wales does not require or explicitly recommend that local planning authorities produce an enforcement plan, charter or policy. However, it is common practice for Welsh authorities to do so in order to be better positioned to meet their legal requirement and better exercise their powers in respect to planning enforcement

[98] Under the Planning etc (Scotland) Act 2006 Scottish local planning authorities have a legal requirement to prepare and publish enforcement charters which set out written procedures for enforcement. Similarly, under the Planning Act (Northern Ireland) 2011, each local council in Northern Ireland is expected to develop a planning enforcement strategy

[99] London Tree Officers Association (2017). *Surface materials around trees in hard landscapes*. London, UK: LTOA. www.ltoa.org.uk/surface-materials-around-trees-document/file
See also: www.tdag.org.uk/trees-in-hard-landscapes.html

Lack of resources is often blamed for no or limited pro-active oversight to take place. However, the research for this guide has shown that tools and approaches do exist to deliver effective monitoring with limited staff resources, and costs shared between LPAs and developers.

There are primarily two types of enforcement scenarios in respect to trees and new developments: protection measures during development and planting survival after development completion. Tree protection enforcement – while remaining subject to high procedural standards – often needs to be handled differently to planting survival or other planning breach cases. With tree protection issues, enforcement notices may be too slow a process. For example, where ground compaction around trees on a development site is being aggravated dramatically each time a vehicle passes over its root system, action needs to be taken quickly to prevent permanent and irremediable damage. Under such circumstances, the serving of a Temporary Stop Notice (TSN) – requiring the construction activity causing damage to cease immediately – is likely to be considered more appropriate.

1.2.3 British standards

Key points
The standards for tree-related issues and opportunities on a development site primarily fall into the following categories:
- Design, demolition and construction.
- From nursery to independence in the landscape.
- Works to trees.
- Nursery stock specification for trees and shrubs.
- Topsoil specification.
- Biodiversity code of practice.

British Standards are advisory documents which are often specified in contracts. BS5837:2012 *Trees in relation to design, demolition and construction – Recommendations* is probably a familiar key technical reference that defines a best practice approach to achieve good integration of existing and proposed trees in new developments,

Tree planting standard: the Greater Lyon approach

With the recent update of its local plan, Greater Lyon has started to require private developments to contribute to the delivery of its canopy cover objective. Development management policies featured in the Local Plan define the minimum area of land that new developments must set aside as 'planting ground'. The plan also sets out qualitative design requirements, which include the following:
- All planting grounds must be used for stormwater infiltration.
- A minimum of two-thirds of the required planting ground must be provided as one continuous area, with any given section having to be at least 4 metres wide.
- All planting grounds must be planted combining, as much as context permits, three strata of vegetation: grass, shrub and trees.
- A tree must be planted or retained for every 50 square metres of planting ground provided.
- Footpaths are allowed within planting grounds, provided they are permeable, but do not count towards the planting ground area calculation.

Temporary Stop Notices (TSN): a powerful enforcement tool

TSNs allow LPAs[100], where expedient to do so, to stop very quickly any further work that they think amount to a breach of planning control. TSNs are typically used where public safety or public amenity is at risk or where serious and irreversible damage to the environment may occur.

Serious and irreversible damage to trees can happen very quickly on a development site. If planning conditions related to tree retention and protection are not being complied with, there is usually an imminent threat of damage to the trees involved. If the outstanding issues cannot be resolved there and then on site with an LPA officer, then the serving of a TSN will require immediate cessation of the works amounting to a breach. It remains effective for up to 28 days after it was served. A TSN cannot be appealed and failure to comply with it is a criminal offence, which, if prosecuted, can lead to an unlimited fine.

[100] Under section 171E of the Town and Country Planning Act 1990 in England and Wales, section 144A of the Town and Country Planning (Scotland) Act 1997 in Scotland and section 135 of the Planning Act (Northern Ireland) 2011 in Northern Ireland

but it is not the only one. See box right for an overview of the technical standards that are most useful to best address tree-related issues and opportunities on a development site.

For developers and their consultant teams, adherence to these standards will inform a landscape and arboricultural submission which is likely to both increase the likelihood of gaining planning consent, and lead to a higher quality in the scheme as built. For planners, these standards provide sound technical references to improve the quality of processes and outcomes expected when drafting local policy, guidance and planning conditions or when engaging in discussions on a development proposal, especially at pre-application stage.

1.3 Urban tree value: metrics for decision-making

1.3.1 Trees as capital assets

Key points

The primary purpose of growing trees in urban areas is to provide economic, environmental and societal benefits. Realising such benefits requires a sound understanding of how and when such benefits are accrued:

- The larger the tree, the greater the benefits it is likely to deliver.
- In contrast to trees grown for timber production, urban trees need to reach and live through their mature stage to maximise their benefit delivery over time and deliver good return on investment.

Getting good long-term returns from the inclusion of trees in a development project is best achieved through:

- Having access to tree value estimations to inform design. Such estimations should include potential accrued monetary asset value of trees and the value of environmental and societal benefits delivered as the trees mature.
- Retaining and protecting existing trees with good prospects.
- Prioritising tree longevity, size, and species diversity in the planting design and species choice.

