# Soil Requirements of Healthy Urban Trees

GreenBlue URBAN

Establishing the future urban landscape


# Healthy Urban Soil

Trees require adequate supply of uncompacted, well aerated, and moist soil in order to thrive. These soil conditions enable tree roots to obtain all the essential elements they require for healthy growth - nutrients, oxygen, and water. They also happen to be the elements found in the soil of natural forest settings. In built-up urban areas however, these soil circumstances are often unavailable. In this ebook, we provide a soil quality definition and explain the soil requirements of urban trees.

Soil is the uppermost layer of the earth's crust and is the medium in which trees and other plants grow and spread their roots. Soil is comprised of finely ground rock particles and materials such as sand, silt, clay, and gravel; with void spaces between particles containing air and water.


Although some potential urban soil limitations can be addressed with specie selection – such as spatial constraints, soil PH, wet & dry soil, and even salt contamination – one soil condition that cannot be mitigated by plant selection is compacted soil.  Adequate provision of quality, uncompacted soil is essential for the long term success of urban trees.

Soil type usually refers to the different sizes of mineral particles in a particular sample. Each size plays a significantly different role. For example, sand represents the largest particles and determines aeration and drainage characteristics, whereas sub-microscopic clay particles are chemically active binding with plant nutrients and water.

The ratio of these particle sizes determines soil type: loam, clay, clay-loam, silt-loam, and so on. Sandy soils have very large particles allowing plant roots, water, and air to move freely. Whereas clay particles are very small and pack together tightly, leaving little room for nutrients and root growth.


**Nutrients**

There have been seventeen essential soil nutrients identified. While carbon and oxygen are absorbed from the air, other nutrients, such as water, are obtained from the soil and absorbed by the tree’s roots. Nutrients consist of calcium, sulphur, and magnesium (amongst a range of other trace elements), although the primary nutrients are:

- Nitrogen (for healthy stem and leaf growth)
- Phosphorus (for root growth)
- Potassium (for overall plant health - especially the immune system)


**Organic Matter**

In addition to soil’s mineral composition, organic material also plays a critical role in soil fertility and characteristics for plant life. Organic matter improves sandy soil by retaining water and alters clay soil to make it more permeable, allowing water, air, and roots to penetrate.

Soils change in composition and appearance with depth creating what is known as a soil profile. Soil profiles typically have a top layer of decaying organic matter formed by fallen leaves and other debris deposited by plants. This layer also called the ‘O horizon’. Below the organic matter is topsoil (or ‘A horizon’) which can range in depth from a few inches to several feet. This layer consists of decomposed organic matter and minerals, and is usually dark brown or reddish brown in color. This layer is where most tree roots concentrate.

