The Leading Edge in Trees, Stormwater and Urban Design

deeproot

I. Sizing and Soil Mandates
II. Comparisons
III. Stormwater- the great opportunity for trees.
IV. Q&A

Jim Urban, FASLA

"It's not good design
if the trees die"

Requirements to grow a healthy tree

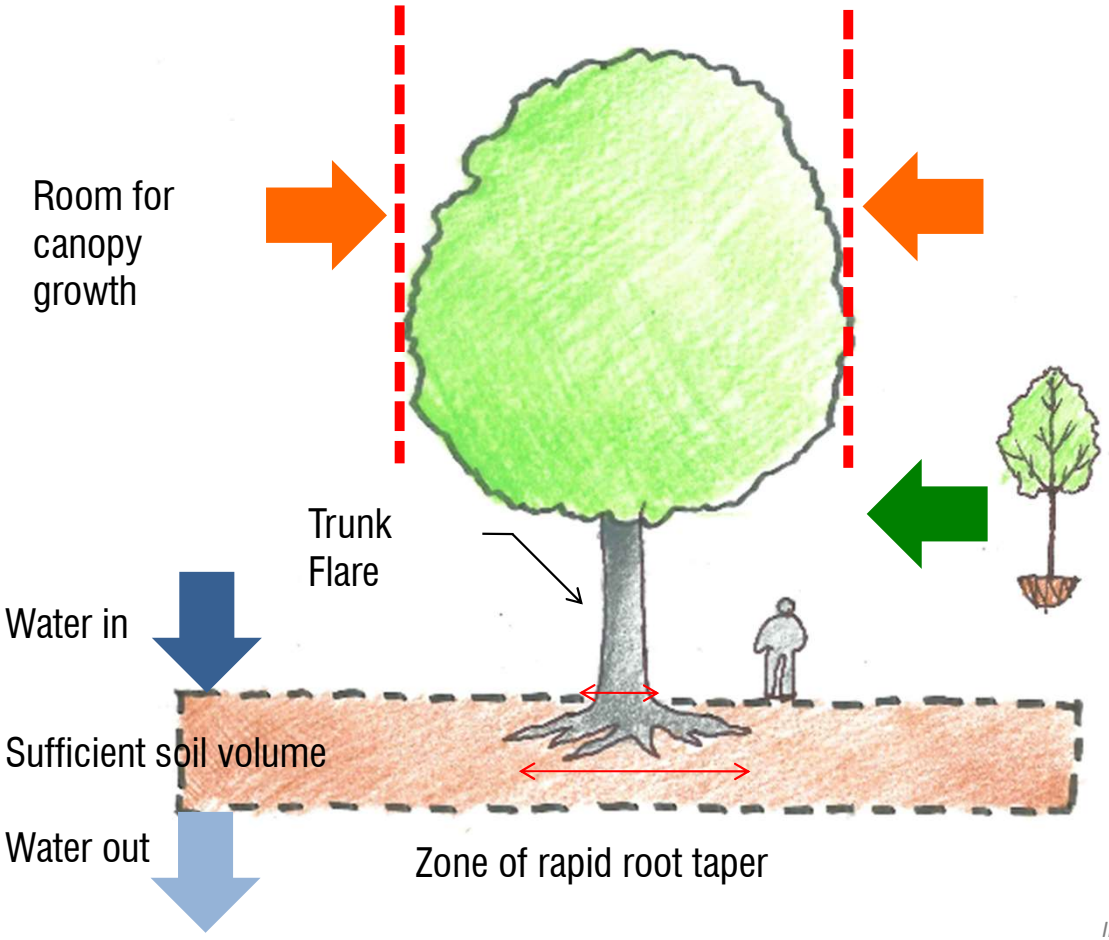


Image: James Urban

How Much Soil to Grow a Big Tree?

2ft3/ft2 CP

.66M/M2 CP

JOURNAL OF
ARBORICULTURE
June 1991
Vol. 17, No. 6

SPECIFYING SOIL VOLUMES TO MEET THE WATER NEEDS OF MATURE URBAN STREET TREES AND TREES IN CONTAINERS

by Patricia Lindsey and Nina Bassuk[1]

Abstract. The small volume of soil in a typical street tree pit or container often is not capable of supplying adequate water as the tree needs it. As a result, trees can experience severe limitations upon healthy growth and development. Current soil volume estimations fail to address three problems: 1) how to predict whole tree water use, especially for a wide range of prevailing climatic conditions, 2) how to tie this prediction to some easily measured tree parameter, and 3) how to incorporate both of the above into some simple yet accurate means of estimating soil volume. A weatherbased methodology for adequately sizing soil volumes is presented to address these concerns. This incorporates the findings of a recent study indicating that whole tree water loss can be reasonably predicted with knowledge of evaporation from a U.S. Weather Bureau Class A pan. A soil volume of 220 ft^3 for a medium sized tree is then calculated. For use as a general estimate, 2ft^3 of soil per 1ft^2 of crown projection is recommended.

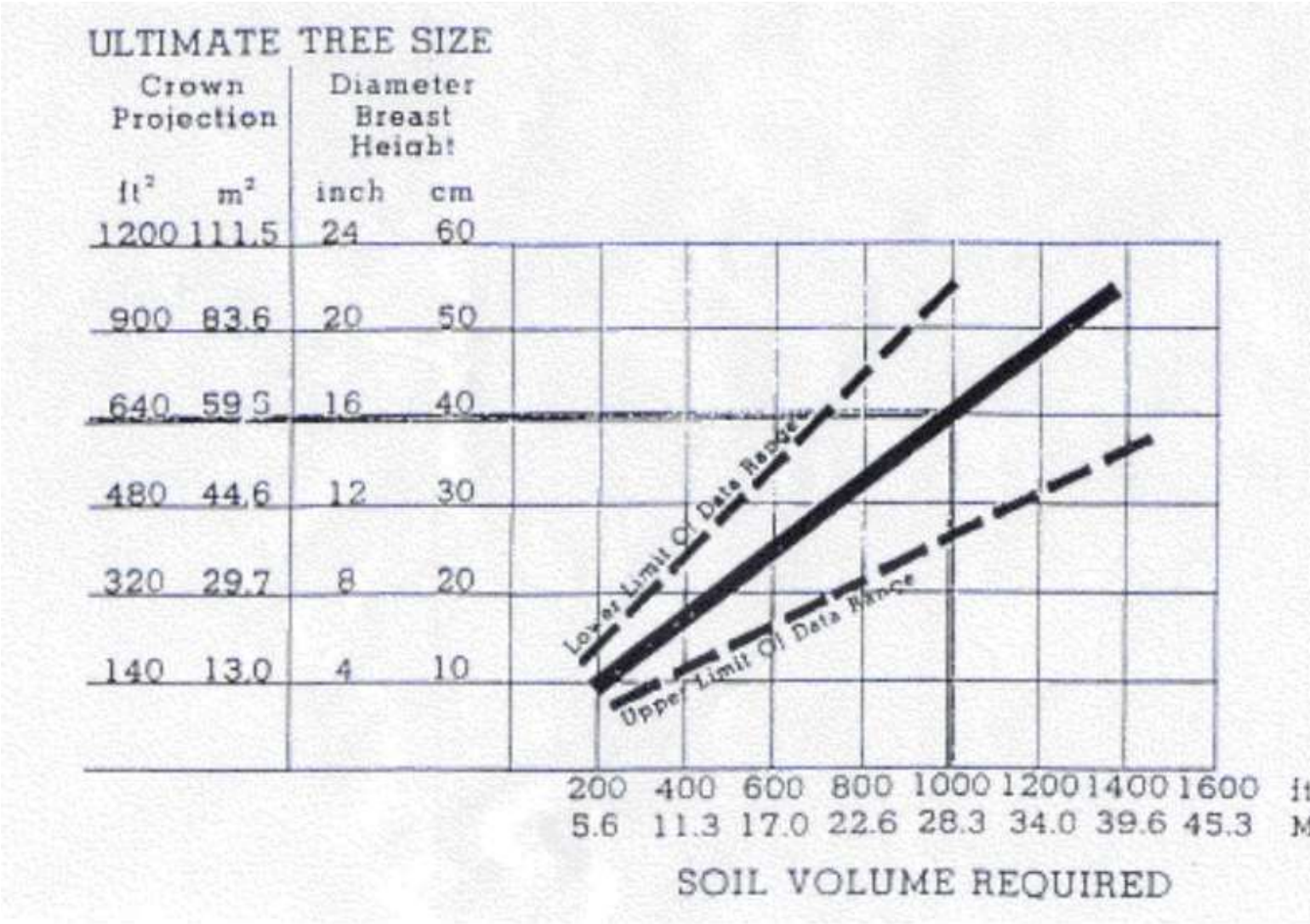
Inadequate soil rooting space can be one of the more important factors in the premature mortality of trees in urban areas (23). Clearly, there is a basic conflict between the biological needs of trees, whose roots systems are generally near the surface and spread laterally, and the small and confined areas they are relegated to in the design of streets in our urban areas. The typical street tree pit, which is inhospitably sandwiched in a narrow strip between the road and sidewalk, places severe limitations upon healthy tree growth and development. The small volumes of soil in these areas often do not hold water sufficient enough to meet transpirational demand, resulting in the tree experiencing periodic to prolonged water deficits.

While the soil serves many functions as a physical and biological medium of root growth, it is in its role as a reservoir for water that is of primary interest in soil volume calculations. Thus far, there has been no widely applicable method for determining the size of a tree pit or container that is based on a tree's water requirements. It is the intent of this article to provide a knowledgeable framework for both critically evaluating and effectively using the soil volume methodology presented here.

Current recommendations. Current recommendations detailing appropriate soil volumes for trees have been culled from a variety of sources in the literature and are presented for comparison in Table 1. Many of these estimates are quite high, up to 7000 ft^3 and would be next to impossible to achieve in most street tree plantings. Some of these recommendations are either simple rules of thumb, or are based on plant factors other than empirically determined water use rates. Further questions and considerations come readily to mind. Are changing regional climatic conditions accounted for in these estimates and is the amount and timing of rainfall integrated in some meaningful way? Are the changing water holding capacities of different soil types accomodated? Over what period of time will this soil volume support the tree and where will the water come from? Are these methods based on whole tree water use rates and do they account for species and canopy size differences? It would also be very useful if whole tree water loss estimations were standardized on one common plant parameter. Soil estimates could then be linked directly to this measurement. No one of these soil volume estimations really addresses all of these concerns

[1]Research graduate assistant and Associate Professor/Program Leader, respectively.

How Much Soil to Grow a Big Tree?



J. Urban: Bringing Order to the Technical Dysfunction Within the Urban Forest; Journal of Arboriculture 18 (2): March 1992

How much soil to grow a big tree?

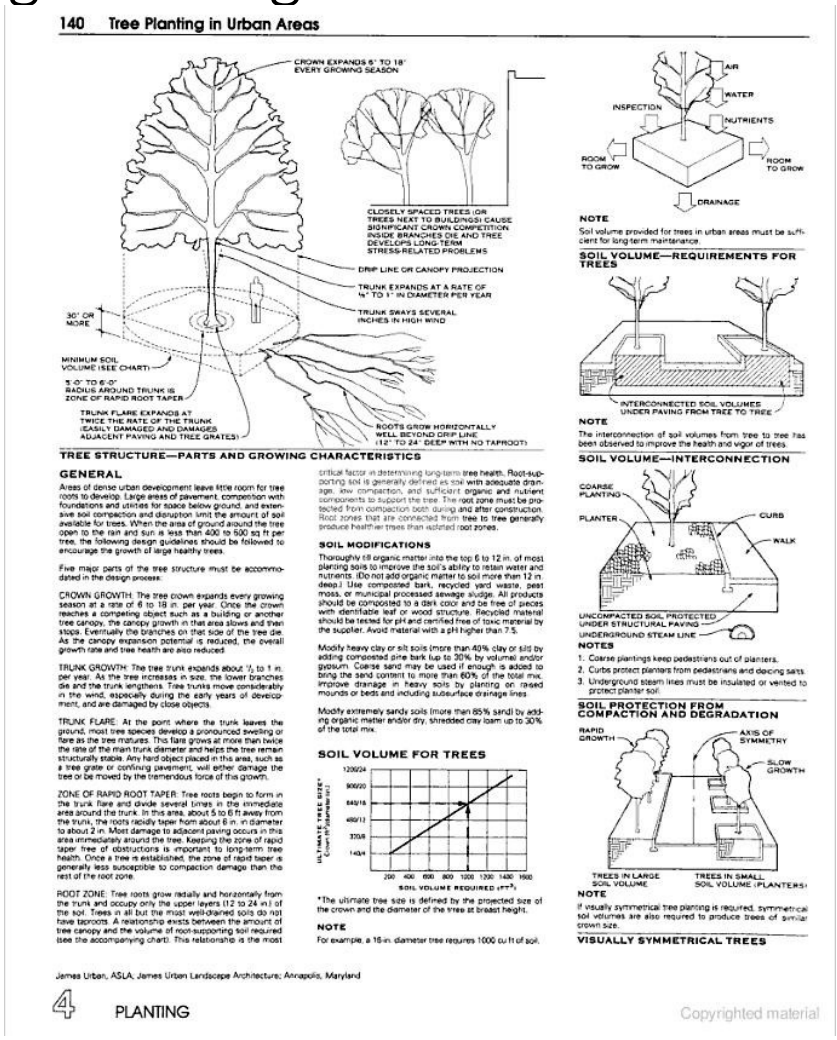
Landscape Architectural Graphics Standards, 2006.

