Using Turf on CU-Structural Soil™

Urban Horticulture Institute
Cornell University
Department of Horticulture
134A Plant Science Building
Ithaca, NY 14853
www.hort.cornell.edu/UHI
Founded in 1980 with the explicit mission of improving the quality of urban life by enhancing the functions of plants within the urban ecosystem, the Urban Horticulture Institute program integrates plant stress physiology, horticultural science, plant ecology and soil science and applies them to three broad areas of inquiry.

They are:

• The selection, evaluation and propagation of superior plants with improved tolerance of biotic and abiotic stresses, and enhanced functional uses in the disturbed landscape.

• Developing improved technologies for assessing and ameliorating site limitations to improve plant growth and development.

• Developing improved transplant technologies to insure the successful establishment of plants in the urban environment.

Authors:
Nina Bassuk, Urban Horticulture Institute, Department of Horticulture, Cornell University
Ted Haffner, Graduate Student, Department of Horticulture, Cornell University
Jason Grabosky, Department of Ecology, Evolution, & Natural Resources, Rutgers University
Peter Trowbridge, Department of Landscape Architecture, Cornell University

Contact:
nlb2@cornell.edu

Layout & Graphics:
Ted Haffner

Photo Credits:
N. Bassuk, T. Haffner, B. Kalter, & P. Trowbridge

Cover Photo:
Porous Asphalt on CU-Structural Soil™
Parking Lot, Ithaca, NY.
The Case for Turf on Cu-Structural Soil: Why do we need it, and how is it used?

Turf is used in all sorts of settings, and for all kinds of reasons. Primarily used as a source of groundcover in residential lawns, turf covers are also found in parks, playgrounds, and athletic fields. In these situations, turf is used both for providing a sense of open green space, and as a protective surface for play. If turf is properly installed, it can have additional uses and benefits in areas such as limited access fire lanes and parking lots. In these instances, turf can lend a sense of open green space and work to reduce temperatures in urban settings that might otherwise be paved in asphalt. Often, however, the requirements for healthy turf growth can be difficult to achieve due to misapplication or misunderstanding of the requirements for a healthy field of grass.

When turf is used in these settings, however, it is susceptible to traffic which compacts the soil, placing extreme conditions and limits on the growth of the turf (Fig. 1.1, 1.2, & 1.3). Ultimately, these limits prohibit drainage, healthy root growth and the ability of the turf to grow at all.

Fig. 1.1 Area of park used for a weekly farmers market in Chicago. Compaction from foot and vehicle traffic has denuded the grass in this section of the park.

Fig. 1.2 Same area from a different angle. Again, notice areas of compaction where traffic has prohibited turf growth within the park.

Fig. 1.3 On this corner the turf has been worn away by lots of vehicle traffic. This traffic compacts the soil and limits drainage, essentially drowning out turf grass from this area.

Fig. 1.4 Turf covered pier in New York City serving as open space in a crowded city. The grass gives a rare opportunity for open space and can be used for both active and passive recreation.
Cornell Developments in Turf Use

Cornell University has combined turf with CU-Structural Soil™ to create a healthy growing medium for the grass that withstands traffic, is designed to be virtually maintenance free, and can be used in areas that receive high levels of both pedestrian and vehicular traffic. These areas include open field public gatherings, fire lanes, and parking lots.

Rather than easily compactible soil or a gravel base that completely lacks soil and nutrients, the Cornell system uses CU-Structural Soil™ (Fig. 1.6). CU-Structural Soil™ has two benefits. The first is that CU-Structural Soil™ is designed to be compacted, and will therefore withstand heavy amounts of traffic, allowing both people, cars and temporary structures to safely use a turf covered surface installed on CU Structural Soil™.

Additionally, however, the Cornell system can allow water to infiltrate the turf surface and hold it in a reservoir underneath the grass. Increased water and air within the CU-Structural Soil™ media not only allows for healthier root and shoot growth for the grass, but also allows rainwater and runoff to be collected and held within the CU-Structural Soil™ reservoir in large amounts until it can slowly infiltrate into the ground below the reservoir. This reduces drainage and sewer system infrastructure and also recharges the groundwater levels over time. This combination, then, not only serves the environment from a water quality standpoint, but also adds a “sustainably green” component to highly urbanized areas.

Fig. 1.5 Example of a driveway using a stone matrix to support the weight of vehicular traffic. Despite the use of this good idea, it is possible to see the impact of car traffic on the grass.