Relevant British Standards

BS 5837:2012 – *Trees in relation to design, demolition and construction – Recommendations* focuses on how to address existing trees in and around a development site (this is currently under review).

BS 8545:2014 *Trees: from nursery to independence in the landscape – Recommendations* provides guidance on how new trees can be successfully grown and planted so that they flourish in the landscape without excessive maintenance.

BS 3998:2010 *Tree Work – Recommendations* lays out the way in which all tree work should be carried out.

BS 3936:1992 Part1 – *Nursery Stock specification for Trees and Shrubs* sets out the quality standards for planting stocks.

BS 3882:2015 *Specification for Topsoil* sets out the requirements used for topsoil classification and composition.

BS 42020:2013 *Biodiversity – Code of practice for planning and development* focuses on how to address biodiversity and ecological issues through the planning process.

BS EN 17037:2018 *Daylight in Buildings* (replacing BS 8206-2) with BRE 209: Site layout planning for daylight and sunlight give objective standards for daylighting and sunlighting within buildings and the spaces in between, including the effects of trees. Appropriate planting positions, densities and species selection to balance shading (to avoid overheating) and daylight requirements can ensure longevity for trees against pressure to remove due to their impact on daylighting.

"Trees are such an important part of our landscape heritage and our future environment that we must take all possible steps to use best practice wherever we can in planning and development projects. This excellent publication from the Trees and Design Action Group provides valuable practical advice on the use of national standards (BS) and other references, which is both timely and very welcome."

Scott Steedman CBE FREng FICE, Director-General Standards – BSI

It is widely recognised that the many benefits provided by trees increase in proportion to the size of the tree. The larger the tree and the larger its canopy the greater the benefits and public goods delivered.

In an urban context the priority is to provide the conditions where a tree can achieve its maximum crown size and fulfil its genetic potential in terms of longevity. This will of course vary from species to species. Large long-lived species have the potential to deliver the greatest benefits and public goods for the longest time-period. Consequently, the return on investment is at its greatest when large long-lived trees are planted and retained.

Trees grown for timber yield a product – timber – and the decision to fell is based on the timber yield at the time of felling. As such, trees are often felled long before they might otherwise die with the priority being to optimise the timber yield against planned timescales.

Urban trees also produce a yield: benefits and public goods. Since benefits and public goods increase with tree size, early felling will reduce the benefit the public goods yielded[101]. The product is diminished and the return on investment consequently reduced.

Early felling and removal in the urban environment often coincides with the start of peak benefit delivery, which should then last decades, with reliable evidence[102] showing that many trees can have life expectancies of 150-300 years, with the potential to deliver peak benefits for most of that period. Of course, the length of time individual trees can be expected to provide benefits will vary with species and growing conditions, but felling them prematurely can deprive communities of a large proportion of their potential benefits, and yet this regularly happens.

To get the greatest return on the investment made to include trees in a project such as those described in this guide, it is in the best interest of land-owners, developers and their consultants to:

- **Gather reliable estimates of the value of trees.** Whether existing or proposed before going ahead with any design proposals (see 1.3.2).
- **Seek to retain existing healthy mature trees with good prospects**. Such trees are already delivering benefits and public goods and

Retaining and protecting existing trees. Angel Building, London 2014. © Sarah Blee, J & L Gibbons

Providing shade and a place to relax. Angel Building, London 2014. © Sarah Blee, J & L Gibbons

[101] Barrell Tree Consultancy (April 2018). *Tree value; the missing metric in built-environment management.* www.barrelltreecare.co.uk/resources/articles-and-papers/btc1252018-ecobuild/

[102] Hand, K and Doick, KJ (2021). *Ecosystem service provision by urban trees: informing species selection.* Farnham, UK: Forest Research

have the capacity to continue this long into the future. There are also circumstances where conserving a tree that has a short lifespan is worth considering, while awaiting new planting to establish.
- **Plant for long-term sustainability.** There may be special circumstances which might warrant a shorter-term approach eg podium planting. Under net zero carbon targets, buildings should be re-purposed and not demolished and so podium planting can be long-lived. Another is deliberate over-planting for early impact, followed by retention of long-term structural planting. For most situations the choice of layout, spacing, planting specifications, species selection, and post-planting care should aim to maximise tree longevity and mature size for maximum benefits and minimum nuisance or inconvenience.

There are many ways in which LPAs can support individual development projects in meeting these principles. The starting point for LPAs, however, is identical to that for those leading development projects: getting good insight into tree value in their local area, and how to account for it in planning decisions.

1.3.2 Available valuation approaches and why use them

Key points
The monetary asset value of trees and the benefits they deliver within or around a development site can be assessed:
- In qualitative terms, using the tree categorisation methodology outlined in BS5837:2012. This is best used at early site assessment stage.
- In quantitative terms, using non-monetary indicators such as canopy cover and tree diversity, or monetary valuation methods such as CAVAT or i-Tree Eco. Such approaches are best used for weighing-up design options in an informed and evidence-based manner, developing mitigation and/or compensation strategies, and guiding strategic planning for tree population management.
- All trees on any development are part of a wider tree population and that it is the whole wider population which delivers the full range of benefits and public goods.