By James Urban FASLA

Edited by Leonard J. Hopper, FASLA

Cities with Soil Volume Mandates

Toronto
Denver
DC
Charlotte
Emeryville, CA
Tucson
NYC DPR High Performance Landscape Guide
Columbus
Cleveland
Edmonton



140 Tree Planting in Urban Areas

CROWN EXPANDS 6" TO 18" EVERY GROWING SEASON
CLOSELY SPACED TREES (OR TREES NEXT TO BUILDINGS) CAUSE SIGNIFICANT CROWN COMPETITION. INSIDE BRANCHES DIE AND TREE DEVELOPS LONG TERM STRESS-RELATED PROBLEMS
DRIP LINE OR CANOPY PROJECTION
TRUNK EXPANDS AT A RATE OF ¼" TO 1" IN DIAMETER PER YEAR
TRUNK SWAYS SEVERAL INCHES IN HIGH WIND
30" OR MORE
MINIMUM SOIL VOLUME (SEE CHART)
5'-0" TO 6'-0" RADIUS AROUND TRUNK IS ZONE OF RAPID ROOT TAPER
TRUNK FLARE EXPANDS AT TWICE THE RATE OF THE TRUNK (EASILY DAMAGED AND DAMAGES ADJACENT PAVING AND TREE GRATES)
ROOTS GROW HORIZONTALLY WELL BEYOND DRIP LINE (12" TO 24" DEEP WITH NO TAPROOT)

TREE STRUCTURE—PARTS AND GROWING CHARACTERISTICS

GENERAL

Areas of dense urban development leave little room for tree roots to develop. Large areas of pavement, competition with foundations and utilities for space below ground, and extensive soil compaction and disruption limit the amount of soil available for trees. When the area of ground around the tree open to the rain and sun is less than 400 to 500 sq ft per tree, the following design guidelines should be followed to encourage the growth of large healthy trees.

Five major parts of the tree structure must be accommodated in the design process:

CROWN GROWTH: The tree crown expands every growing season at a rate of 6 to 18 in. per year. Once the crown reaches a competing object such as a building or another tree canopy, the canopy growth in that area slows and then stops. Eventually the branches on that side of the tree die. As the canopy expansion potential is reduced, the overall growth rate and tree health are also reduced.

TRUNK GROWTH: The tree trunk expands about ¼ to 1 in. per year. As the tree increases in size, the lower branches die and the trunk lengthens. Tree trunks move considerably in the wind, especially during the early years of development, and are damaged by close objects.

TRUNK FLARE: At the point where the trunk leaves the ground, most tree species develop a pronounced swelling or flare as the tree matures. This flare grows at more than twice the rate of the main trunk diameter and helps the tree remain structurally stable. Any hard object placed in this area, such as a tree grate or confining pavement, will either damage the tree or be moved by the tremendous force of this growth.

ZONE OF RAPID ROOT TAPER: Tree roots begin to form in the trunk flare and divide several times in the immediate area around the trunk. In this area, about 5 to 6 ft away from the trunk, the roots rapidly taper from about 6 in. in diameter to about 2 in. Most damage to adjacent paving occurs in this area immediately around the tree. Keeping the zone of rapid taper free of obstructions is important to long-term tree health. Once a tree is established, the zone of rapid taper is generally less susceptible to compaction damage than the rest of the root zone.

ROOT ZONE: Tree roots grow radially and horizontally from the trunk and occupy only the upper layers (12 to 24 in.) of the soil. Trees in all but the most well-drained soils do not have taproots. A relationship exists between the amount of tree canopy and the volume of root-supporting soil required (see the accompanying chart). This relationship is the most critical factor in determining long-term tree health. Root-supporting soil is generally defined as soil with adequate drainage, low compaction, and sufficient organic and nutrient components to support the tree. The root zone must be protected from compaction both during and after construction. Root zones that are connected from tree to tree generally produce healthier trees than isolated root zones.

SOIL MODIFICATIONS

Thoroughly mix organic matter into the top 6 to 12 in. of most planting soils to improve the soil's ability to retain water and nutrients. (Do not add organic matter to soil more than 12 in. deep.) Use composted bark, recycled yard waste, peat moss, or municipal processed sewage sludge. All products should be composted to a dark color and be free of pieces with identifiable leaf or wood structure. Recycled material should be tested for pH and certified free of toxic material by the supplier. Avoid material with a pH higher than 7.5.

Modify heavy clay or silt soils (more than 40% clay or silt) by adding composted pine bark (up to 20% by volume) and/or gypsum. Coarse sand may be used if enough is added to bring the sand content to more than 60% of the total mix. Improve drainage in heavy soils by planting on raised mounds or beds and including subsurface drainage lines.

Modify extremely sandy soils (more than 85% sand) by adding organic matter and/or dry, shredded clay loam up to 30% of the total mix.

SOIL VOLUME FOR TREES

*The ultimate tree size is defined by the projected size of the crown and the diameter of the tree at breast height.

NOTE

For example, a 16-in. diameter tree requires 1000 cu ft of soil.

AIR
WATER
INSPECTION
NUTRIENTS
ROOM TO GROW
ROOM TO GROW
DRAINAGE

NOTE

Soil volume provided for trees in urban areas must be sufficient for long-term maintenance.

SOIL VOLUME—REQUIREMENTS FOR TREES

INTERCONNECTED SOIL VOLUMES UNDER PAVING FROM TREE TO TREE

NOTE

The interconnection of soil volumes from tree to tree has been observed to improve the health and vigor of trees.

SOIL VOLUME—INTERCONNECTION

COARSE PLANTING
PLANTER
CURB
WALK
UNCOMPACTED SOIL PROTECTED UNDER STRUCTURAL PAVING
UNDERGROUND STEAM LINE

NOTES

1. Coarse plantings keep pedestrians out of planters.
2. Curbs protect planters from pedestrians and deicing salts.
3. Underground steam lines must be insulated or vented to protect planter soil.

SOIL PROTECTION FROM COMPACTION AND DEGRADATION

RAPID GROWTH
AXIS OF SYMMETRY
SLOW GROWTH
TREES IN LARGE SOIL VOLUME
TREES IN SMALL SOIL VOLUME (PLANTERS)

NOTE

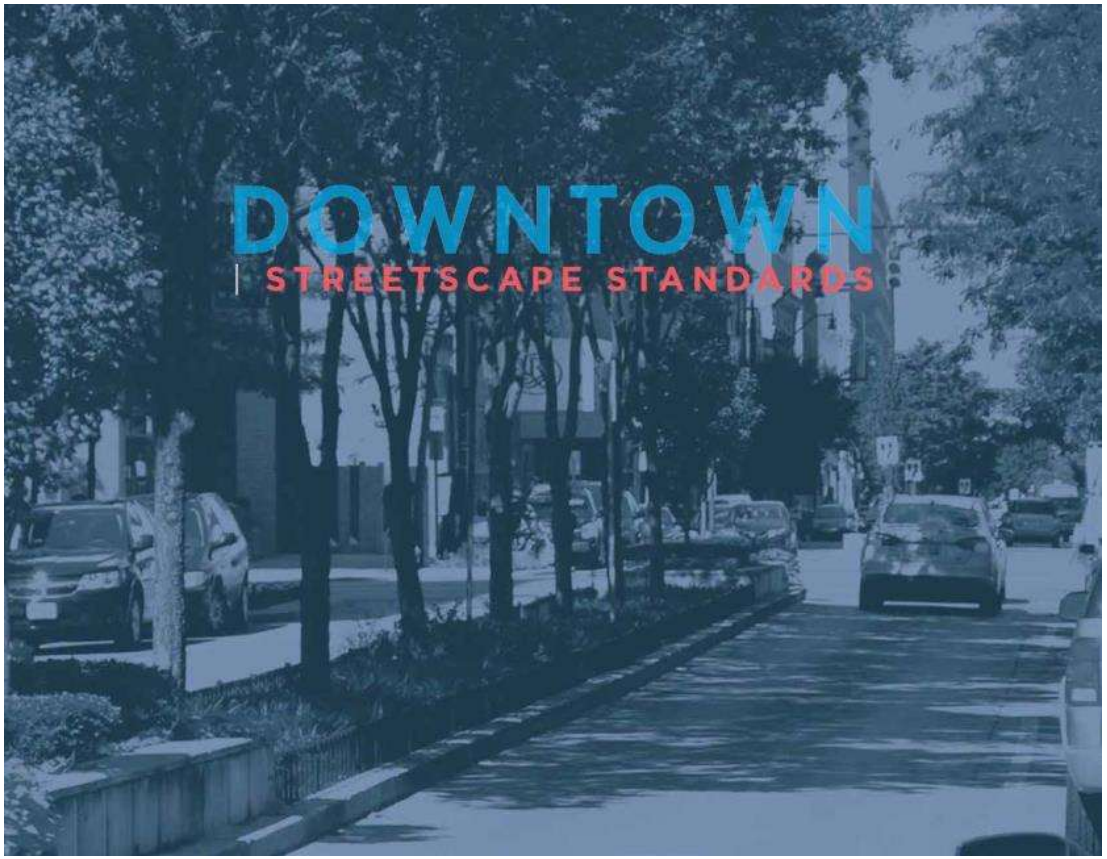
If visually symmetrical tree planting is required, symmetrical soil volumes are also required to produce trees of similar crown size.