Working With Turf: The Grass is Always Greener on the Other Side of the Hill.

Working with turf can be more difficult than just planting grass seed or rolling out sod. The type of grass specified can vary greatly with the site conditions and are highly dependant on the amount of sun and shade, the type of soil and the post installation maintenance regime. Even a professionally installed field of turf can die within months if it is not properly taken care of or if the amount of traffic a field receives is misperceived.

There are commercially available products which help bear the weight of both foot and vehicular traffic yet still allow grass to grow. However, since many of these products are made of plastic, they break down over time and with the application of heavy weight. In instances where these products are more durable, the weight of traffic can still have observable effects on healthy turf growth (Fig. 1.5). Even with stones bearing the bulk of the weight of vehicular traffic, the soil is still compacted to such a level that grass is much thinner and sometimes non-existent within the driving lanes.

Fig. 1.6 A construction detail showing tall fescue sod on a CU-Structural Soil™ reservoir. The 2' CU-Structural Soil™ reservoir allows both grass to root into the soil mixture and also to handle a 100 year storm of 6” of rain in 24 hours in Ithaca, NY. Reservoir allows water to be held until it can naturally infiltrate undisturbed subgrade over time, recharging groundwater levels and reducing runoff.
CU-Structural Soil™ Basics

CU-Structural Soil™ (U.S. Patent # 5,849,069) is a two-part system comprised of a rigid stone “lattice” to meet engineering requirements for a load-bearing soil, and a quantity of soil, to meet tree requirements for root growth. The lattice of load-bearing stones provides stability as well as interconnected voids for root penetration, air and water movement (Fig. 1.9). The uniformly graded 3/4”-1 1/2” angular crushed stone specified for CU-Structural Soil™ is designed to ensure the greatest porosity. Crushed or angular stone provides more compaction and structural interface of stone-to-stone than round stone. Because stone is the load-bearing component of structural soil, the aggregates used should meet regional or state department of transportation standards for pavement base courses.

Fig. 1.7 Gravel used in turf based systems that handle high levels of vehicular traffic. Gravel alone lacks soil nutrients and water holding capacity necessary for healthy turf growth.

Fig. 1.8 CU-Structural Soil™ Matrix. Soil particles within media are clearly visible and allow soil nutrients and water holding capacity for healthy turf growth.

Fig. 1.9 Conceptual diagram of CU-Structural Soil™ including stone-on-stone compaction and soil in interstitial spaces used as a base course for pavements.
Since among soil textures, clay has the most water and nutrient-holding capacity, a heavy clay loam or loam, with a minimum of 20% clay, is selected for the CU-Structural Soil™ system. CU-Structural Soil™ should also have organic matter content ranging from 2%-5% to ensure nutrient and water holding while encouraging beneficial microbial activity. A minimum of 20% clay is also essential for an adequate cation exchange capacity.

With carefully chosen uniformly-graded stone and the proper stone to soil ratio, a medium for healthy root growth is created that also can be compacted to meet engineers’ load-bearing specifications (Fig. 1.11 and 1.12). The intention is to “suspend” the clay soil between the stones without over-filling the voids, which would compromise aeration and bearing capacity. CU-Structural Soil™ utilizes Gelscape® hydrogel as a non-toxic, non-phytotoxic tackifier, in addition to stone and soil components.

Soil Compaction and the Importance of Macropores
Both new and ongoing construction disturbs and compacts soil (Fig. 1.13), crushing the spaces in between the soil. These spaces are called pores, and are made up of different sizes: small pores are micropores, while large spaces are called macropores (Fig 1.14). Water and air travel through the larger macropores.
What Happens When Roots Encounter Dense, Compacted Soil?

When turf roots encounter dense soil (Fig. 1.16), they stop growing. If grass grows at all, it grows thinly and often bare spots are created in the field or lawn where the compaction occurs. Additionally, compaction makes grass more vulnerable to drought stress during dry periods and excessive ponding during wet periods. If a dense soil is waterlogged, grass roots can also rot from lack of oxygen. CU-Structural Soil™ has the same water retention and drainage characteristics as a sandy-loam despite its compaction. When combined with a turf ground cover, water and air can move through the sod and into the soil macropores preventing root rot and allowing root growth deep into the CU Structural Soil™ rooting media.