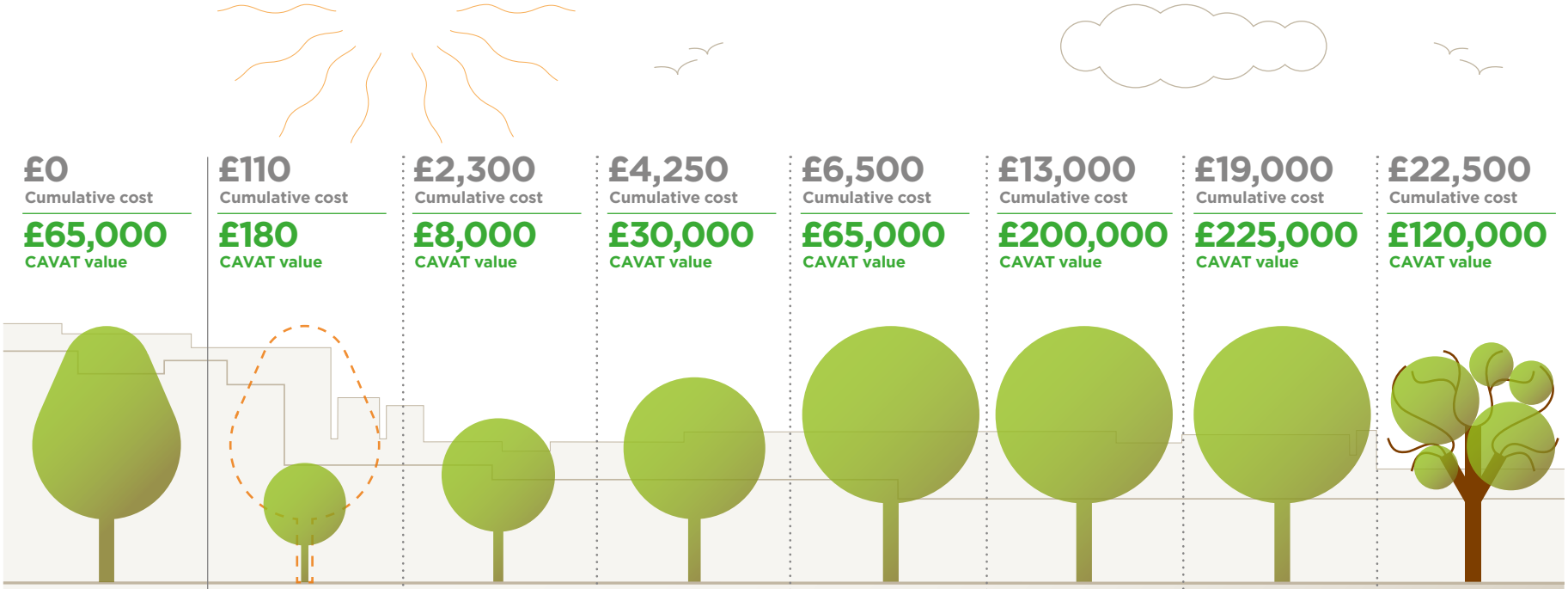
Podium planting for long-term benefits

This well-used garden is over a new basement adjacent to a re-purposed building. The specification provided a 2 metre depth to ensure adequate drainage. A crate system supports the paved areas and walls for the planters.

Seething Lane Garden, City of London – soon after completion in 2018. © DeepRoot

Climate-based design created a shady 'woodland' for contemplative walks and a sunny lawn for summer picnics. © City of London

An example tree's asset value calculated using CAVAT[103] (Capital Asset Value for Amenity Trees)



	Existing mature tree (90 years)	Replacement sapling (At planting)	Established young tree (30 years)	Early mature tree (60 years)	Mature tree (90 years)	Mature tree (175 years)	Veteran tree (250 years)	Senescent tree (300 years)
Cumulative cost	£0	£110	£2,300	£4,250	£6,500	£13,000	£19,000	£22,500
CAVAT value	£65,000	£180	£8,000	£30,000	£65,000	£200,000	£225,000	£120,000
	When a tree is healthy and there is no requirement to remove it	The replacement tree has only a fraction of the value of the mature tree it replaced, (0.28%)	After 30 years the replacement tree still has only 12.5% of the value of the tree it replaced	Even after 60 years the value of the replacement tree, now showing the characteristics of the species in maturity but still significantly smaller than the tree it replaces, still is worth less than 50% of the tree it replaced	After 90 years the tree has achieved the same value as the tree it replaced	At the peak of its maturity, the tree's value as a public asset has continued to grow	Careful management has largely maintained the quality and completeness of the mature tree. Its value now includes the many additional benefits that come with veteran status	The structure of the tree has reduced but its quality and health have been maintained by careful management. It retains significant asset value

This example assumes:
- Both the existing mature tree and its replacement sapling are in a publicly accessible urban area. Trees in cities will generally have a higher value, but equivalent costs.
- The replacement sapling is planted carefully, and allowed to thrive.
- The location is one where a tree can grow without constraint to maturity and reach its full potential.
- It shows if a mature tree has to be replaced, it must be done in a way that can achieve the potential lifelong asset value.

