M25 junction 10/A3 Wisley interchange
TR010030

9.127 Applicant's Submission of Extracts
Modern Arboriculture, Up by Roots & Applied Tree Biology, (document accompanying volume TR010030/9.117)

Rule 8(1)(c)(i)

Planning Act 2008

Infrastructure Planning (Examination Procedure) Rules 2010

Volume 9

July 2020

Infrastructure Planning

Planning Act 2008

The Infrastructure Planning (Examination Procedure) Rules 2010

M25 junction 10/A3 Wisley interchange

Development Consent Order 202 [x]

9.127 Applicant's Submission of Extracts

Rule Number:	Rule 8(1)(c)(i)
Planning Inspectorate Scheme Reference	TR010030
Application Document Reference	TR010030/9.127
Author:	M25 junction 10/A3 Wisley interchange project team, Highways England and Atkins

Version	**Date**	**Status of Version**
Rev 0	03 July 2020	Deadline 11

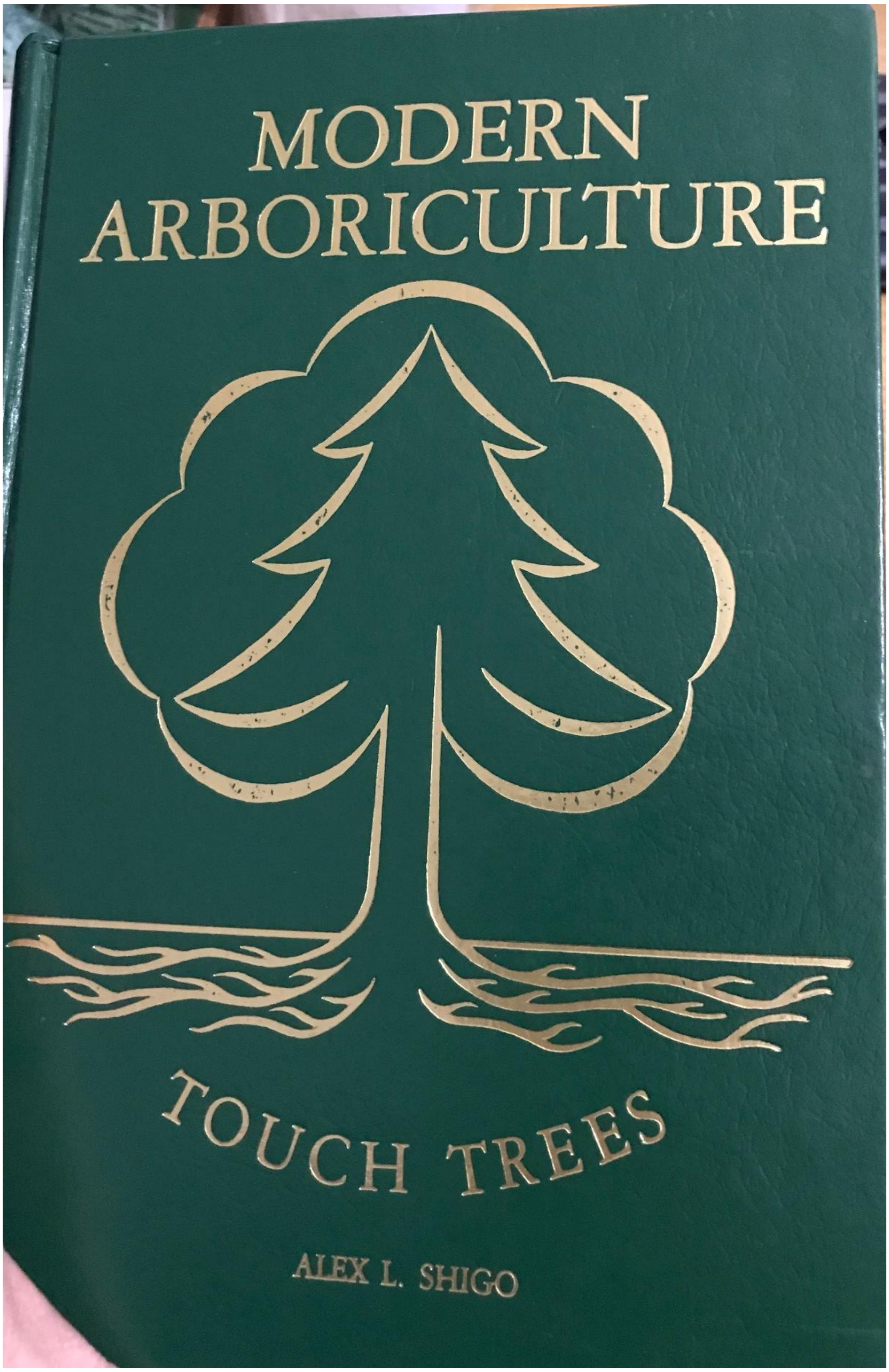
Table of contents

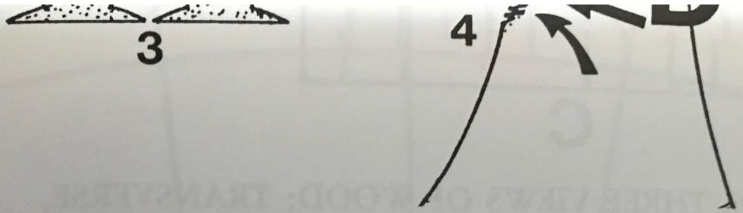
1. Introduction

1.1.1 This document sets out extracts from Modern Arboriculture, Up by Roots & Applied Tree Biology which is referred to in Response to Question 3.1.15 in the Applicant's Comments to Interested Parties D10 Submission (documents reference TR010030/9.117) at Deadline 11.