<table>
<thead>
<tr>
<th>Metric</th>
<th>Structural Soil</th>
<th>Soil Alone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Total Porosity @ 95%-100% Proctor:</td>
<td>31.04%</td>
<td>32.9%</td>
</tr>
<tr>
<td>Mean Macropores Based on Total Pore Volume @ 95% Proctor:</td>
<td>57.41%</td>
<td>2.26%</td>
</tr>
<tr>
<td>Infiltration rate:</td>
<td>&gt;24”/hr</td>
<td>0.5”/hr</td>
</tr>
</tbody>
</table>

Loss of macropores has three negative consequences (Fig. 1.15): restricted aeration within the soil profile, diminished water drainage from the soil profile, and the creation of a dense soil that is difficult for roots to penetrate (Fig. 1.16). These effects all limit usable rooting space in urban environments.

Macropores

- the relatively large spaces between soil aggregates
- water drains quickly through macropores
- air diffuses through macropores

Macropores are spaces between soil aggregates that allow water, air and subsequently root growth.
The Basics of Growing Turf:
Contrary to popular belief, growing healthy turfgrass is very difficult to achieve. Grass is often a finicky plant to grow. With many different factors involved in the process, it is not so simple as spreading seed or unfurling a roll of sod. Proper decision making at every step of the planning, design, installation and post-installation process is absolutely necessary. A few of the basics are described below and should be used as a rough guide only.

Warm Season vs. Cool Season Turf Grasses
Warm-season grasses grow particularly well generally south of the Mason Dixon line. These grasses flourish in the warm climates of the south. As such, they are lush from late spring to early fall, but go dormant in the cooler months. Cool-season grasses flourish in the spring and fall with possible dormancy in the extreme heat of mid-summer. These turfgrasses will go dormant in winter. A cool-season grass will do well in the south in the middle of winter, but will go dormant in the summer and appear as if it were dead. Conversely, a warm-season grass may do well in the north if extreme heat occurs, but will appear as if dead the remainder of the year.

Sun/Shade Considerations
Most turfgrass likes full sun, and few species grow well in partial shade. For cool season grasses, these include fine fescues, tall fescues, creeping bentgrass, Kentucky bluegrass, and perennial ryegrass in descending order. For warm season grasses these include St. Augustinegrass, zoysiagrass, centipedegrass, bahiagrass, Bermudagrass, seashore paspalum, and buffalograss in descending order.

Soil Considerations
Most turfgrass is seeded or sodded directly onto soil. While for most planting scenarios this practice is fine. For highly trafficked areas, however, this practice is disastrous and will result in poor drainage, thinned areas of turf and/or large swaths of bare soil (Fig 1.17 & 1.18). Since soil is easily compactible, the US Golf Assoc. recommends planting grass on a sand based soil. This type of soil is allows for good drainage and is more resistant to compaction, yet requires more irrigation. Additionally, if the sand layer profile is not thick enough or underdrainage is insufficient, a perched water table will result, ultimately drowning the turf (Fig.1.19).
Designing and Working with Turf and CU-Structural Soil™

Working with turf and CU-Structural Soil™ requires a change in the way that designers and contractors go about their work. Rather than just installing sod or seeding grass directly onto existing soil, entire areas will need to be excavated to a depth of at least 18” to 3’, depending on desired reservoir depth, and filled with CU-Structural Soil™. Once the CU Structural Soil™ mix is in place, it must be compacted with a vibratory or rolling compactor. Once compacted, the sod should be installed directly onto the CU-Structural Soil™ and then irrigated for a number of weeks until established. Once established, research indicates that maintenance requirements are minimal, other than regular mowing and periodic fertilization.

For new construction, the procedure outlined above is not overly difficult to do. For existing, highly trafficked areas, stripping 18” to 3’ of topsoil can result in extra costs. It is easy for designers to overlook the long-term benefits of the Cornell system during the planning, design and installation process.

Fig. 1.20 Construction detail for a bare root tree in typical parking lot island or plaza surrounded by turfgrass parking stalls. Turfgrass in parking lots should be installed in the parking lanes only, and not in travel or turning lanes. These turfgrass covered spaces can then act as bioswales, receiving and holding the runoff from the parking lot until it filters into the subgrade below, recharging groundwater levels over time.
Designing with CU-Structural Soil™ and Turf for Parking Lots, Fire Lanes and Public Spaces

With the guidelines outlined on the previous page, a few simple construction details will provide the bulk of the information needed for bidding and installation of a construction project. While the simple drawings below (Fig. 1.21) are helpful, keep in mind that every design is different and will necessitate the level of detail appropriate for each different design scenario. Additional details will be needed for, ADA compliance, curbing, tree planting and staking, hydrant water supply, signage and additional drainage, if necessary.