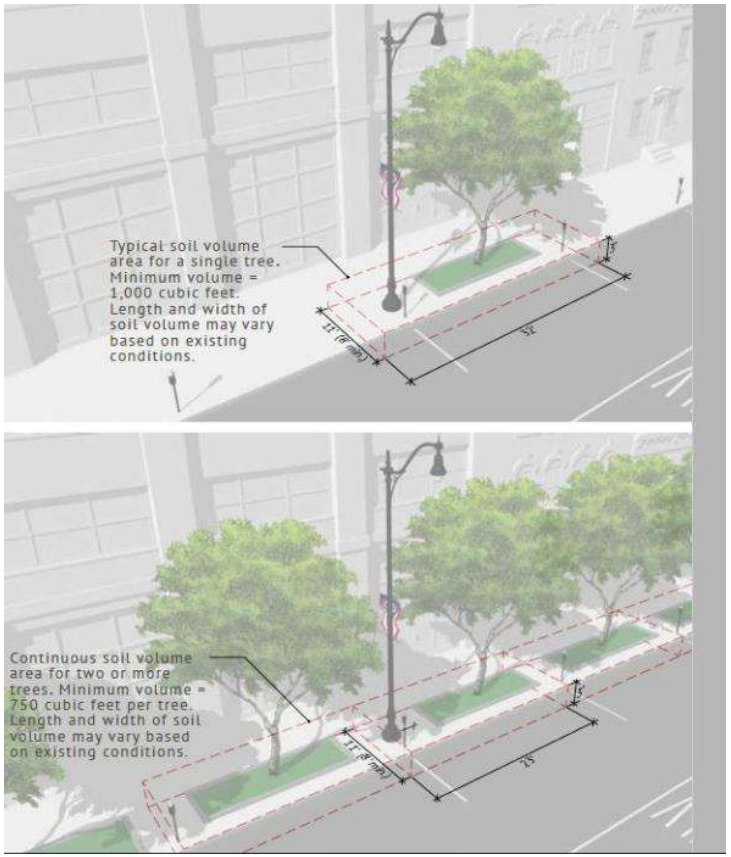
VISUALLY SYMMETRICAL TREES

James Urban, ASLA; James Urban Landscape Architecture; Annapolis, Maryland

4 PLANTING

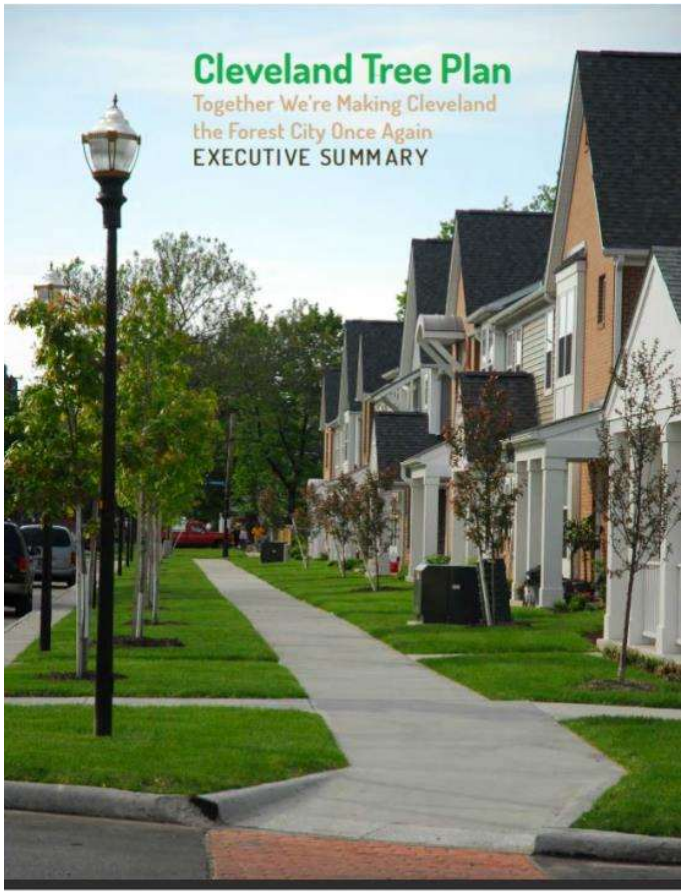
Columbus Downtown Streetscape Standards

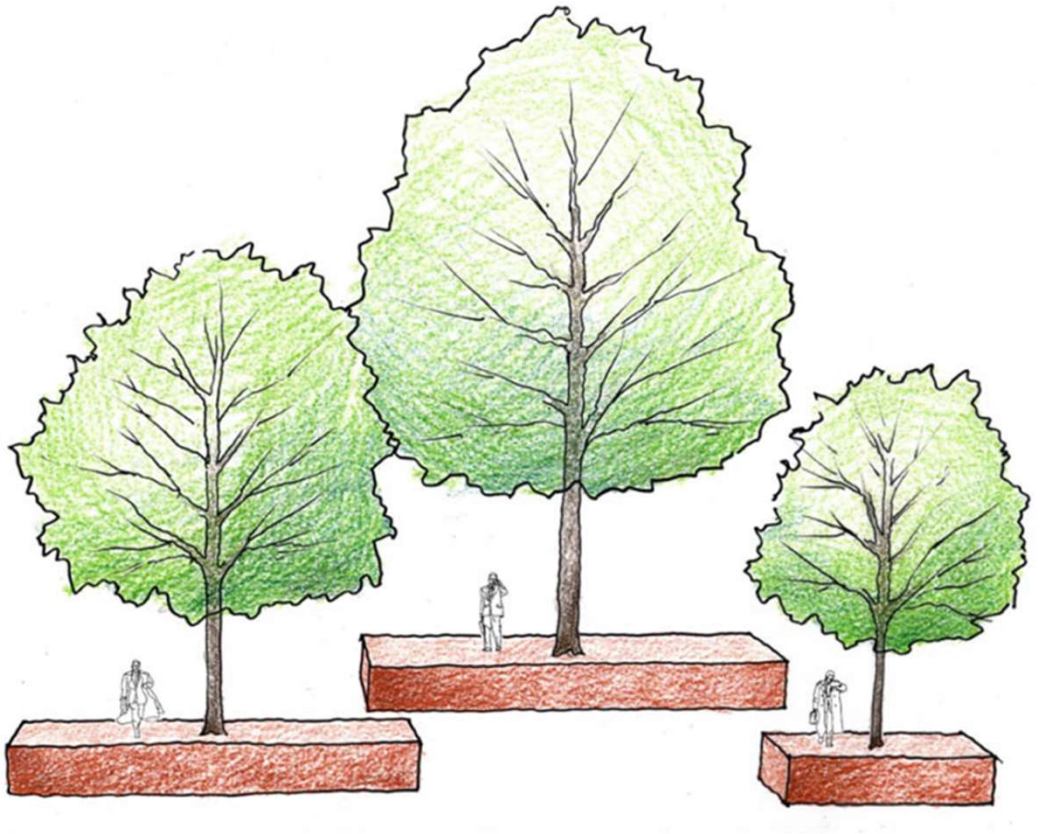




1000 ft3 of soil for Street Trees and 750 ft3 of soil for shared rooting
Adopted October 2015

Cleveland Tree Plan





300ft3 for small trees; 600 ft3 for medium trees; 1000ft3 for large trees
Adopted October 2015

University of Florida- IFAS Standard

CHAPTER 6

URBAN DESIGN FOR A WIND RESISTANT URBAN FOREST

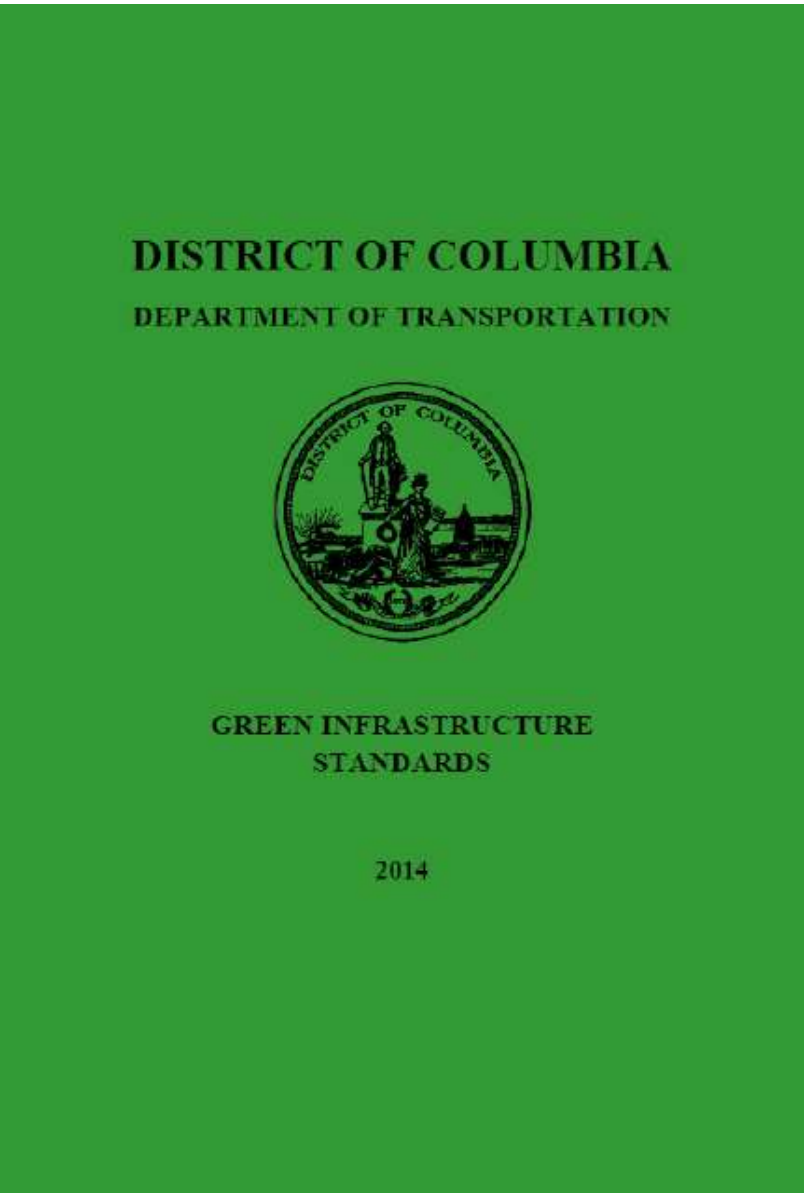
PUBLICATION Nº
ENH 1056

EDWARD F. GILMAN
TRACI PARTIN

UF UNIVERSITY of FLORIDA
IFAS Extension

Table 1. Soil requirements for trees based on their size at maturity.

TREE SIZE AT MATURITY	TOTAL SOIL AREA*	Volume 3’
SMALL Height: shorter than 30 ft	10 ft x 10 ft	200 ft3
MEDIUM Height or spread: lesser than 50 ft	20 ft x 20 ft	1200 ft3
LARGE Height or spread: greater than 50 ft	30 ft x 30 ft	2700 ft3



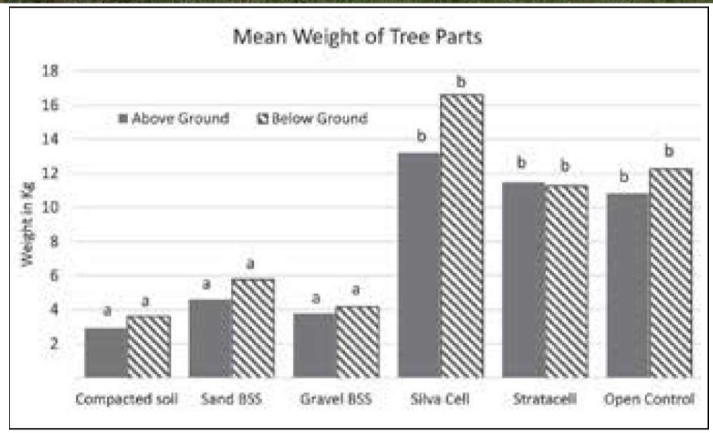
District of Columbia 2014 GI Standards

- Street Tree Soil Volume Mandate

- 1500 ft3 for large trees
- 800 ft3 for medium trees
- 500 ft3 for small trees

- 25% reduction for shared rooting

How Much Soil to Grow a Big Tree?



JOURNAL OF
ARBORICULTURE

August 1982
Vol. 8, No. 8

THE ECOLOGY OF TREE ROOTS AND THE PRACTICAL SIGNIFICANCE THEREOF[1]

by Thomas O. Perry

Abstract. Tree root growth is opportunistic and occurs wherever the environment is favorable. A balance exists between the root system and the remainder of the plant, so that if part of the root system dies, part of the crown will also die. Both parts are connected by a well-developed conduction system. Approximately 99 percent of the roots occur within the surface meter of soil and extend outward over an area one to two or more times the height of the tree. Large woody roots form the framework and are typical in pattern for each species. The fine feeder roots occur in the leaf and litter layer, if present, and the surface mineral soil. Keen root competition occurs at the surface if a turf exists under the tree. Also, herbicides, etc. used on lawns may have detrimental effects on the trees through these fine absorbing roots. In the urban environment roots may follow cracks and crevices in pavements, pipelines, sewers and cables. At the same time the installation of these utilities may cut across established tree root systems with unfortunate consequences.

Plant roots, including tree roots, grow in the soil, on the surface of the soil, in the water, and in the air — wherever the essentials of life are available. Except for the first formed roots which respond to gravity, roots do not grow toward anything or in any particular direction (up, down, or sideways). Root growth is opportunistic and takes place wherever the environment is favorable, typically in soil from which roots obtain plant. The patterns of growth and extent of tree roots and the relationship of typical roots to typical forest soils are illustrated. Then, the behavior of roots in more atypical circumstances is described (in deep sands, in swamps, under pavement, down crevices, in shopping centers, and down sewer lines).

The practical consequences of these root-soil relationships are explored in relationship to human activities. People kill trees in hundreds of ways. Most of the ways involve soil disturbance and ignorance of where roots grow in the soil and what roots do (what function roots perform). The latter portion of this paper is devoted to describing a few ways tree death is brought about and how the causes can be avoided.

The Relationship Between Roots and the Remainder of the Plant

Growth of a plant is an integrated phenomenon that depends on a proper balance and functioning of all plant parts. If a large portion of the roots is killed, a corresponding portion of the leaves and branches will die. If a tree is defoliated repeatedly, some of its roots will die. The finest roots of a tree


Baranoff Oak, Safety Harbor, FL

Urban Forest Canopy Goals

AMERICAN FORESTS
- SINCE 1875 -

1994-2017

Major municipalities should have a 40% Urban Forest Canopy Cover

40% of a City will be loamy soils

A More Nuanced Approach

2017-2020

1. **Development densities**
   dense development patterns with more impervious surfaces have less opportunity for cover

2. **Land use patterns**
   residential areas may have more opportunity for canopy than commercial areas, but canopy cover tends to be less in residential areas of disadvantaged communities versus wealthy ones

3. **Ordinances**
   parking lot shade ordinances promote cover over some impervious areas; Soil volume mandates

4. **Climate**
   canopy cover in desert cities is often less than tropical cities