2. Books extracts

2.1 Shigo A.L (1991). Modern Arboriculture. Shigo and Trees. Section 25 Sapwood, Heartwood.

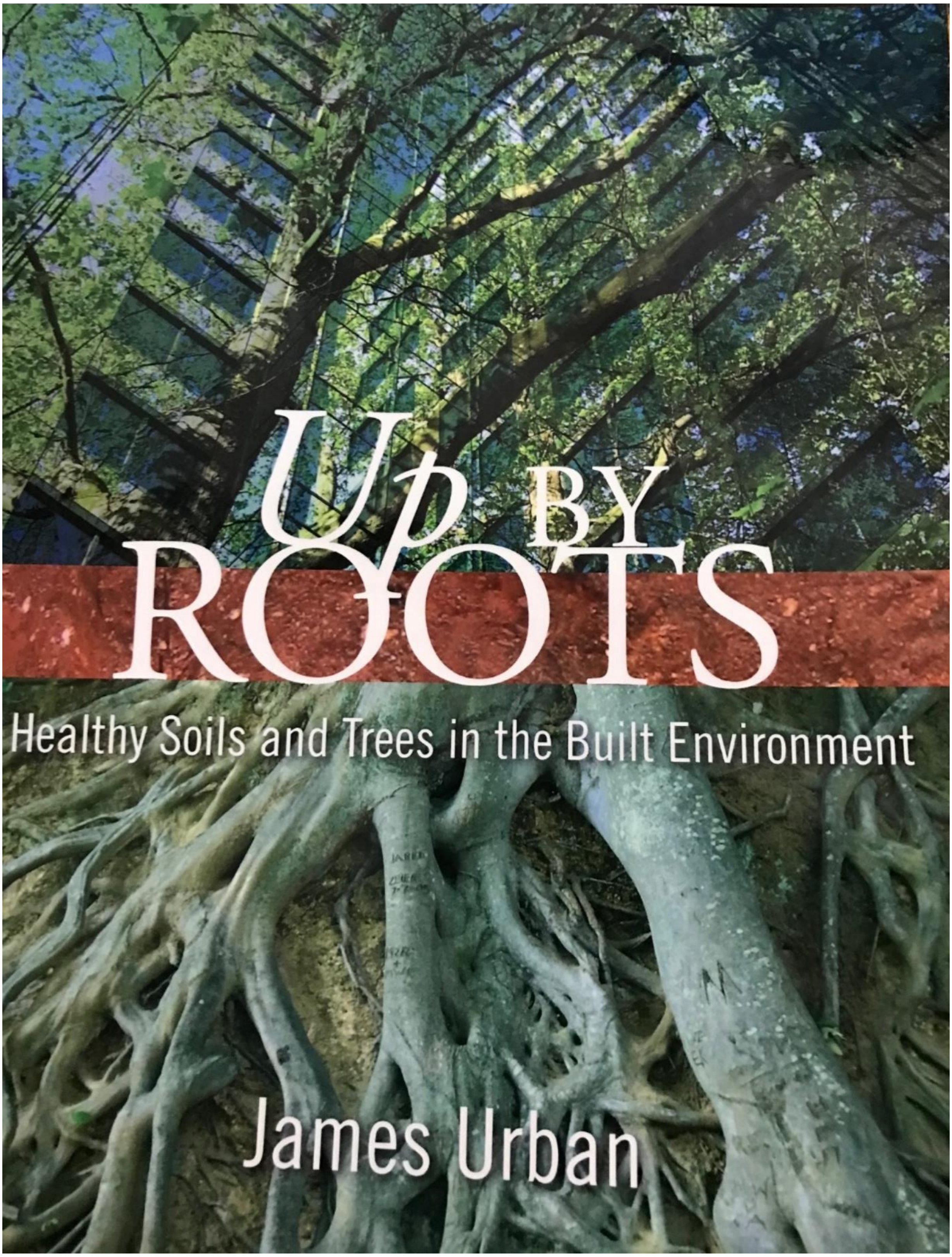




25. SAPWOOD, HEARTWOOD

Wood is a highly ordered arrangement of cells that have walls of cellulose and lignin in all gradations from living, to dying, to dead. Sapwood [S] contains living cells; heartwood [H] does not. But, there is more to sapwood and heartwood. Sapwood has 4 major functions: 1. transport from root to shoot and radially into and out of wood; 2. storage of energy reserves in living parenchyma cells, axial and radial; 3. mechanical support cells with strong walls of cellulose and lignin; 4. defense by conversion of energy reserves to chemicals that resist the spread of pathogens. Heartwood [H] is age-altered protection wood. As the inner sapwood parenchyma cells die, their walls and sometimes their cell contents are filled with chemicals that resist decay. Because these chemicals can be extracted in other chemicals, the protection substances are called extractives. Heartwood formation is genetically controlled. Energy is required to form the extractives. Energy is required to transport nitrogen-based chemicals out of the dying cells. The extractives usually impart a color darker than sapwood to the heartwood. Heartwood maintains a mechanical support function as the core of static mass and it reacts when injured to form boundaries. Heartwood will discolor.

2.2 Up By Roots. Healthy Soils and Trees in the Built Environment. International Society of Arboriculture Page.73. Essential Plant Functions.



ESSENTIAL PLANT FUNCTIONS

The two essential life functions of a tree are