Reservoir Sizing: How Deep is Deep Enough?

The depths specified for the reservoirs below the turf in the adjacent construction detail (Figs. 1.21) were created to mitigate a 100 year storm of 6” in 24 hours, based on local rainfall data for Ithaca, N.Y. This level of mitigation is quite high, but keep in mind that precipitation is both regional and highly variable from location to location.

In order to properly mitigate any storm, exact rainfall data must be obtained from local sources such as state university extension agencies and local meteorological stations. To help design the proper reservoir depth to accommodate for any rain event, the chart below (Fig. 1.22) can be used as a general aid. This information is based on the known void space for CU-Structural Soil™ of 30%. It is important to note that while depths less than 24” will both support and mitigate a storm event up to 5.4” in 24 hours, it will not support adjacent large tree growth because the reservoir will be too shallow to accommodate healthy tree root growth. For healthy trees, a reservoir depth of 24” to 36” is optimum.

<table>
<thead>
<tr>
<th>Size of Rain Event</th>
<th>Depth of Reservoir Needed to Mitigate Rain Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8”</td>
<td>6”</td>
</tr>
<tr>
<td>3.6”</td>
<td>12”</td>
</tr>
<tr>
<td>5.4”</td>
<td>18”</td>
</tr>
<tr>
<td>7.2”</td>
<td>24”</td>
</tr>
<tr>
<td>9”</td>
<td>30”</td>
</tr>
<tr>
<td>10.8”</td>
<td>36”</td>
</tr>
</tbody>
</table>

Fig. 1.22 Reservoir depths and the corresponding levels of mitigated rain events based on the 30% void space within CU-Structural Soil™ mix. Numbers in gray box illustrate the depths necessary to accommodate optimum healthy tree root development.
Additional Drainage Needs for Large Amounts of Rainfall and Runoff

Although turfgrass covered CU-Structural Soil™ reservoir is a great way to collect rainwater and runoff as regulated by the National Pollution Discharge Elimination System (NPDES) guidelines and decrease demands on existing municipal storm water sewage systems, there may be rain events that generate more runoff than the reservoir below the turf can handle. In cases such as this, additional drainage should be used. In these situations, it is important to remember that additional drainage should be installed as close to the surface as possible so as not to compromise the water holding capacity of the reservoir (Fig. 1.23).

![Subsurface drainage installation. Note that drain pipe should be placed 1/3 to 1/2 the depth of the reservoir profile. This will ensure reservoir retains water and allows infiltration into subgrade below as well as ensuring that reservoir does not flood and flow back through the porous asphalt.](image)

**Fig. 1.23** Subsurface drainage installation. Note that drain pipe should be placed 1/3 to 1/2 the depth of the reservoir profile. This will ensure reservoir retains water and allows infiltration into subgrade below as well as ensuring that reservoir does not flood and flow back through the porous asphalt.

Existing Installations and Photo Simulations

Turf on CU-Structural Soil™ has been successfully used at a Mercedes dealership in Georgia. At this installation, the soil in an entire median was excavated and replaced with CU-Structural Soil™ and then sod was placed on top (Figs. 1.24 and 1.25) After installation, the entire median can now properly withstand the compaction from the weight of the cars and serves as a flexible open space for the dealership, providing impromptu space to display inventory, or as overflow parking for the dealership. After three years, this installation is maintenance free and as healthy as the day it was installed.

![Turf on CU-Structural Soil™ at a car dealership in Georgia. The soil in the entire median was excavated and replaced with the CU-Structural Soil™ mix and used as a space to display inventory.](image)

**Fig. 1.25** Turf on CU-Structural Soil™ at a car dealership in Georgia. The soil in the entire median was excavated and replaced with the CU-Structural Soil™ mix and used as a space to display inventory.