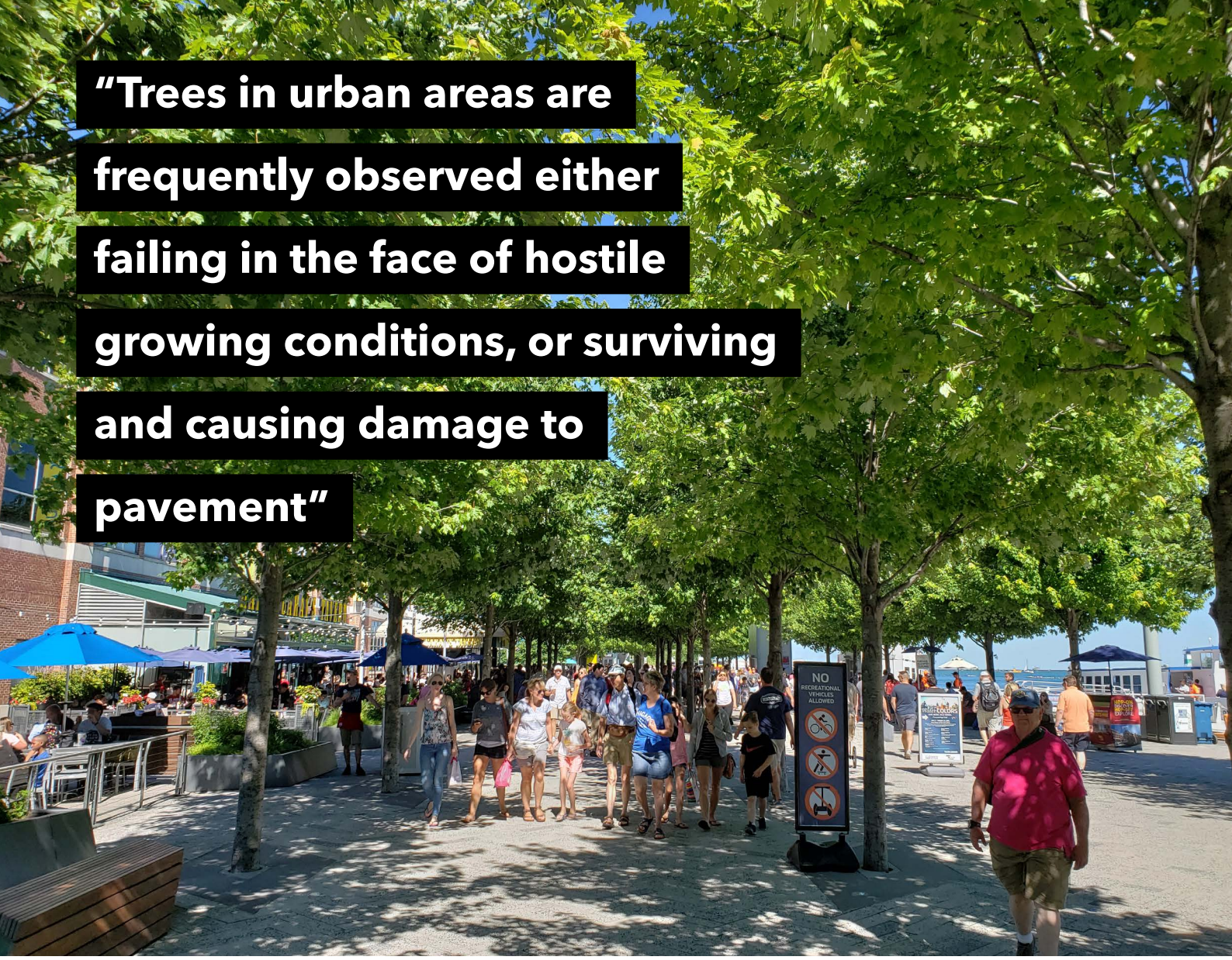

Under the topsoil is subsoil (‘B horizon’) which generally lacks organic matter and therefore has poorer nutritional value. If oxygen levels are sufficient and drainage is adequate, tree roots can penetrate into this layer.

Below the soil layers lies the parent material (‘C horizon’), which is the main source of soil. This material can be transitional, heavy clay, or soft stone. Organic matter and weathering usually do not affect this layer.


**Cation Exchange**

Nutrient uptake in the soil is achieved by cation - positively charged ion - exchange. Fibrous roots pump hydrogen ions (H+) into the soil which displace cations attached to negatively charged soil particles, making the cations available for uptake by the root.

Roots, and specifically fibrous roots, are the most important organ for the uptake of nutrients.




# How Much Soil Do Trees Need?

Trees need appropriate amounts of moist, well aerated, and uncompacted soil in order to mature in the urban environment. These conditions enable the tree’s roots to obtain nutrients, oxygen, and water - all essential for healthy tree growth. After defining in detail the soil requirements needed for healthy root growth, let’s discuss how much of this soil trees need to thrive and reach maturity.

In addition to the nutrients that trees obtain from soil through their roots, they also need oxygen and water that occupy the voids between soil particles. These voids are abundant in uncompacted soil, however, soil in urban areas is usually compacted to provide structural stability for paved surfaces - making void space between soil particles nonexistent.