AMERICAN FORESTS
- SINCE 1875 -

Greenbelts

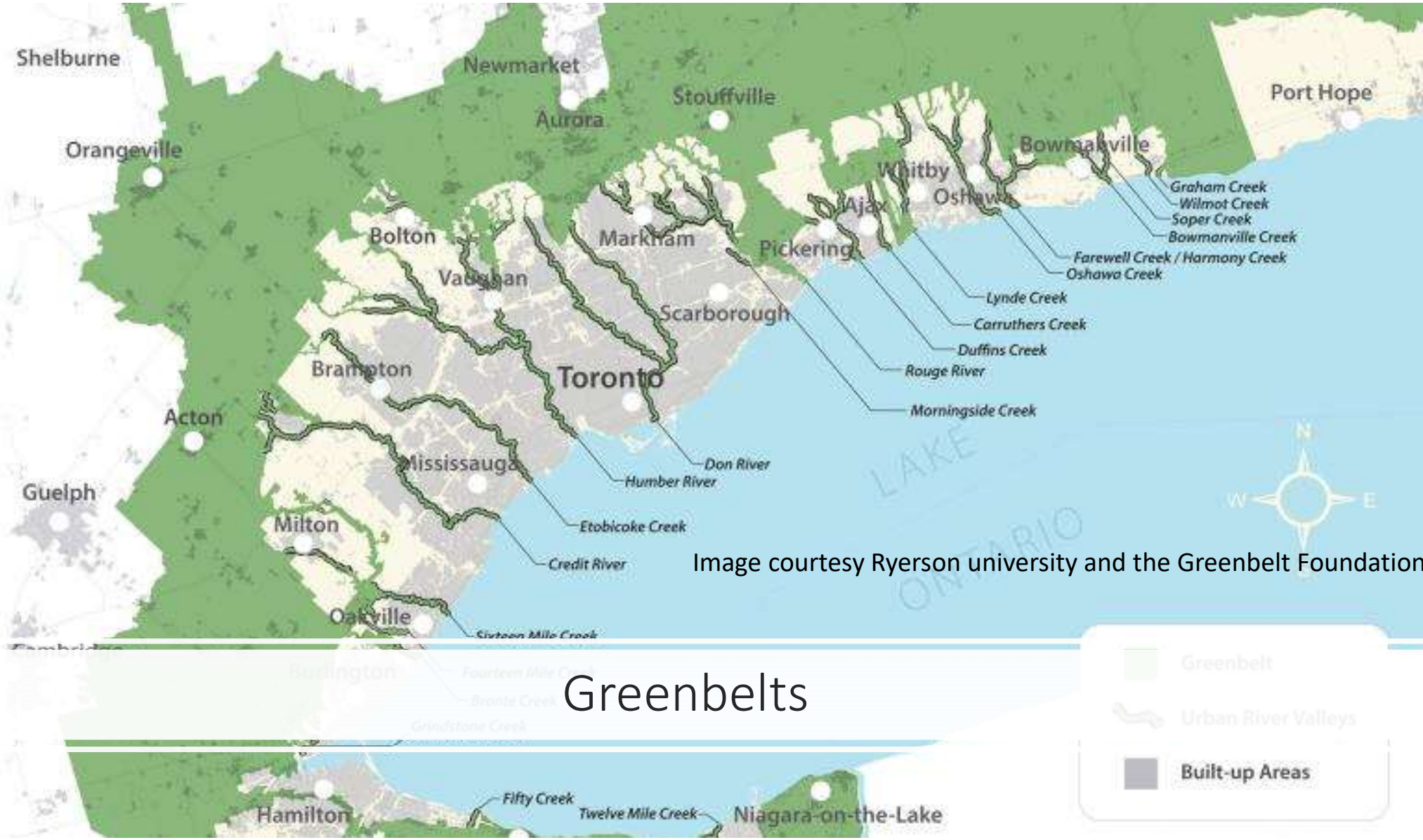
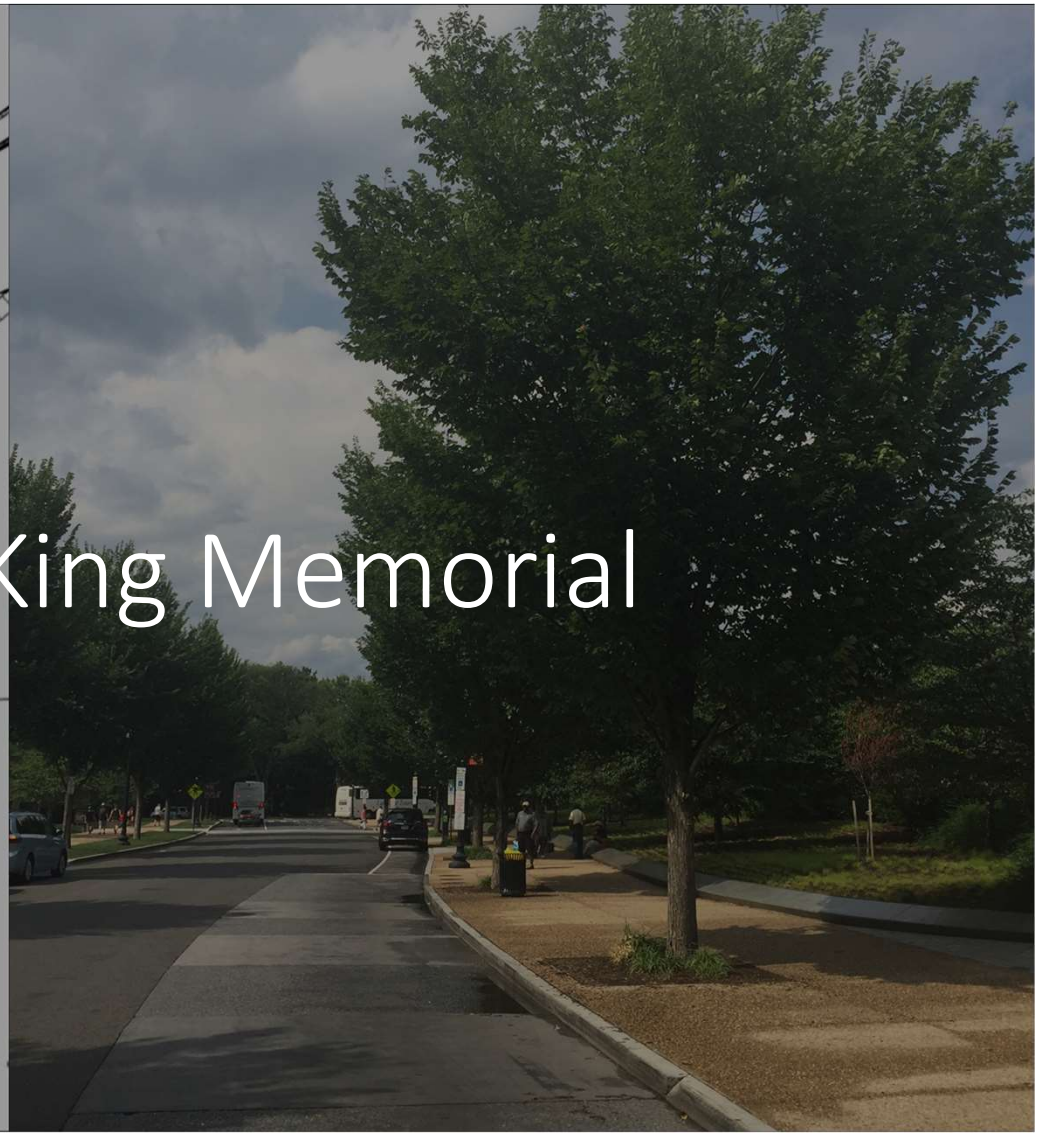


Image courtesy Ryerson university and the Greenbelt Foundation


POSTS
OPS
OPTS
HUB
HACKER

Martin Luther King Memorial



What's missing from this picture?

"**The undervaluing of soils** is one of the singular failings of the conventional development approach."
*Sustainable Sites Initiative – Guidelines a**nd Performance Benchmark Draft 2008 (ASLA, 2008)***

Photo courtesy of James Urban

Shared ROW: No room for soil

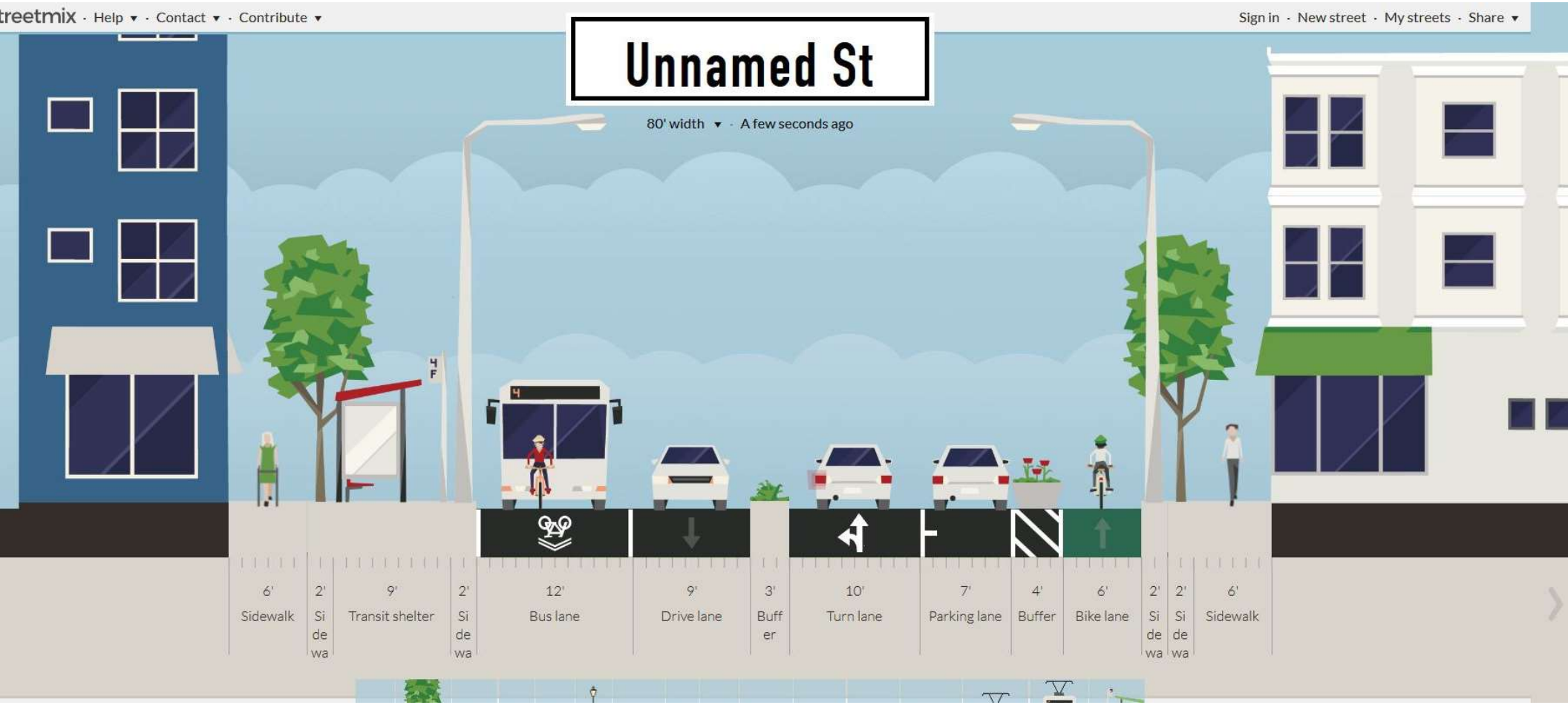
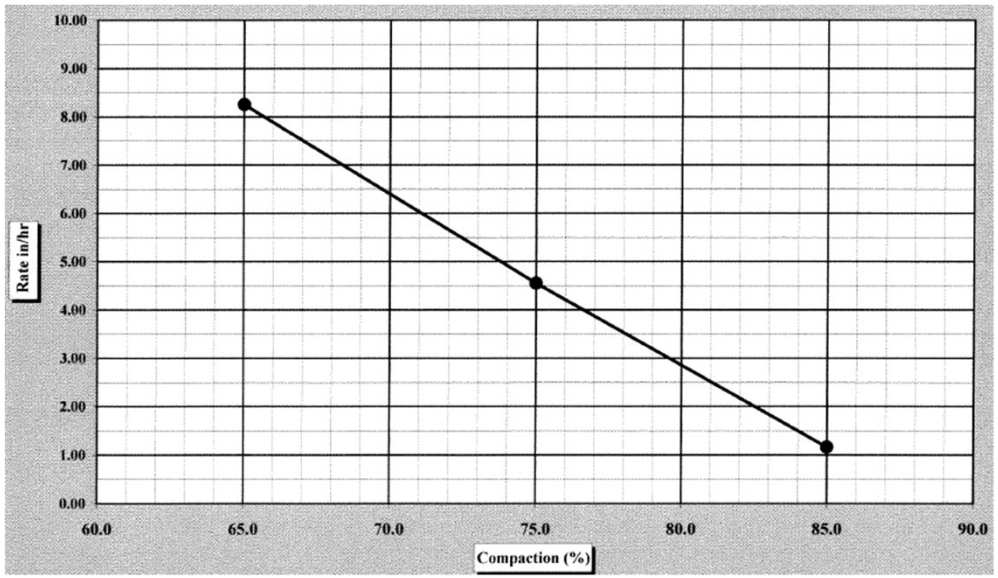


Image courtesy of www.streetmix.net

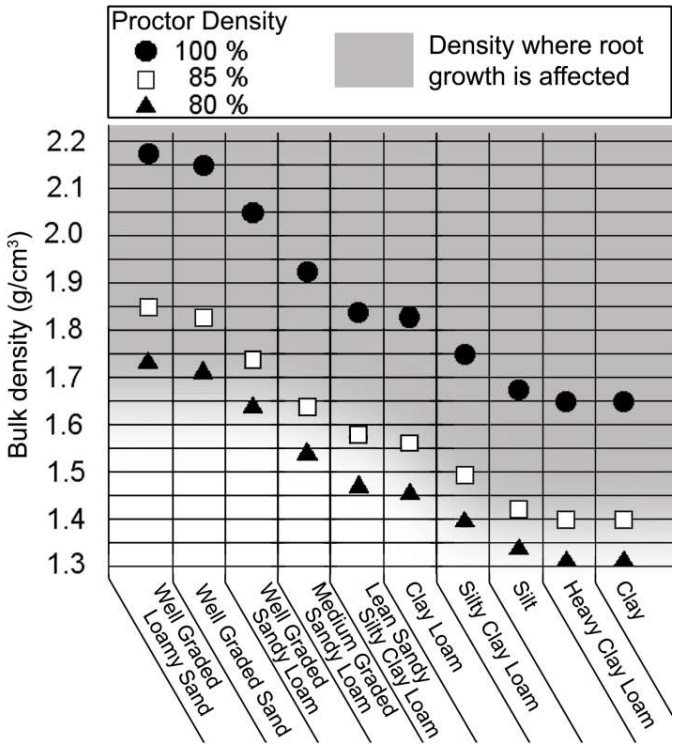
Compaction, Filtration and Plant Health

Infiltration reduction



Source: www.bae.ncsu.edu/stormwater

Root Restriction



Source: James Urban; Up by Roots;
Adapted from Daddow and Warrington USFS 1983

Compaction affects infiltration rate of soil and plant growth

Suspended pavement mitigates both issues

What is Suspended Pavement?