![In winter when the sod is dormant, the median serves as additional storage and display space for the dealership's inventory. This flexibility is invaluable to the dealership.](image)

**Fig. 1.26** In winter when the sod is dormant, the median serves as additional storage and display space for the dealership's inventory. This flexibility is invaluable to the dealership.
Realities of Working With Turf in Parking Lots: Lessons Learned

A turf covered parking lot is not a new idea and has been used successfully since the invention of the automobile for church parking lots, flea market parking lots and is now being used at professional sports stadiums like Pro-Player Field. Despite these instances, there are helpful tips to keep in mind when designing with turf and CU-Structural Soil™:

- Minimize vehicular wear on the turf as much as possible. To do this, place turf only in the parking stalls and not in the driving lanes of the lot.
- Angle parking stalls to minimize turning from automobile wheels. Excessive turning causes the turf grass leaf blades to tear and can create bare patches in the turf. Research indicates that the turf can recover from this type of damage, but it takes extra time.
- Use turf only in overflow parking areas on the outskirts of large lots.
- Use inset stonework between stalls, or posts to demark parking stalls. This design maneuver may cost more upfront to install, but will save time and money during post-installation maintenance.
- Carefully research local stormwater data and runoff calculations to set the proper depth CU-Structural Soil™ reservoir. Doing so will increase upfront design costs, but will ensure the proper functioning of stormwater mitigation techniques over time.
- Determine through testing the type of soil and the seasonal water table levels underneath the reservoir. Clay soils will drain much more slowly than sandy soils and will influence how much water the reservoir can take and will also determine infiltration and groundwater recharge rates from the reservoir into the subbase below the reservoir.
- Use additional drainage as necessary to decrease flooding and inundation from extreme storm events. Although CU-Structural Soil is highly porous, flooding will occur if the rate of groundwater recharge is slower than the rate that the reservoir receives both the rain and runoff.
- Specify proper post-installation maintenance regimes. Mowing every 10 days is necessary, as is the application of annual fall fertilization with proper application rates.
- Never snow plow a turf portion of the lot. The blades from the plow will damage the turf surface, removing the turf and necessitating costly replacement.
<table>
<thead>
<tr>
<th>Shade Tolerance for Cool-season Grasses:</th>
<th>Shade Tolerance for Warm-season Grasses:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excellent</strong></td>
<td><strong>Excellent</strong></td>
</tr>
<tr>
<td>Red Fescue, Velvet bentgrass</td>
<td>St. Augustinegrass, Manila-grass</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td><strong>Good</strong></td>
</tr>
<tr>
<td>Rough bluegrass, Creeping bentgrass, Tall fescue</td>
<td>Zoysiagrass</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td><strong>Fair</strong></td>
</tr>
<tr>
<td>Colonial bentgrass, Redtop, Perennial ryegrass, Meadow Fescue</td>
<td>Centipedegrass, Carpetgrass</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td><strong>Poor</strong></td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>Buffalograss, Bermudagrass</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drought Tolerant Grasses:</th>
<th>Traffic Tolerant Grasses:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Excellent</strong></td>
<td><strong>Excellent</strong></td>
</tr>
<tr>
<td>Buffalograss</td>
<td>Zoysiagrass</td>
</tr>
<tr>
<td>Burmudagrass</td>
<td>Bermudagrass</td>
</tr>
<tr>
<td>Zoysiagrass</td>
<td><strong>Good</strong></td>
</tr>
<tr>
<td>Bahiagrass</td>
<td>Bahiagrass</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td><strong>Medium</strong></td>
</tr>
<tr>
<td>Crested wheatgrass</td>
<td>Perennial ryegrass</td>
</tr>
<tr>
<td>Hard Fescue</td>
<td>Kentucky bluegrass</td>
</tr>
<tr>
<td>Sheep Fescue</td>
<td>Meadow fescue</td>
</tr>
<tr>
<td>Tall fescue</td>
<td>Canada bluegrass</td>
</tr>
<tr>
<td>Red Fescue</td>
<td>Red fescue</td>
</tr>
<tr>
<td><strong>Medium</strong></td>
<td><strong>Poor</strong></td>
</tr>
<tr>
<td>Kentucky bluegrass</td>
<td>Carpetgrass</td>
</tr>
<tr>
<td>Redtop</td>
<td>Creeping Bentgrass</td>
</tr>
<tr>
<td>Timothy</td>
<td>Redtop</td>
</tr>
<tr>
<td>Canada bluegrass</td>
<td>Colonial Bentgrass</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td><strong>Centipedegrass</strong></td>
</tr>
<tr>
<td>Perennial ryegrass</td>
<td></td>
</tr>
<tr>
<td>Meadow fescue</td>
<td>Centipedegrass</td>
</tr>
<tr>
<td>St. Augustinegrass</td>
<td><strong>Very Poor</strong></td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>Timothy</td>
</tr>
<tr>
<td>Centipedegrass</td>
<td><strong>Rough bluegrass</strong></td>
</tr>
<tr>
<td>Carpetgrass</td>
<td></td>
</tr>
<tr>
<td>Italian ryegrass</td>
<td></td>
</tr>
<tr>
<td>Creeping bentgrass</td>
<td></td>
</tr>
<tr>
<td>Rough bluegrass</td>
<td></td>
</tr>
<tr>
<td>Velvet bentgrass</td>
<td></td>
</tr>
</tbody>
</table>