- Photosynthesis, the production of the needed chemicals for growth processes.
- Respiration, the use of those chemicals in growth and decay.

During photosynthesis, the plant stores energy in the sugar molecules it makes. During respiration, the plant releases that stored energy as it uses the sugar molecules or when they decay.

Photosynthesis combines water and carbon dioxide in chlorophyll cells energized by sunlight to produce sugar and oxygen and storing energy. Respiration uses those molecules and oxygen to change the sugar molecule from one form to another, releasing energy and producing excess water and carbon dioxide.

Photosynthesis creates and stores sugar reserves as sequestered carbon-based molecules over the life of the tree. Respiration decays those reserves, continuing to release carbon long after the tree has died.

Photosynthesis

Photosynthesis can be seen as a fairly simple process of tearing apart and then recombining CO_2 from the air and water, using the energy of the sun to make sugar and oxygen. The tree uses the sugar and the oxygen goes back into the atmosphere. Life on earth could not exist without that excess oxygen, which comes from organisms as small as single-cell algae in the sea to the grandest of trees. All other non-green organisms reap the benefits. Figure 1.5.5 shows a simplified model of the photosynthesis process. It is probably not necessary to know how many C's and H's move through the plant to successfully design a landscape, but a simple understanding of this most basic of all life functions should be within the vocabulary of people who depend on it for the success of their work.

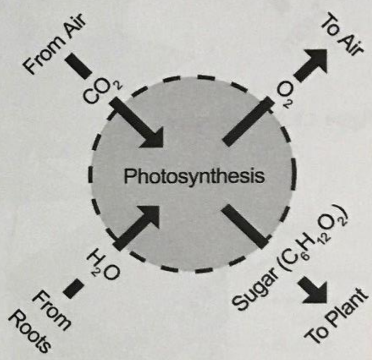


Figure 1.5.5. Photosynthesis.