[103] See: www.ltoa.org.uk/resources/cavat

There are different ways to assess the asset value and the benefits delivered by trees: Some are qualitative, others are quantitative or a combination of both. Such assessments may or may not include a monetary expression of the asset value of the trees in question and the benefits they provide.

Delivering value to future users, to those taking the risks of seeing the project through as well as to local communities and the wider environment, is at the core of any planning and development endeavour. Using indicators to ascertain how well a project uses trees is key to achieving best value and return on investment.
The choice of indicator and valuation approach needs to be based on the stage and nature of the project. It is advisable to seek specialist advice before using such indicators to ensure the most appropriate choice is made.

1.3.3 The metrics of canopy cover and tree species diversity

Key points

Canopy cover and species diversity provide simple metrics which are easily understood and communicated. It helps in validating the use of trees to secure lasting environmental net gains in the development process – from policy through to design, implementation and the monitoring of progress. It is recommended that such metrics are incorporated in:

- The baseline technical information gathered for the preparation of a Local Plan and site allocations as well as a tree and woodland or green infrastructure strategy.
- Local planning policy (eg as part of the development management policies, an area action plan, or a neighbourhood plan).
- The design process dealing with individual sites at the local level, led by development teams and the development proposal assessments conducted by LPAs.

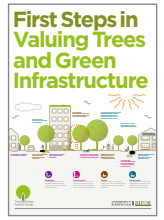
The metrics used to evaluate the value of and the benefits achieved can be very sophisticated and detailed. The number and sophistication of metrics should be proportionate to the design and complexity of the project, and whether it is strategic or local.

Different approaches to assessing canopy cover

Canopy cover measurement using aerial photography and satellite imagery is a useful metric at the strategic level to inform the broader planning and management of whole tree populations (see page 45). At the local level, more detailed canopy cover assessments are assisting LPA officers, elected council members, and the general public to better understand sometimes complex impacts on canopy cover, and for decision makers to be properly informed when evaluating development proposals, both against other options and over time. In the context of planning submissions, a range of approaches are emerging, typified by examples from two LPAs:

- Wycombe District Council pioneered a comprehensive methodology based on a site canopy cover target, which culminated in its *Canopy Cover Supplementary Planning Document* (2020)[104]. Its policy requires all sites of half a hectare or more (and are outside of its town centres) to achieve at least 25% canopy cover. For smaller sites and any within the designated town centre areas, the requirement is to '*maximise*' canopy cover. A hierarchical approach to first retain existing trees, then provide through new tree planting, and finally to include green roofs and green walls in the calculations to make up any short fall.
- Oxford City Council[105] avoided a specific canopy cover target, requiring applicants to demonstrate compliance with the *Oxford Urban Forest Strategy* (2021), assisted by providing broad guidance on important principles in its *Green Spaces Technical Advice Note 9* (2021), but leaving the applicants' technical advisors to demonstrate how. It broadly requires an assessment of the canopy cover impact of the proposed development against a no-development baseline, taking full account of the existing tree cover (including its future growth), the proposed losses through tree removals, and the likely gains through new tree planting. More specifically, because planning must consider future impacts as well as present, these comparisons should consider the impacts over time, with convenient and useful timescales being 10, 20, and 30 years. This approach also facilitates an estimation of when in the future the canopy cover losses from development will break-even, turning a net loss into an accumulating net gain.

Canopy cover assessment in this planning context is still in its early stages, and a widely accepted standard methodology has not yet emerged, which provides an opening for innovative and creative solutions to this complex problem. However, specifying the detail of a compulsory method so early in the evolution process could be counterproductive, potentially stifling invention, side-lining the ability to try and test new ideas, and losing the opportunity to learn from experience. Canopy cover assessment is proving to be very helpful, but the detail of how to do it is very much down to local circumstances and expertise.



TDAG's guide compiles accessible information and advice about the use of economic valuation approaches for trees and green infrastructure, which tool or method to choose and how to get started.

[104] See: https://buckinghamshire-gov-uk.s3.amazonaws.com/documents/Canopy-Cover-SPD_3qAkk4z.pdf

[105] Oxford City Council's *Oxford Urban Forest Strategy*. https://www.oxford.gov.uk/downloads/file/7722/urban_forest_strategy_september_2021
Oxford City Council's *Green Spaces Technical Advice Note 9*. https://www.oxford.gov.uk/downloads/file/7501/tan_9_green_spaces