Traditional planting

Design for maturity

Image: James Urban

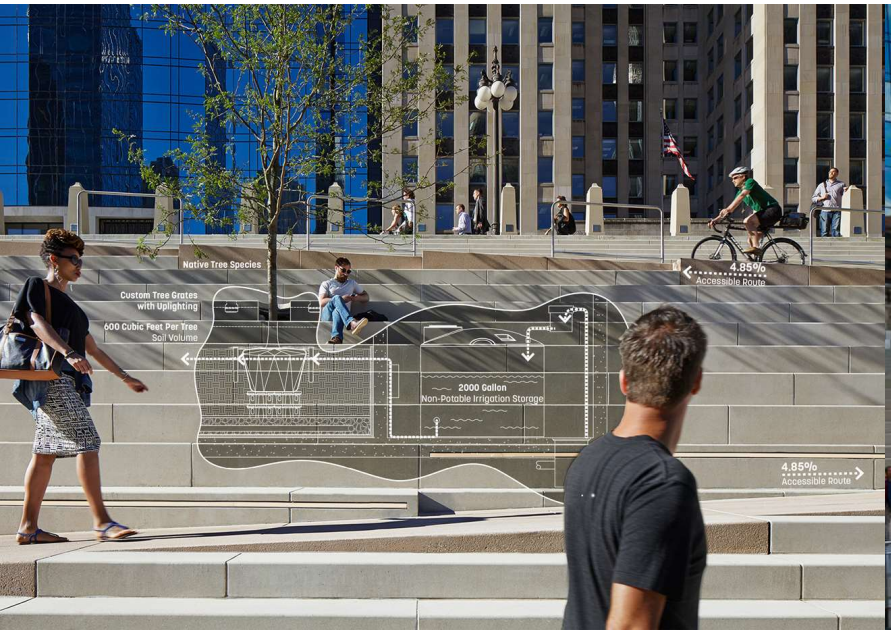
Suspended Pavement Longevity- 52 years

Christian Science Center, Boston, MA
Trees planted in 1968 in a custom system.
Approximately 800 cubic feet of soil per tree

Suspended Pavement Longevity- 35 years

Market Street, Philadelphia, PA 1985- Delta Group- John Collins
800 ft3 of soil per tree in share rooting

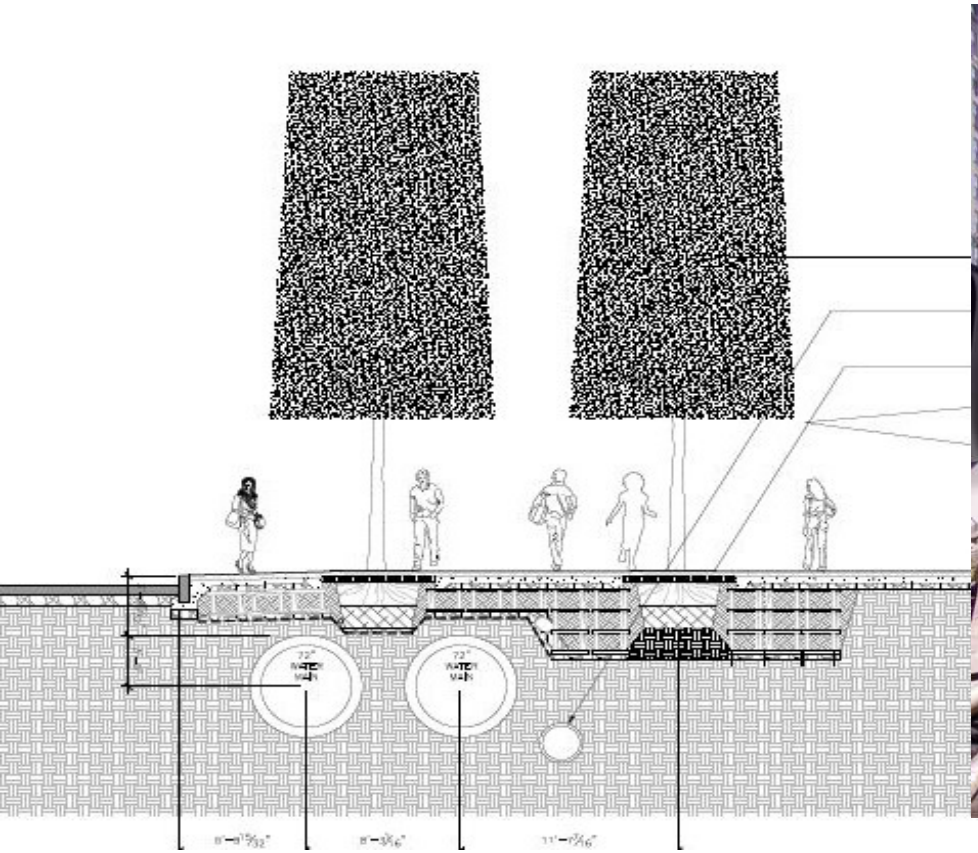
Custom Systems



Photos & images Courtesy of Jacobs Ryan Landscape Architects

Chicago River Walk River Theatre- 2017
ASLA General Design Award 2018
Sasaki And Associates
Jacobs Ryan

Metropolitan Museum of Art (New York, NY) *OLIN Studio*



Metropolitan Museum of Art (North Bosques, Pollarded)

2014

2019

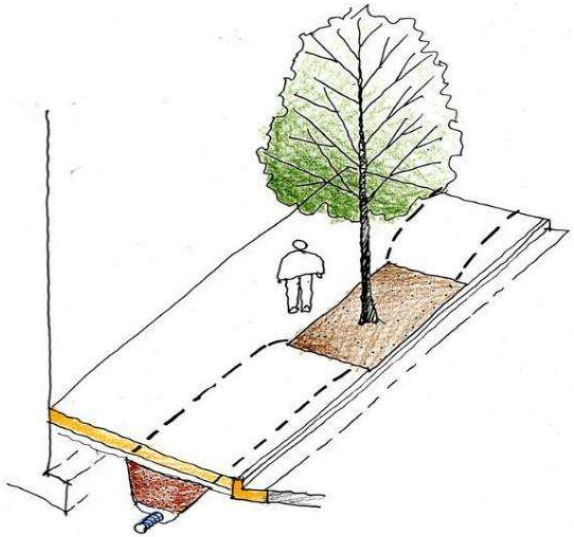
Metropolitan Museum of Art (North Allee)

2014

2017

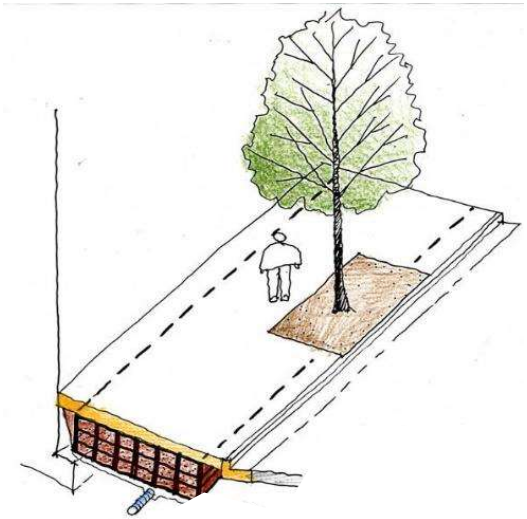

South Allee, August 2019

Does Soil Quality Matter?



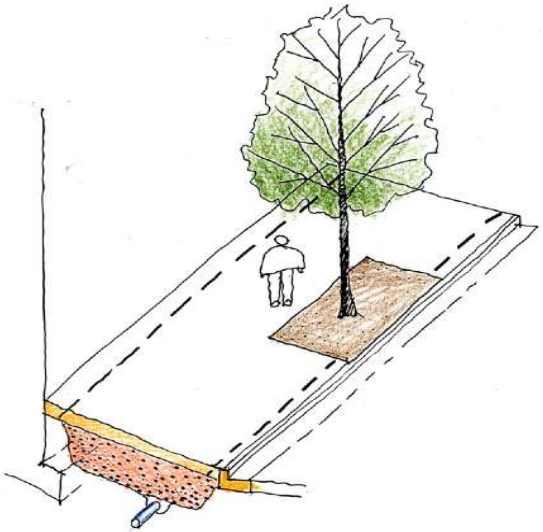
Custom Systems

- Reinforced Concrete
- PIP
- Concrete Forming Systems



Soil Cells

- Post and Deck
- Segmented
- Connected
- Independent



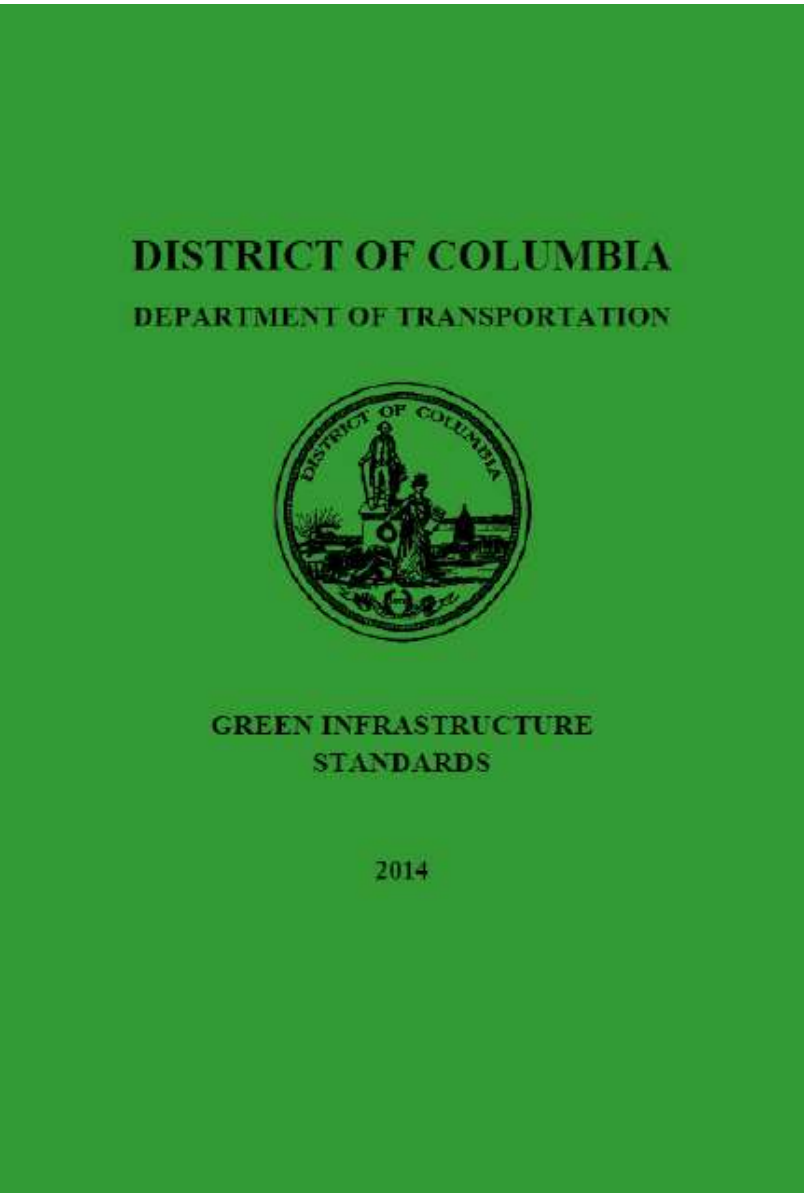
Structural Soils

SBSS

- *Amsterdam*
- *Pine and Swallow*
- *Turf Mixes*

GBSS

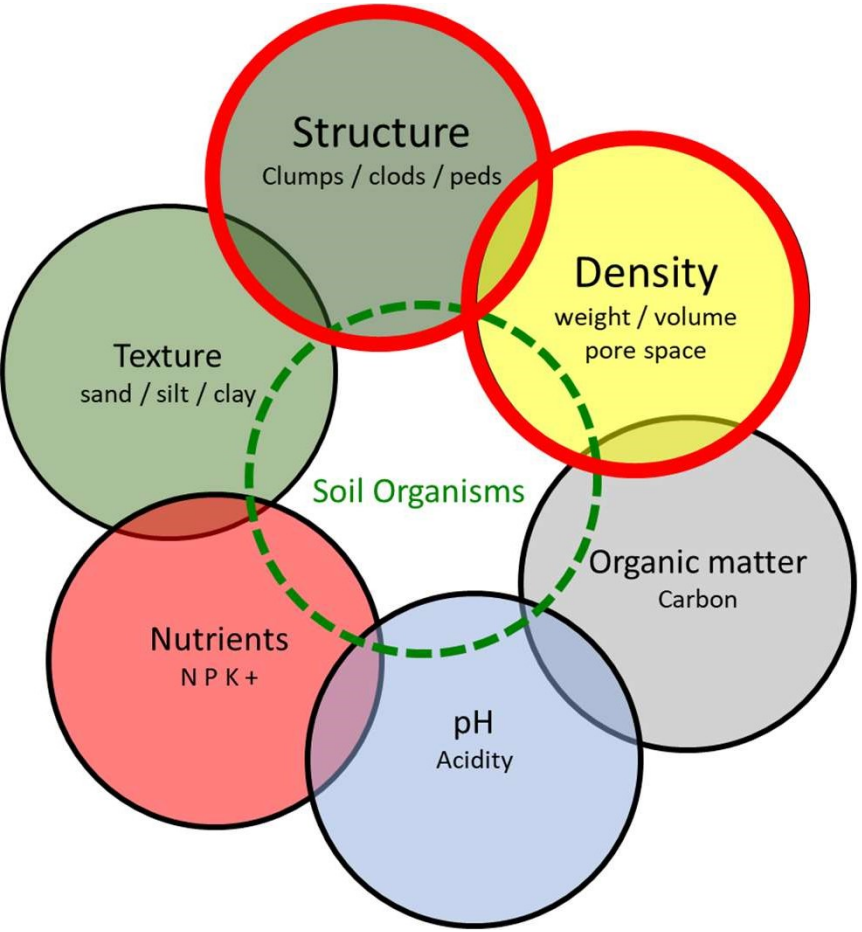
- CU Soil
- Stockholm
- Garn Wallace
- Stalite