These lists were taken from “Turfgrass: Science and Culture” by James Beard. They are by no means the only environmental qualifiers that should be considered when specifying a grass to use with CU-Structural Soil, but should be used as a helpful guide. Other environmental factors which should be considered are temperature, and pH.
Frequently Asked Questions

Is CU-Structural Soil™ and turf susceptible to frost heave?
Observation of CU-Structural Soil™ throughout the US and Canada shows that the depth of the reservoir negates any heaving due to consequent freezing and thawing. Additionally, there have been no observed instances of freeze/thaw damage in any CU-Structural Soil™ installations in the fifteen plus years since its inception. Based on drainage testing and swell data on this extremely porous system, CU-Structural Soil™ appears quite stable.

What is the recommended depth for CU-Structural Soil™ underneath the turf surface?
We suggest a minimum of 24” but 36” is preferred to mitigate large amounts of rainfall and runooff. Reservoir depths between 24” to 36” will mitigate between 7.2” and 10.8” of rain in a 24 hour period. A rooting media of soil or sand between the CU-Structural Soil™ reservoir and the specified turf is not needed on top of CU-Structural Soil™ because it was designed to be as strong as a base course. Properly compacted to 95-100% Proctor Density or Modified Proctor Density, it has a CBR of 50 or greater.

What is the recommended length and width for CU-Structural Soil™ and porous asphalt installation?
CU-Structural Soil™ was designed to go under the entire area covered by turf. This homogeneity would ensure uniform engineering characteristics below the pavement, particularly in regard to frost heaving and drainage and also to ensure proper turf and any adjacent tree root development. Since the root system of trees installed within the turfgrass/CU-Structural Soil™ system helps to remove water from the reservoir, it would be best to use CU-Structural Soil™ for the entire reservoir.

How does the turf and CU-Structural Soil™ system deal with pollutants such as oil?
Pollutants from automobiles may injure turfgrass with prolonged exposure. However, a few hours of exposure will most likely not harm turf. Research shows that 97.9%-99% of the hydrocarbons found in pollutants such as oil are suspended within the first few inches of the surface. During suspension, microorganism biodegrade the hydrocarbons into their constituent parts of simple chemical components which cease to exist as pollutants and render them harmless to the environment.

What type of maintenance is needed for a turfgrass and CU-Structural Soil™ system?
Our research was performed with the idea of the most basic maintenance regime in mind. Test plots on the Cornell campus received no maintenance other than routine mowing once every 7 to 10 days during the growing season. Additional annual fertilization in the fall is recommended with the proper application rates.

Won’t the soil migrate down through a CU-Structural Soil™ profile after installation?
The excavation of a seven-year-old installation did not show any aggregate migration. The pores between stones in CU-Structural Soil™ are mostly filled with soil so there are few empty spaces for soil to migrate to.

What happens when neighboring tree roots expand in CU-Structural Soil™?
There will come a time when the roots will likely displace the stone, but if the roots are, as we have observed, deep down in the profile, the pressure they generate during expansion would be spread over a larger surface area. We have seen roots move around the stone and actually surround some stones in older installations, rather than displace the stones.

Can you plant trees in CU-Structural Soil™ in and around the turf surface?
Yes. CU-Structural Soil™ was designed and developed for trees in urban environments that required compaction. It would be desirable to use CU-Structural Soil™ under the tree ball to prevent the root ball from sinking. Planting trees directly in CU-Structural Soil™ provides a firmer base for unit pavers close to the root ball than does conventional soil. If the tree pit is sufficiently large, greater than 5’ x 5’, a conventional soil could be used in the open tree pit surrounding the root ball with CU-Structural Soil™ extending under the pavement.
Research papers supporting this work:

- Cahill, Thomas, Adems, Michelle, and Marm, Courtney. Porous Asphalt: The Right Choice for Porous Pavements, Hot Mix Asphalt Technology September-October.
- Ferguson, Bruce K. “Preventing the Problems of Urban Runoff” Renewable Resources Journal (Winter 1995-1996) 14-18
- Ferguson, Bruce K. “Porous Pavements” Taylor and Francis Group; Boca Raton, London, New York, Singapore, 2005