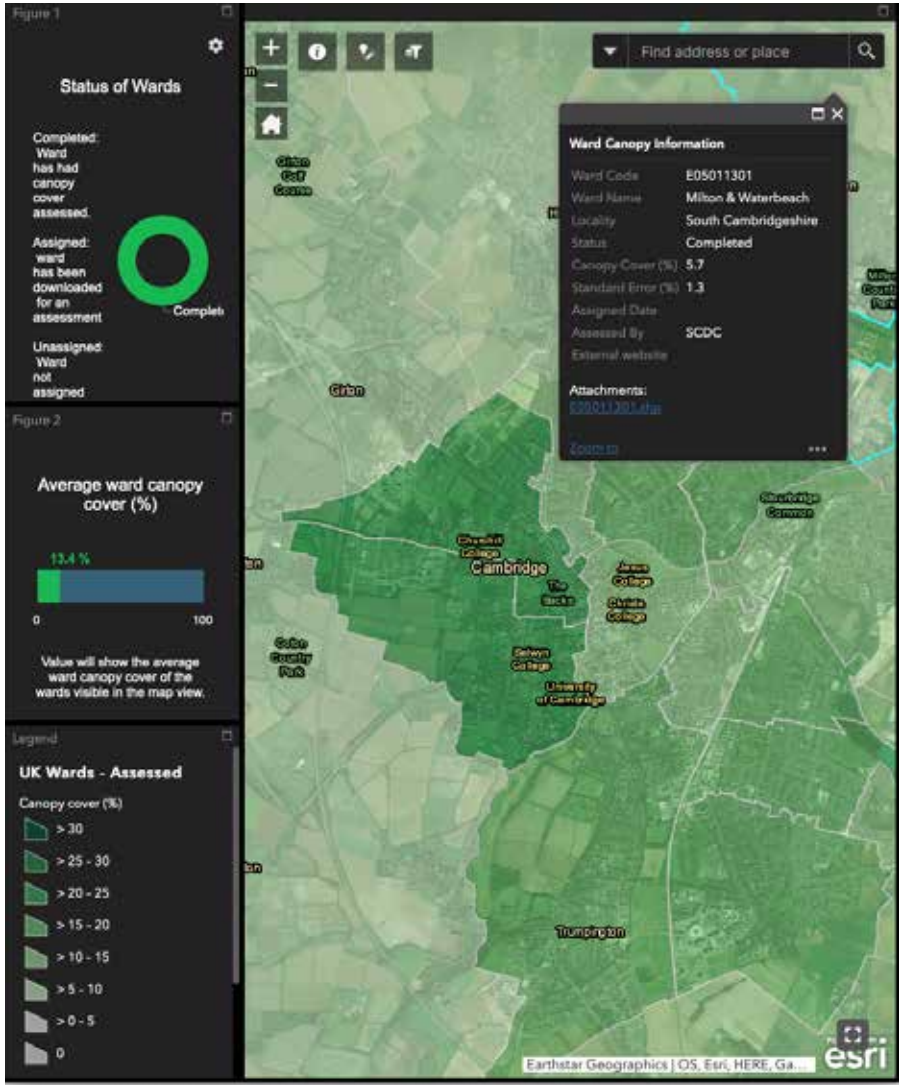
This guide recommends that canopy cover and tree species diversity are used as the minimum.

Canopy cover assessment helps in validating the use of trees to secure lasting environmental net gains in the development process – from policy through to design, implementation, and the monitoring of progress (see box previous page and box overleaf).

Where there is an existing tree inventory, species diversity is a useful metric as it is widely recognised that the more species present in any tree population the greater the resilience of that population to external threats such as those posed by climate change and invasive non-native pests and diseases. If there is no inventory, then details of the current species mix will have to be created by inspection on the ground.

A new inventory can include both canopy cover and species diversity to create an outline of a local urban forest, defining in measurable terms what 'no net loss' and 'improvement' mean for any area – whether an entire borough, a particularly sensitive area, for example, a city centre, or a single development site.

i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service, featuring helpful tools (www.itreetools.org). Development is ongoing, including for biodiversity, energy consumption and wellbeing in the UK. Forest Research included an assessment of the social and cultural value of trees within the i-Tree Eco project for the Wirral (www.forestresearch.gov.uk/research/i-tree-eco/i-tree-eco-projects/i-tree-eco-wirral/).



This map shows the variation in tree canopy cover across Cambridge in England, taken from a citizen science project that seeks to map tree canopy cover at electoral ward level across the UK. You can access the results at: bit.ly/canopy-cover-web-map. If your area of interest has not yet been assessed, you can contribute to the project and obtain the data you need free of charge. Assessment of a single ward takes just 45 minutes to 1 hour. For full details see: bit.ly/urbancanopycover. Users can also define their area of study if they are interested in canopy cover at levels eg for a development site.

Canopy cover

This is a two-dimensional metric identifying the area of ground covered by the tree canopy when viewed from above. It is normally calculated in square metres (m^2) or hectares (ha), but often expressed as a percentage cover of a defined area. Quantifying tree canopy cover has been identified (Britt and Johnston, 2008[106]; Escobedo and Nowak, 2009[107]; Schwab, 2009[108] and Doick Buckland and Clarke, 2020[109]) to be one of the first steps in the management of the urban forest. The reasons why canopy cover is so highly regarded as a metric to guide sound decision-making are simple: canopy cover is relatively easy to measure and provides a good proxy for the benefits provided by the urban forest. As such, although imperfect[110] – especially when considered on its own – it provides a quick indicator of the extent to which a proposal using trees is likely to deliver value. Simply put: if canopy cover is maintained or enhanced, then it is likely that the project is on the right track. If the impact of the proposal is negative, then value is most likely being lost.