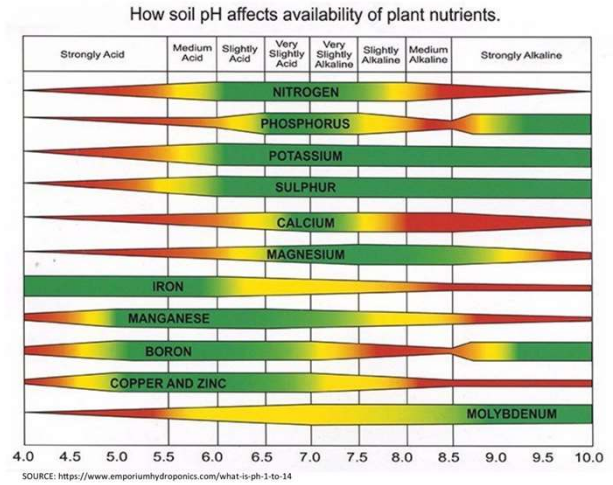


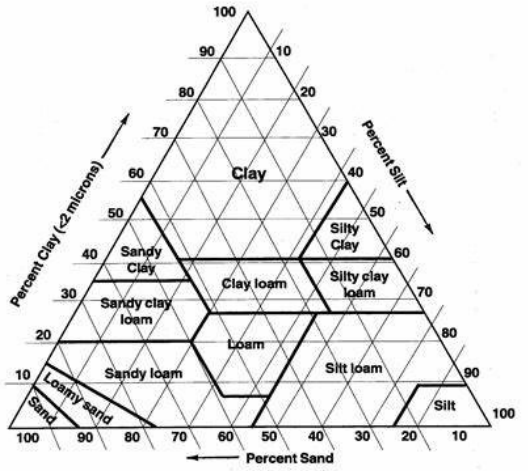
District of Columbia 2014 GI Standards

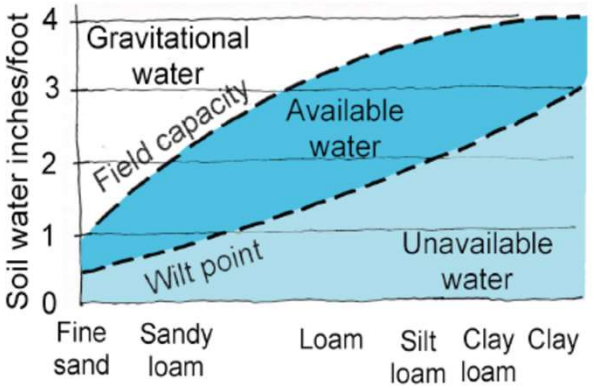
- Street Tree Soil Volume Mandate

  Gravel Based Structural Soil
  Sand Based Structural Soil
  Loam Soil
  Load Bearing Units
  Suspended pavement









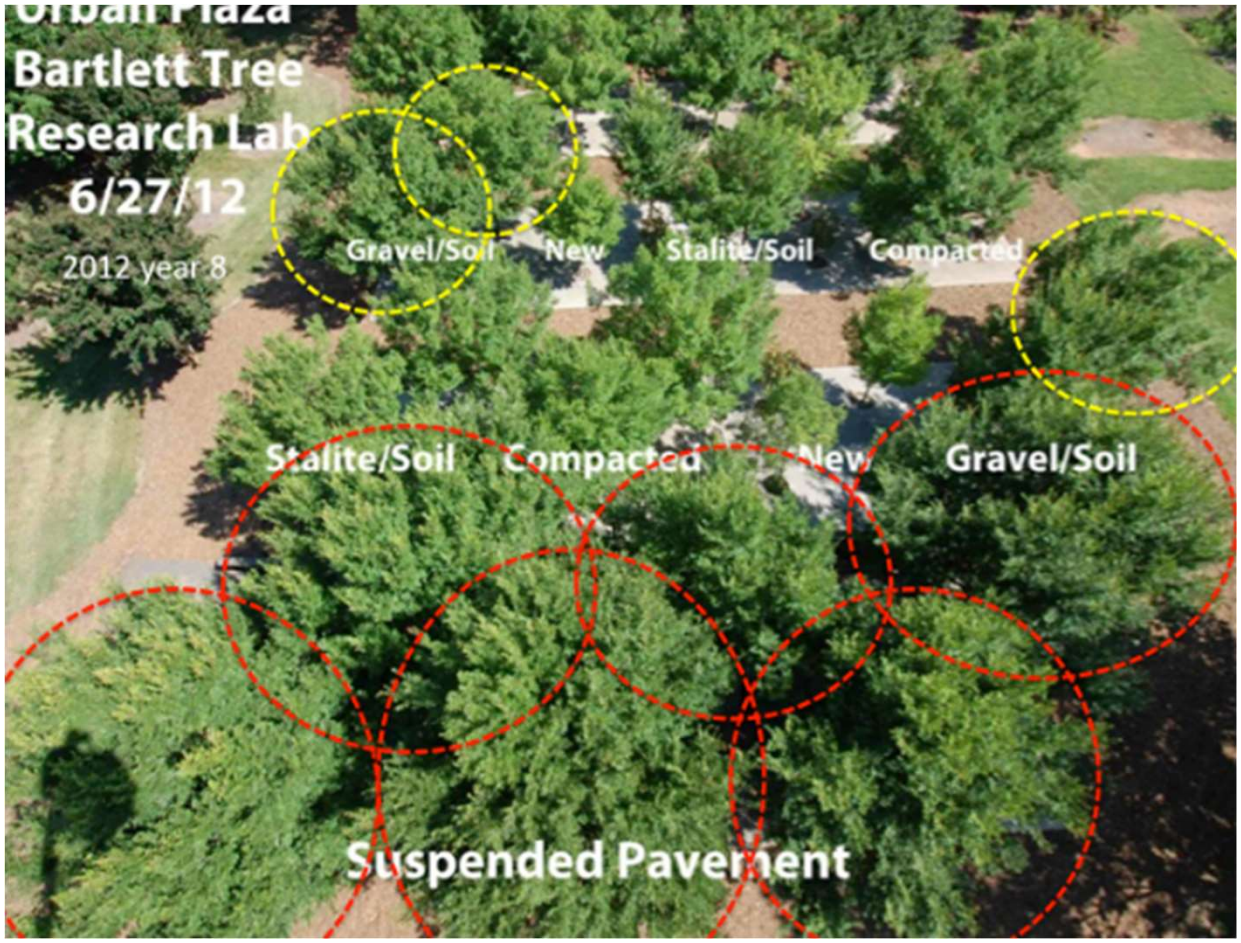
What is a High Quality Soil?

The perfect metaphor for a high quality soil
www.soilrebuilding.org

What is a high quality soil?

Unscreened sandy clay loam with 3-5%OM, 10% mature compost and a pH suited to the plants

Research Points to Planting soil



Smiley 2012

2018: Structural Soils Equivalent to Compacted Control

Image Courtesy of Bartlett Tree

Bartlett Soil Under Pavement Study 2017 Results

Silva Cells

Strata Cells

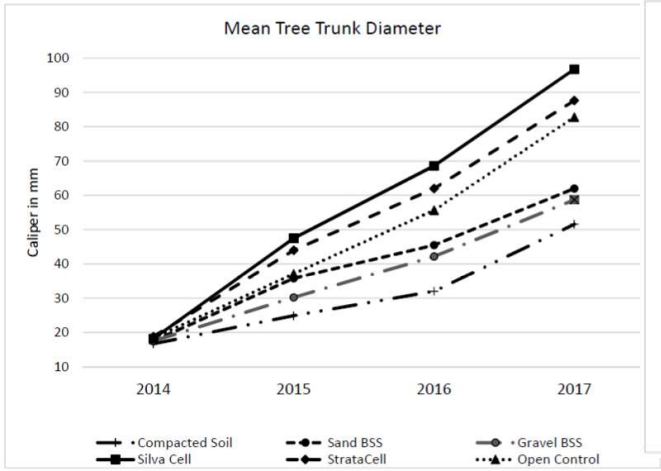
Gravel structural soil

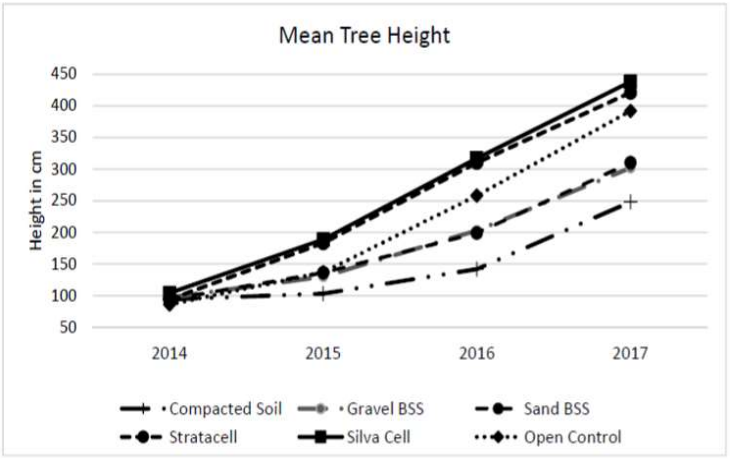
Sand soil

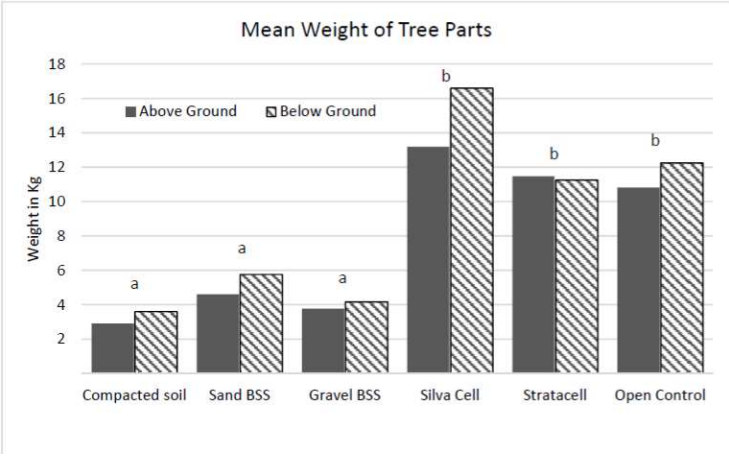
Uncompacted Control

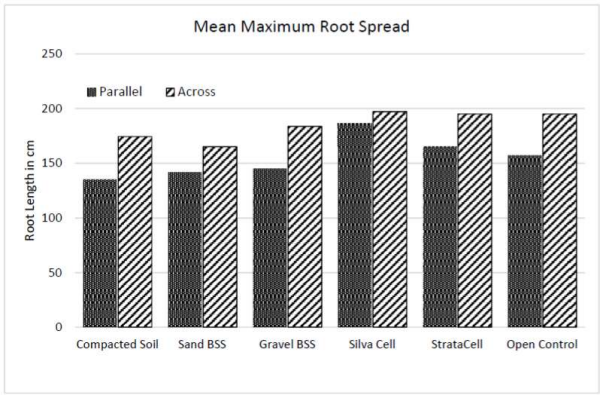
Compacted Control

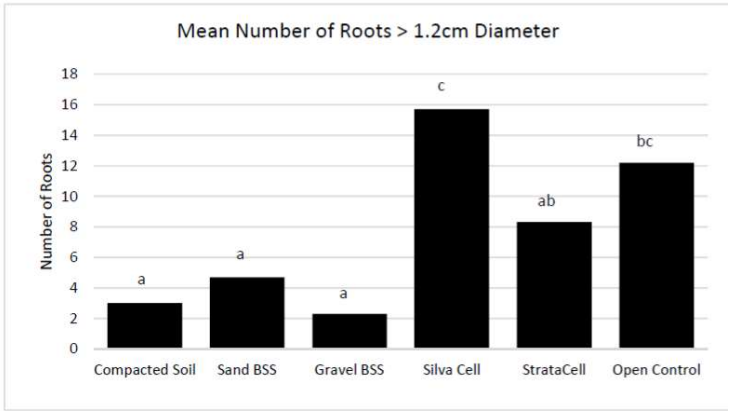
Data: Load Bearing Module with Loam is Best