**"Sidewalk heave and other damage caused by shallow rooting is the cause of millions of dollors of infrastructure damage every year"**

If soil alone is depended on as a structural material and required for the load-bearing of buildings, vehicles, and pedestrians; it will be compacted to the point that air and water are excluded and a totally insufficient space for root growth will be available.

Trees planted in unsuitable urban tree pits are usually surrounded by compacted soil which often leads to the roots seeking out the space between the compacted soil and the paved surface above, where air and water are present. This then causes root heaving in the pavement, as shown above.

When a tree's need for nutrients, water, and air can no longer be met, the health of the tree suffers and the tree begins to decline and eventually die. Trees grown in these conditions hardly ever reach maturity and do not provide the many benefits that healthy trees offer.

This challenge creates a fundamental conflict for trees in paved areas. Careful consideration needs to be taken regarding the above and below ground space to ensure that each tree has what it requires to reach maturity. The old method of providing a tree pit area the size of the pavement opening is clearly insufficient and results in a lifetime of costly pavement repairs and commits the tree to an untimely death.

So, how much uncompacted soil do trees need to be healthy and reach maturity? Various methods of determining required soil volume may be used to calculate the approximate below ground space that a tree should need for healthy root growth.

**Mature Canopy Method**

Likely the simplest method of calculating soil volume, is estimating the projected mature tree canopy diameter and multiply it by a depth of 2ft. GreenBlue offers a complimentary tree pit soil calculator that will conveniently provide these calculations for you. Access it for free: greenblue.com/tree-pit-soil-calculator

**As a general rule:**

- Allow 32ft for canopy development for large trees
- Allow 20ft for canopy development for medium trees
- Allow 10ft for screens, shelter belts, or park group plantings
- Allow a minimum of 8ft in any instance

The availability of space for tree roots to develop is crucial to a tree's health, since a growing tree's roots will extend far into the surrounding soil to more than twice the diameter of the mature tree's canopy"

**Mature Trunk Caliper Method**

Trunk diameter is another predictor of root spread. For young trees less than about 8" in diameter, the ratio of root radius to trunk diameter has been found to be around 38:1 - therefore a 6" diameter tree at maturity could have a root system extending nearly 20ft from the trunk.

**Suggested Soil Volumes**

Minimum recommended soil volumes are:

Small Tree: 5-15 cubic meters
Medium Tree: 20-40 cubic meters
Large Tree: 50+ cubic meters

So how do we maximize uncompacted soil volume available for root growth without jeopardizing a stable base for sidewalks and roads? Soil support cells assemble underground to form a structural matrix filled with uncompacted soil to accommodate healthy root growth, while also providing a load-bearing structure for paved surfaces. They are the proven method for street trees, successfully implemented on thousands of projects around the world.

By understanding the soil conditions that urban trees need to reach maturity, landscape architects and related professionals can take the required steps in specifying the systems and best practice procedures that will ensure the success of our urban tree populations.


## About GreenBlue Urban

Founded in 1992, GreenBlue was established to conduct research into urban tree planting practices and provide solutions to assist trees in their battle to thrive in urban areas. With the goal of drastically improving urban planting success and increasing leaf canopy in cities, GreenBlue tirelessly analyzed the challenges, the causes of failure, and the reasons for premature mortality in urban trees. We then examined the negative impact that poor planting can have on urban infrastructures. Having identified the key issues in both of these areas, we systematically researched the solutions for those issues and designed practical products and systems to address them.

Local authorities, landscape architects, engineers and other related professionals increasingly turn to GreenBlue for guidance and best practice advice in tree planting implementation. As the global market leader and specialist in urban landscape products, GreenBlue and our overseas partners are able to offer the results of nearly twenty years of frontline experience, exhaustive research, product development and field trials. Our program of continuous product development ensures that specifiers and clients can rest assured that the systems we offer for urban planting schemes represent the best available. For further information, please visit our website or contact our knowledgeable team of consultants.

www.greenblue.com
sales@greenblue.com

UK Sales: 0 1580 830 800
NA Sales: 1 866 282 2743

GreenBlue® URBAN
Establishing the future urban landscape