Strategic canopy cover does not normally provide details of species mix, age class diversity or tree heatlh, whereas the more detailed assessment in a planning context at the local level does.

Canopy cover metrics, as a minimum, should inform:
- Local Plan site allocations, as well as trees and woodland and green infrastructure strategies.
- Site design at the local level by development teams and development proposal assessments by LPAs. Such analysis of the impacts of a development on canopy cover should include not only the implications of tree loss but the length of time mitigation, through planting, that it will take to yield equivalent or increased canopy cover. Timeframes, tree species, tree age profile and local growing conditions are important parameters to consider when predicting future canopy cover in the narrower planning context of individual sites.

Canopy cover at the heart of decision-making

In 2015, the United Nations identified urban trees as contributing to eight of its 17 Sustainable Development Goals[111], which is an endorsement of their importance at the highest international level. Innovative LPAs, eg Wycombe District Council and Oxford City Council, lead the vanguard promoting sustainability by placing canopy cover at the heart of local planning policy. However, as with all pioneering initiatives, practical experience is likely to identify improvements and other LPAs seeking to adopt similar approaches would be wise to take heed of emerging practical lessons. Initial observations are raising questions about where further research and development may be beneficial:
- Should town centres be excluded (as is currently the case in the Wycombe approach)? Although more challenging in terms of space, town centres are often where canopy cover is most needed.
- Should there be a site size threshold below which a different standard applies? It might be considered reasonable to exclude individual households, but should sites that cannot meet the standard be required to pay for offsite tree planting?
- Could the use of specific planning conditions to control the quality and extent of the rooting environment for new trees be a more effective planning approach than insisting on the complex and often costly work needed to assess the detailed soil conditions before planning consent is granted?
- Would specific reference to *BS 8545 (2014) Trees: from nursery to independence in the landscape – Recommendations* in a planning condition and its rigorous enforcement be an effective mechanism for improving the success rate of new tree planting, and therefore future canopy cover?

Monitoring overall canopy cover increase over time will be important.

TDAG's guide provides clear information with a decision-making tool for appropriate tree species selection.

106 Britt, C, Johnston, M. (2008). *Trees in Towns II – A new survey of urban trees in England and their condition and management*. London, UK: Department for Communities and Local Government

107 Escobedo, F, Nowak, D (2009). *Spatial heterogeneity and air pollution removal by an urban forest*. Landscape and Urban Planning, 90 (3-4) pp. 102-110

108 Schwab, J (2009). *Planning the Urban Forest: Ecology, Economy, and Community Development*. New York, NY, USA: USDA Forest Service

109 Doick, KJ, Buckland, A and Clarke, TK (2020). *Historic Urban Tree Canopy Cover of Great Britain*. Farnham, UK: Forest Research. www.mdpi.com/1999-4907/11/10/1049

110 Canopy volume is a better proxy for the amount of benefits delivered by trees – as species with a columnar shape are at a disadvantage when considered only in the horizontal plane. However canopy volume data is harder to acquire

111 *Urban Forests and the SDGs*. https://www.fao.org/3/c0210e/c0210e.pdf

Tree species diversity

This is a useful indicator of the resilience of the tree population concerned and its ability to deliver a wide range of benefits over time.

It is vital that investment in urban trees is not undermined by changes in the microclimate or incoming pests and pathogens. Climate change is causing a greater occurrence of extreme weather events such as prolonged and more severe droughts, increased heavy rainfall events and extreme winds, all of which can weaken the ability of trees to fight off pests and pathogens. At the same time, the increasing movement of people and goods is facilitating the introduction of pests and pathogens against which the local trees will have no 'inbuilt' evolutionary defences to fend off.

An effective strategy to mitigate against these growing risks is to avoid mono-specific planting and maximise the diversity of species present in an area. Academics[112] and standards (BS8545) recommend a species distribution following the 10/20/30 rule where no family represents more than 30%, no genus more than 20% and no individual species more than 10% of the total tree population. Therefore, if one species cannot cope with increasing summer droughts or is severely affected by a new pathogen, the whole tree canopy found in that area will not disappear as a result. Enough species choices and guidance (eg TDAG's *Tree Species Selection for Green Infrastructure: A Guide for Specifiers*[113]) are now available to ensure that diversification is not pursued blindly, at the expense of appropriateness or design composition.

Species diversity provides multiple benefits from trees. Some benefits are related to the age and structure of trees, whereby older, larger, and healthier trees contribute greater services (eg carbon sequestration, temperature cooling or stormwater management) and others are related to a wide range of species-specific characteristics.

Understanding impacts on tree species diversity should be integral to:
- Trees and woodland or green infrastructure strategies.
- Site design by development teams and development proposal assessments by LPAs.