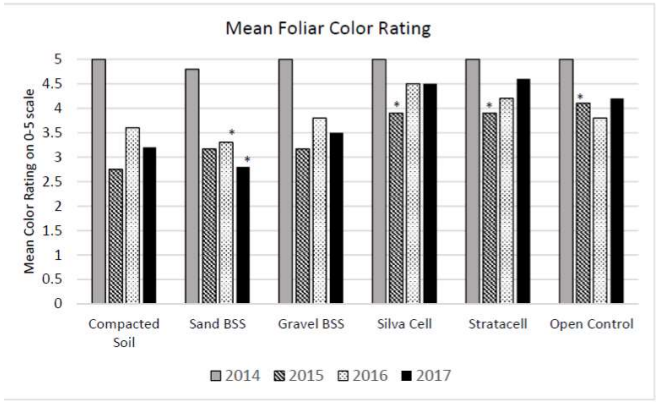












City of Toronto

2013
Trees in hard boulevard Best Practice M

2018
Toronto Green Standard

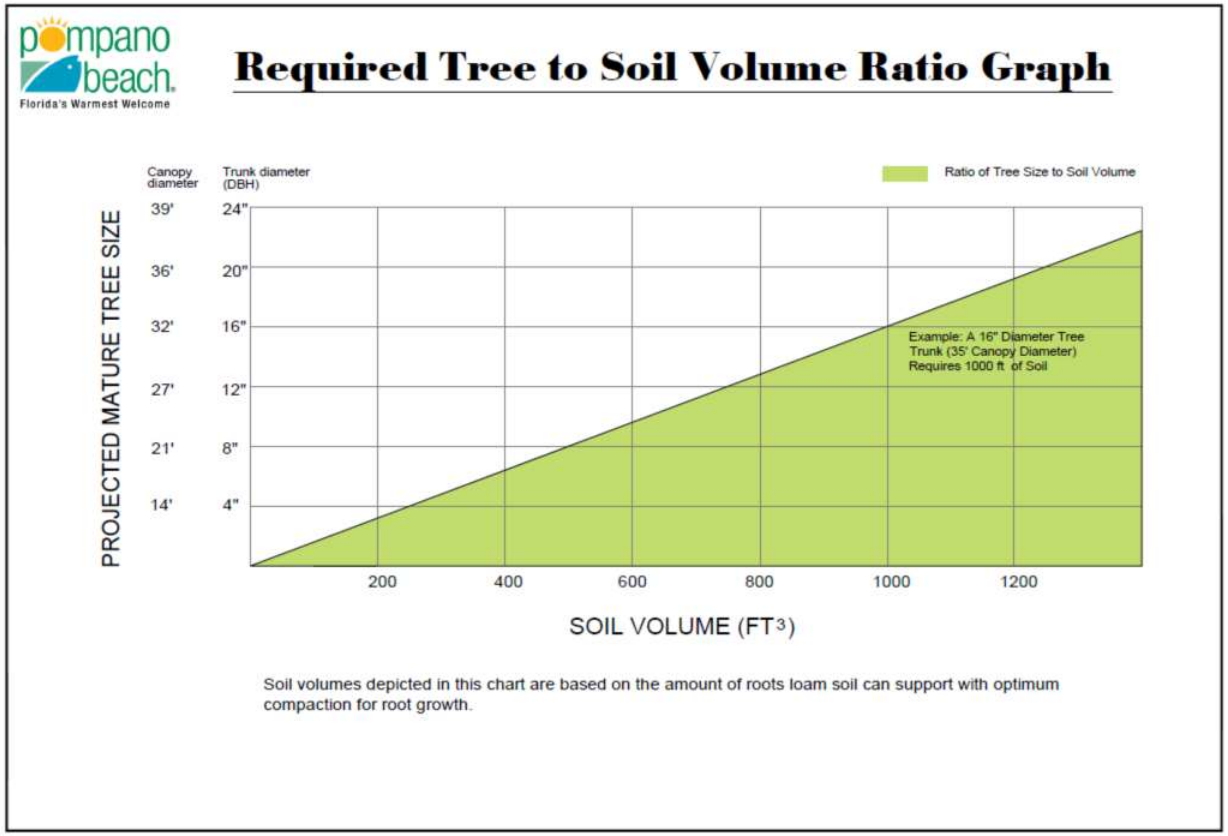
30 M^3 per street tree

15 M3 per street tree in shared rooting volume

Structural Soils not permitted

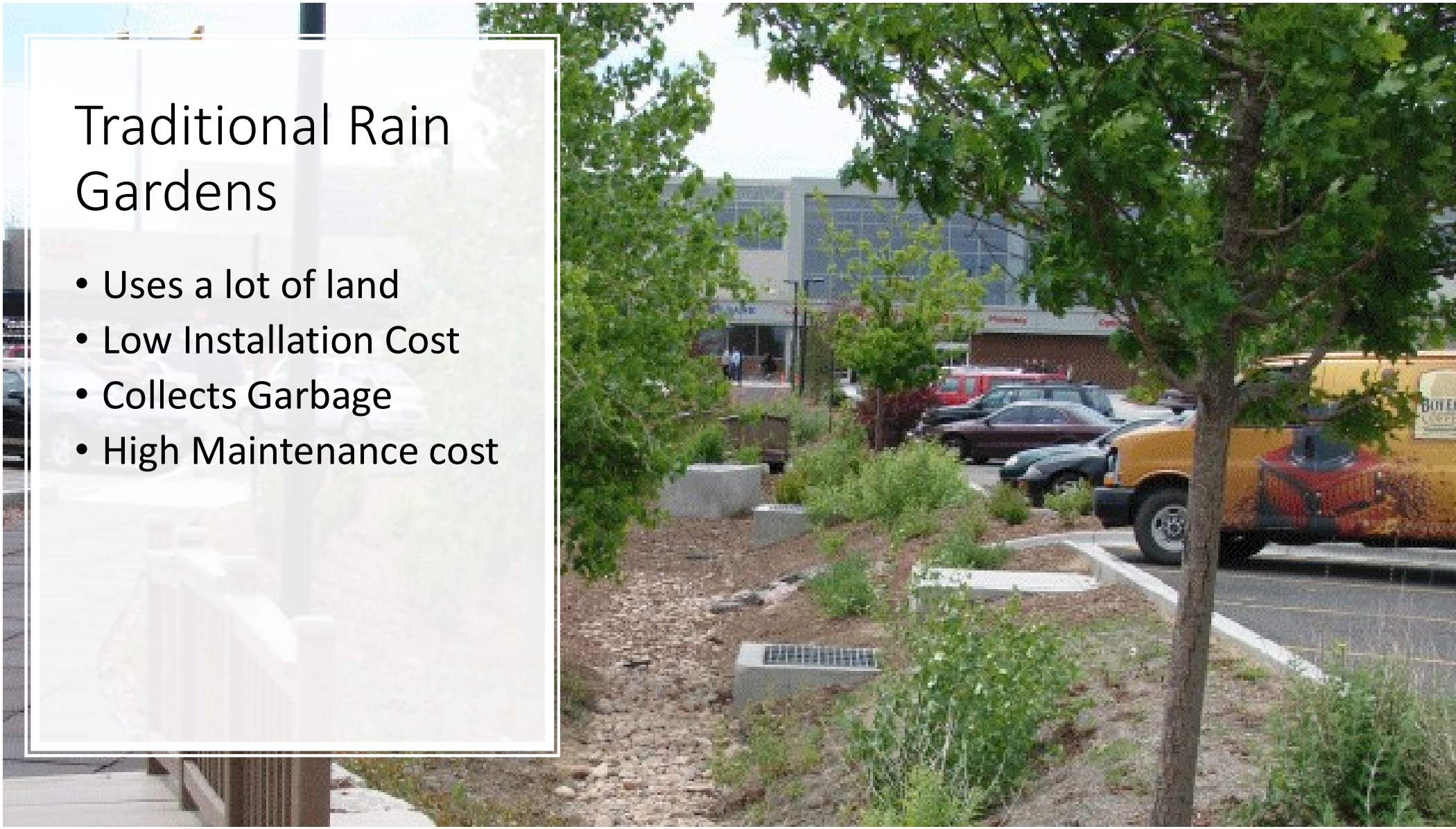
Pompano Beach TOD Standard Adopted 2018

Structural Soils not permitted



Traditional Rain Gardens

- Uses a lot of land
- Low Installation Cost
- Collects Garbage
- High Maintenance cost



Streetside Swales: Trees do not play a significant role

SW 12th Avenue Green Street
Portland, OR
by Kevin Robert Perry, *ASLA*
ASLA General Design Award of Honor
2006

- Uses Less land
- Collects Garbage
- Higher Installation Cost
- High Maintenance Cost
- Forget ET and CI

Rain Garden Beneath Pavement

- Multiple land uses
- High Installation Cost
- Low Maintenance cost
- Choice of Soils

What is a CSO?