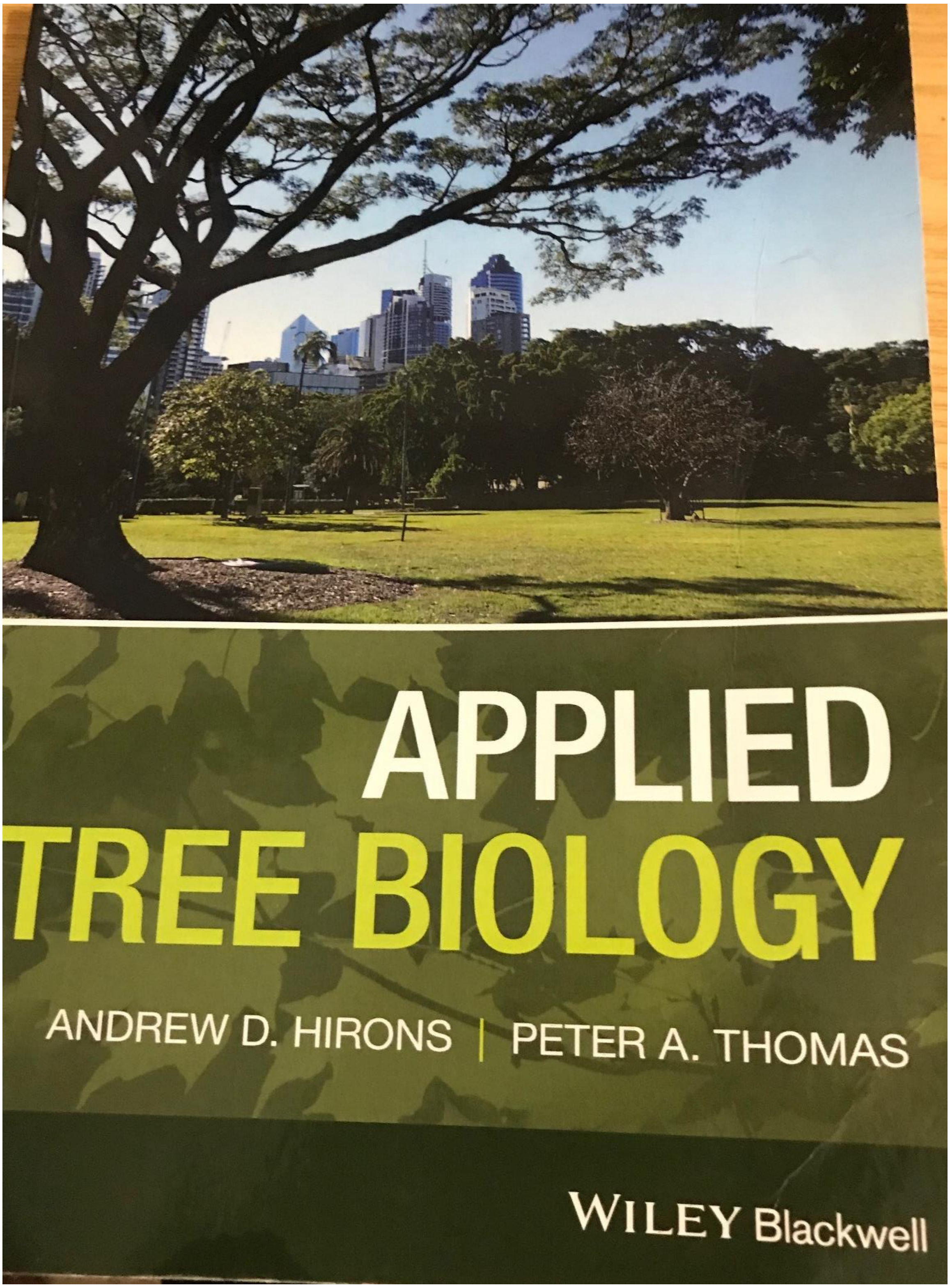
Notice that only three elements, O, H, and C, actually show up in the final molecule. Why then is it so important to have all those other elements we discussed in the previous chapter? As these simple sugars move through the plant, they combine with essential elements, forming more complex and specialized molecules to build plant structure and use other chemicals to facilitate plant functions. There is very little nitrogen in the wood of a tree, but it is in the leaf helping with the work of creating sugar.

Photosynthesis in trees is not restricted to the leaf. There is a great deal of chlorophyll in the stem of a tree. You can see it as a green tinge on the wood when the stem bark is scraped off. This chlorophyll produces as much as 20 percent of the tree's sugar and functions as long as the air temperature is above 40°F.