Native versus non-native trees – a word of caution

It is not uncommon for the proportion of native species to be used as the only metric featured in local policy or in the set of Key Performance Indicators (KPIs) reported on a project when it comes to trees. Rigid adherence to such an approach can severely compromise climate change and pest resilience in a tree population. While evidence shows that native trees help to promote native insect and bird diversity, enhance the ecological integrity of urban ecosystems[114] and reduce biotic homogenisation[115], the soundness of prioritising the planting of native trees in all circumstances is questioned by many academics[116].

Objections are raised primarily on two grounds:
- The list of tree species deemed 'native' to the UK only contains about 30 species[117]. Among these, few are tolerant of the stressful conditions found in the built environment and their ability to adapt to the impact of climate change is currently unknown. At the same time, the level of vulnerability from such a constrained choice of species is only made worse by the tree planting stock available from nurseries of which most are clones and so genetically identical. The potential impacts of any pest or disease on a tree population composed exclusively of clonal cultivars of a small number of native trees would be devastating[115].
- Tree planting in the urban environment needs to balance biodiversity and ecological health concerns with the need to avoid creating tree-related risks while using green infrastructure to meet a broad range of needs[118].

The built environment includes many different land uses and levels of density. Each has constraints, needs, and ownership profiles, all of which affect tree species choices, planting styles and management practices that cannot be easily satisfied by a native-only species palette. Different approaches are needed to support biodiversity in these different contexts. For example, incorporating native tree species for new planting in parks, open spaces and low-density residential areas could be considered a good strategy[115]. But, metrics to measuring the success of native tree planting would need to be subsidiary to overall targets in respect to canopy cover and species diversity.

The only strategy that will most likely be highly efficient at supporting wildlife in the context of new developments regardless of context is the careful retention of existing trees[115] and shrubs. While not directly measured by the two indicators advocated above, the retention of existing trees is the easiest way to maintain good canopy coverage on any site. In addition to the benefits already presented above monitoring tree canopy cover therefore also provides a means to indirectly monitor biodiversity loss.

[112] Santamour, FS (1990). *Trees for urban planting: Diversity, uniformity and common sense*. Proceedings of the 7th Conference of the Metropolitan Tree Improvement Alliance (METRIA), 7: 57–65
[113] See: www.tdag.org.uk/tree-species-selection-for-green-infrastructure.html
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[118] Almas, AD and Conway, TM (2016). *The role of native species in urban forest planning and practice: A case study of Carolinian Canada*. Urban Forestry and Urban Greening, 17, 54-62

What about native species?

The one strategy that is most likely to be highly efficient for supporting wildlife in new developments, regardless of context, is the careful retention of existing trees[115] and shrubs. While not directly measured by the two indicators advocated above, the retention of existing trees is the easiest way to maintain good canopy coverage on any site. In addition to the benefits already presented, monitoring tree canopy cover also provides a means to indirectly monitor biodiversity loss.

The built environment includes many different land uses and levels of density. Each has constraints, needs, and ownership profiles, all of which affect tree species choices, planting styles and management practices that cannot be easily satisfied by a native-only species palette (see box previous page). Different approaches are needed to support biodiversity in these different contexts. For example, incorporating native tree species for new planting in parks, open spaces and low-density residential areas could be considered a good strategy[115]. But, metrics to measuring the success of native tree planting would need to be subsidiary to overall targets in respect to canopy cover and species diversity.

Native Veteran oak in Dulwich Park, London. © London Wildlife Trust

Non-native trees, if chosen wisely, can provides multiple benefits. *Ulmus* cultivars are resistant to Dutch elm disease and make good street trees. Kelham Island, Sheffield. © Andrew Hirons

[115] Alvey, AA (2006). *Promoting and preserving biodiversity in the urban forest*. Urban Forestry and Urban Greening 5 (4), 195–201

Glossary

Absorption rate: in real estate, the rate at which homes that are available in a particular market are sold over a specific time frame.

Arboriculturist: cultivates and manages trees, hedgerows including felling, preserving, planting and protecting trees and providing information and advice on specific tree-related issues.

Biodiversity Net Gain (BNG): under the Environment Act 2021, all planning permissions granted in England (with a few exemptions) will have to deliver at least 10% biodiversity net gain from November 2023 and from April 2024 for small sites.

Bioretention: the process by which soils and both woody and herbaceous plants are used to remove contaminants and sediments from surface water runoff.

Crown: is the foliage bearing section of the tree formed by its branches and not including any clear stem/trunk.

Cultivar: a tree variety that has been selected for one or more outstanding characteristics, and that is being cultivated and usually reproduced by cloning to preserve genetic makeup. For example: *Pinus sylvestris* 'Gold Coin' (Scots pine 'Gold Coin', characterised by its rounded shrub form and bright light yellow foliage).

Developable area: is the land available on a site for development, within the net site area.

Evapotranspiration: is a combination of evaporation and transpiration. Evaporation is the process by which water from soil and plant surfaces changes from a liquid to a vapour and transpiration is the process by which trees absorb water through their roots and transfer it up to the leaves where it evaporates into the environment through leaf pores.

Family: a taxonomic category ranking used in biological classification that includes one or several genera. Trees belonging to the same family would have evolved from the same ancestors and resemble each other in general appearance and technical character. For example: Oak – Family (*Fagaceae*), Genus (*Quercus*), Species (*Robur)*.

Formative pruning: the removal of appropriate branches of a young tree to avoid future structural defects while giving it the desired form.

Genera: plural of genus.

Genus: a taxonomic category ranking used in biological classification that brings together several species that are closely related and share similar characteristics. For example, all trees in the Pine genus (*Pinus*) have long, narrow needles bound in bundles and hard, woody cones with thick, tough scales.

Green infrastructure (GI): a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services in both rural and urban settings.

Hedonic valuation: is used to estimate economic values for ecosystem or environmental services that directly affect market prices. It is most commonly applied to variations in housing prices that reflect the value of local environmental attributes.

Invasive: see invasive non-native species.

Invasive non-native species: a non-native animal or plant that has the ability to spread causing damage to the environment, the economy, our health and the way we live.

Keystone species: a species which has a disproportionately large effect on a particular ecosystem relative to its abundance.

Low traffic neighbourhood (LTN): is a scheme where motor vehicle traffic in residential streets is greatly reduced by minimising through traffic.

Material consideration: in planning law throughout the UK, a matter that should be taken into account in deciding a planning application or on an appeal against a planning decision.

Post-planting care: minimum five-year maintenance programme of watering, formative pruning, adjusting of support systems.

Regression analysis: a statistical method for identifying which independent variables have impact on a dependant topic of interest.

Root protection area: the minimum area around a tree deemed to contain sufficient roots and rooting volume for the tree to thrive and mature, and where the protection of the roots and soil structure is treated as a priority.

SMART action plan: an effective delivery method for a Strategy. SMART stands for Specific, Measurable, Achievable, Realistic and Time-specific.

Species: is the lowest taxonomic ranking in biological classification. A natural group of trees in the same genus made up of similar individuals. For example: *Pinus sylvestris* (common name: Scots pine).

Tree population: refers to all of the trees found in an area, irrespective of ownership, size, age, or species.

Tree rooting environment: the wider area of growing medium that roots can expand into to support the growth of the tree.

Urban forest: is the ecosystem containing all of the trees, plants and associated wildlife in the urban environment, both in and around the city.

Tree variety: is a subdivision of a species having a distinct, though often inconspicuous, difference and breeding true to that difference. For example: *Pinus sylvestris* var. *hamata* (common name: Caucasian pine).

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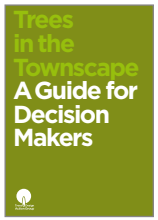


Trees in the Townscape: A Guide for Decision Makers

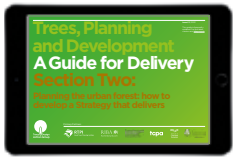
12 action-oriented principles as a 21st century approach to urban trees, providing decision makers with the references they need to fully realise this potential.

Trees in Hard Landscapes: A Guide for Delivery

Starting from the point where the policy decision to retain or plant trees has been made, this guide explores the key four building blocks to success – collaborative process, designing with trees, technical design solutions and species specific criteria.

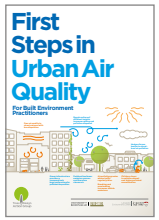
Tree Species Selection for Green Infrastructure: A Guide for Specifiers

Provides clear information with a decision-making tool for appropriate tree species selection in the context of climate change, for all urban planting sites and to aid the diversification of the urban forest.



Trees, Planning and Development: A Guide for Delivery

Articulates the range of returns trees offer new developments and how to secure these returns. The main document is supported with additional briefing notes providing further guidance and research based evidence.

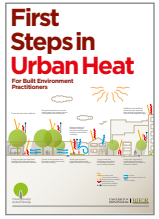


First Steps in Urban Air Quality

Compiles the basics built environment professionals need to know about urban air quality and how design of our urban infrastructure – including green infrastructure – determines where air pollution is produced, and how it disperses.

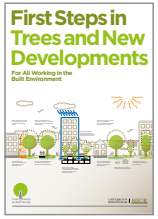
First Steps in Valuing Trees and Green Infrastructure

Compiles accessible information and advice about the use of economic valuation approaches for trees and green infrastructure, which tool or method to choose and how to get started.



First Steps in Urban Heat

Provides an overview of the sources and circulation of heat within our urban areas, including the cooling benefits provided by green infrastructure, and other cooling solutions.



First Steps in Trees and New Developments

Sets out simple principles of good practice from pre-to post-planning for achieve both housing and tree planting targets.

Case Study Library

Case studies may be included in the guides or are referenced in the Case Study Library. These reflect different project viewpoints, aim to offer impartial, factual information and are periodically reviewed to check the progress of tree planting.

How our guides are developed

As is TDAG's practice, it has been an exercise in cross-disciplinary collaboration, made possible through the generous financial support of our sponsors (see Financial support pages).

Please Note: while very effort is made to ensure that the information in TDAG guides is obtained from reliable sources, the TDAG Trust is not responsible for any errors or omissions or for the results obtained from the use of this information. TDAG guidance cannot replace professional advice.

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