Sugar, Glucose, Carbohydrates, Starch, Cellulose, Lignin

Sugar as used in this text is another name for **glucose**, the chemical produced by the leaves during photosynthesis. **Glucose** is a **carbohydrate** and is the basic building block of all tree cells. These molecules combine in more and more complex forms, eventually becoming **starch**, which can be stored in the tree for future use. Trees can break down starches into glucose when needed. **Cellulose** is a complex starch and makes up much of the rigid fiber in the tree. **Lignin** is a particular molecule in the cell walls of wood. It biodegrades more slowly than cellulose and is found in larger quantities in some bark, particularly of conifer species.

2.3 Hirons, A & Thomas, P (2017). Applied Tree Biology. Wiley Blackwell. Page 147.



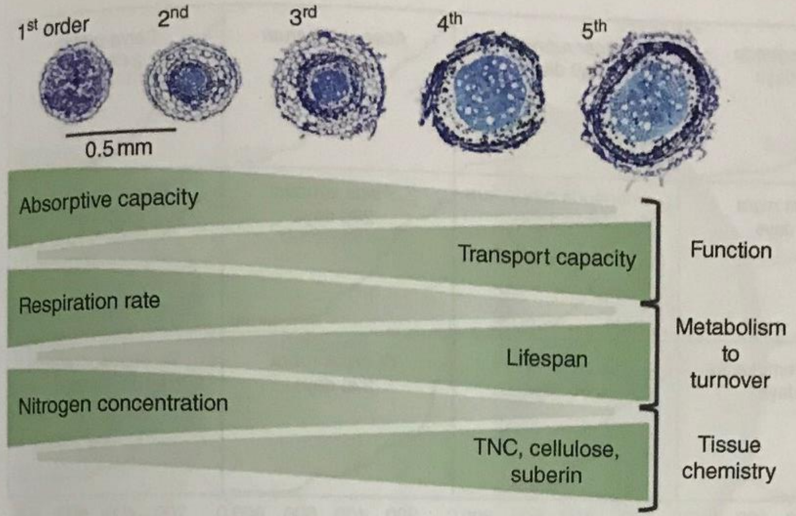


Figure 4.5 Root cross-sections of Norway maple *Acer platanoides*, showing a typical pattern of increasing root diameter and secondary (woody) development with increasing root order. Notice that first- and second-order roots have little or no secondary development, and first- to third-order roots still possess intact root cortical cells; fourth- and fifth-order roots have lost all cortex and instead have secondary xylem. Triangles depict simplified patterns of root function (absorptive and transport capacity) and root traits (respiration rate per gram of root; lifespan; total non-structural carbohydrates (TNC); and other aspects of tissue chemistry) with increasing root order. Root function may not change linearly, depending upon the trait and species. It is also worth noting that despite their recognised importance to root function, many aspects of tissue chemistry (including cellulose, suberin and phenolic content) are not well studied, and patterns of root function with root order may vary across species. *Source:* McCormack *et al.* (2015). Reproduced with permission of John Wiley and Sons.

(typically fourth and fifth orders) are predominantly involved with conduction (transport), anchorage and storage of carbohydrates, but will also be able to take up some water (Figure 4.5).

The contrasting roles of fine and coarse roots lead to different life expectancies of individual roots within a single root system. Coarse roots usually increase in diameter (via secondary growth) to improve their ability to conduct water, their biomechanical performance and their resistance to decay. As a result, they may persist for years, decades and even centuries. Conversely, the highly dynamic fine root system, particularly the finest lower order roots, rapidly proliferates within resource-rich patches until they are depleted, at which point the roots rapidly die off, whilst, elsewhere in the root system, other fine roots will be growing. This *fine root turnover* can result in an individual root lifespan of just a few days. In temperate trees, the median fine root lifespan has been found to vary, between 95 days in aspen *Populus tremuloides* to 336 days in white oak *Quercus alba*. This results in quite different fine root survivorship profiles (Figure 4.6). For example, in aspen, just 30% of the fine roots survived longer than 200 days, whereas in white oak 80% of fine roots survived longer than 200 days (McCormack *et al.* 2012). It is also clear that some of the higher-order fine roots may persist for several years, particularly in regions where there are less marked seasonal differences in water availability and soil temperature.

Printed on paper from well-managed forests and other controlled sources.

Registered office Bridge House, 1 Walnut Tree Close, Guildford GU1 4LZ
Highways England Company Limited registered in England and Wales number 09346363