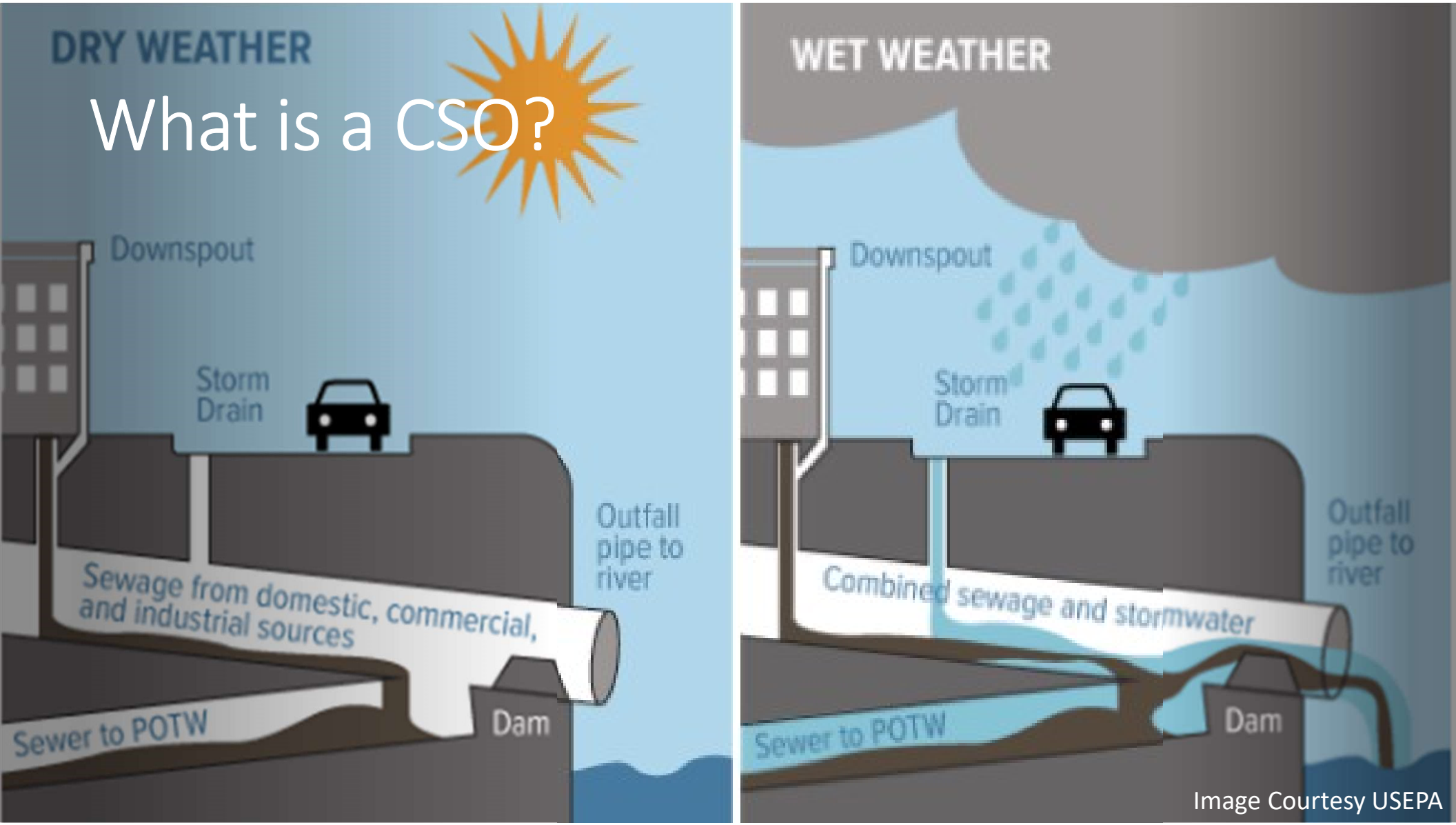


Image Courtesy USEPA

Paerdegat Basin- 2012

Combined Sewer Overflow Facility
Brooklyn, NY, 2012

$404 million to build

$25 million/year operating cost

50 million gallon Capacity

Only functions 80 days per year

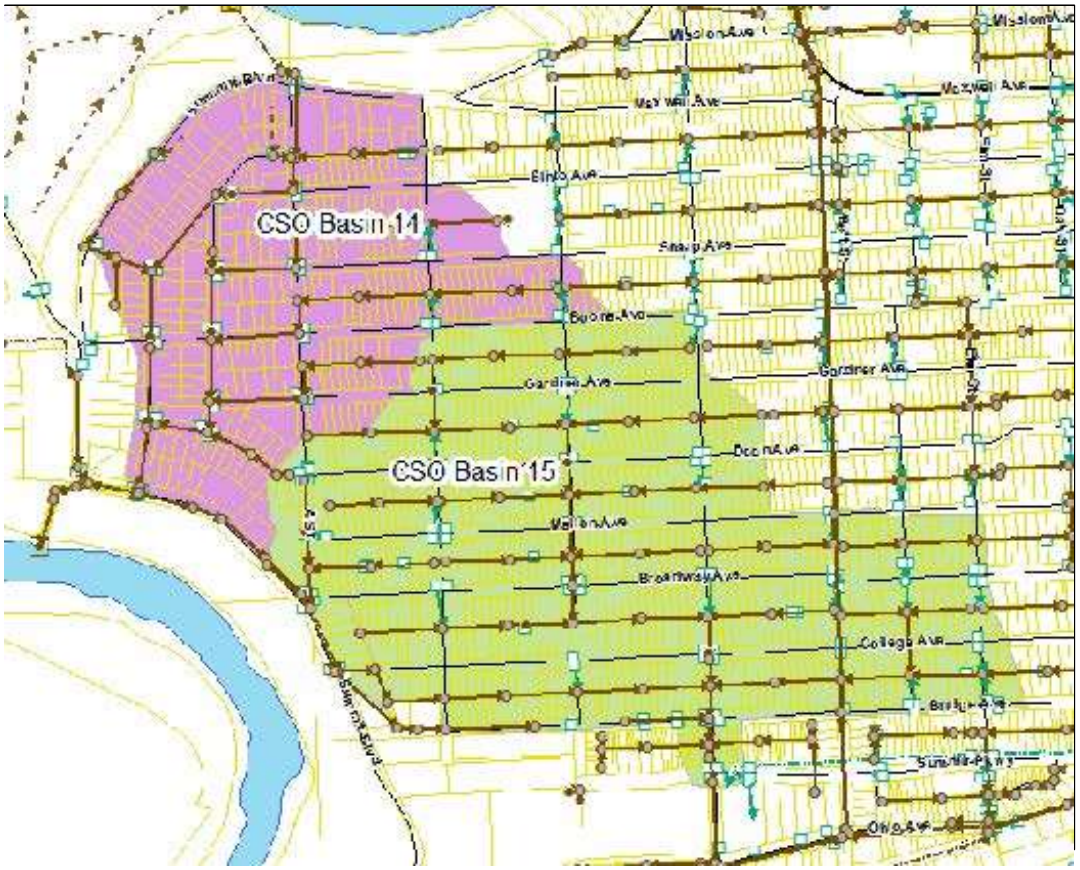
$8.08 CPG (no conveyance)

Gowanus Lowands, Brooklyn NY

CSO 14 & 15 Basin Improvements
Spokane, Washington

Area: Historic district west of downtown
Description: Stormwater separation to reduce combined sewer overflow to the Spokane River.

Between CSO 14 & 15, there were a total of 21 impervious areas which connected directly from catch basins to sanitary sewer. The city was looking at a number of stormwater mitigations for local capture and treatment of those 21 locations within the West Central neighborhood.



Objectives of Project:

- Reduce overflows to one per year, per location over 20 yrs.
- Stay within budget
- Provide benefits with low maintenance cost

deeproot

CSO 14 & 15 Basin Improvements

City of Spokane, Dept of Engineering Services served as the owner and designer of this project.

They considered 3 options to address their objectives - bioretention / storage tanks / soil cells. Chose the option of soil cell for the following reasons:

*Small system footprint

*Allowed curb lines and parking to remain

*No system medium replacement needed

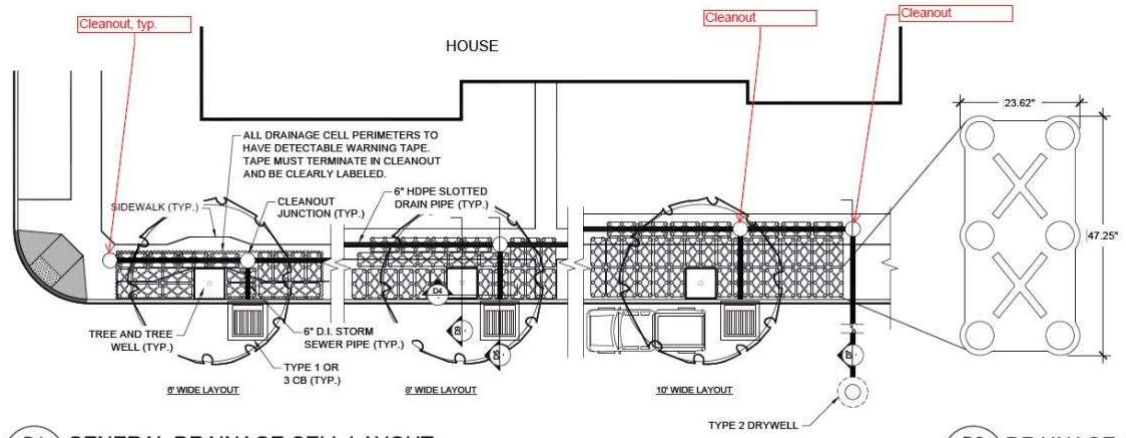
*Approved as bio-infiltration equivalent

*Reduced overall maintenance

*Treated stormwater with infiltration at the site

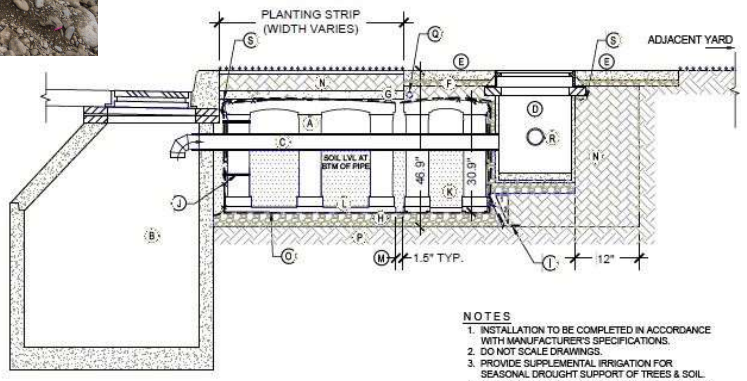
deeproot

CSO 14 & 15
Basin Improvements



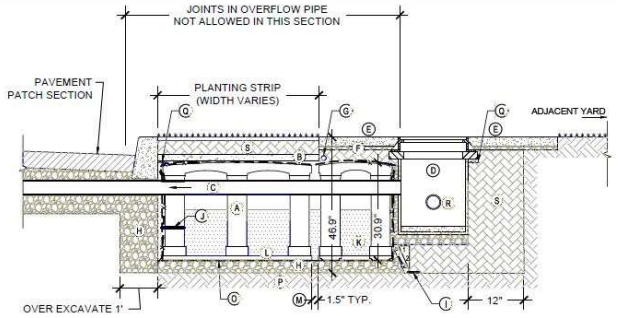
D1 R-5 GENERAL DRAINAGE CELL LAYOUT
NOT TO SCALE

D2 R-5 DRAINAGE CELL
NOT TO SCALE



NOTES
1. INSTALLATION TO BE COMPLETED IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS.
2. DO NOT SCALE DRAWINGS.
3. PROVIDE SUPPLEMENTAL IRRIGATION FOR SEASONAL DROUGHT SUPPORT OF TREES & SOIL.
4. 4. DRAINAGE CELL BASES TO BE SET AT CONSTANT ELEVATION. DEPTH OF EXCAVATION MAY VARY.

D5 R-5 SECTION - DRAINAGE CELL SYSTEM THROUGH CATCH
NOT TO SCALE



NOTES
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D7 R-X SECTION - CLEANOUT TO DRYWELL
NOT TO SCALE

CSO 14 & 15 Basin Improvements

- The CSO 14 & 15 project is an example for any community which has a combined sewer system that is overtaxed, failing, and old. In the urban environment where space is a premium, every municipal district has to comply with state and federal regulatory requirements to account for the conveyance of those stormwater discharges and to reduce the occurrences of untreated sanitary wastewater and runoff from rainfall and snowmelt.

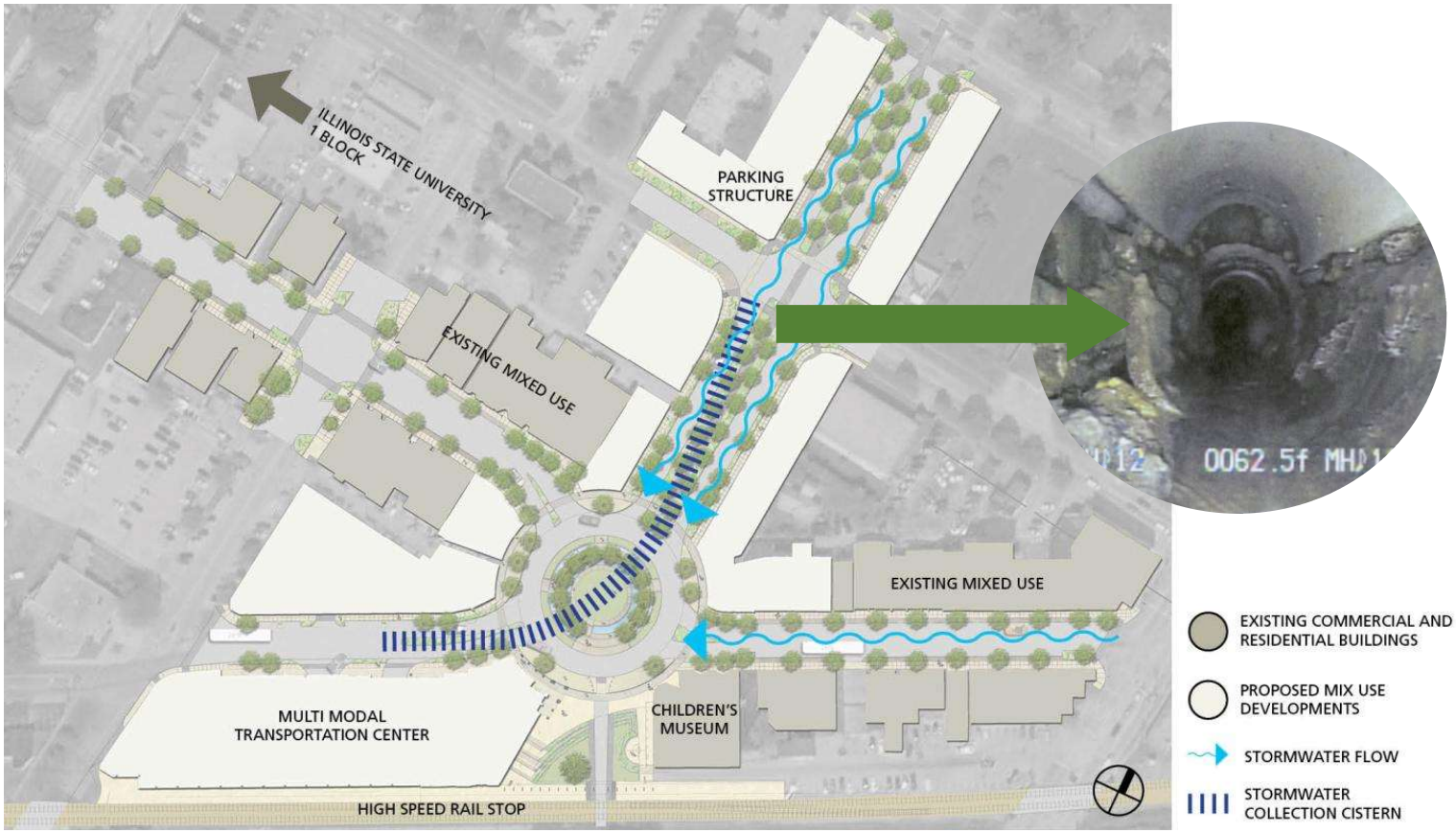
CSO 14 & 15 Basin Improvements

- In 2017, prior to the project, the city reported 144 outfall events at 26 monitoring sites in which 71 million gallons of untreated water was released into the Spokane River.

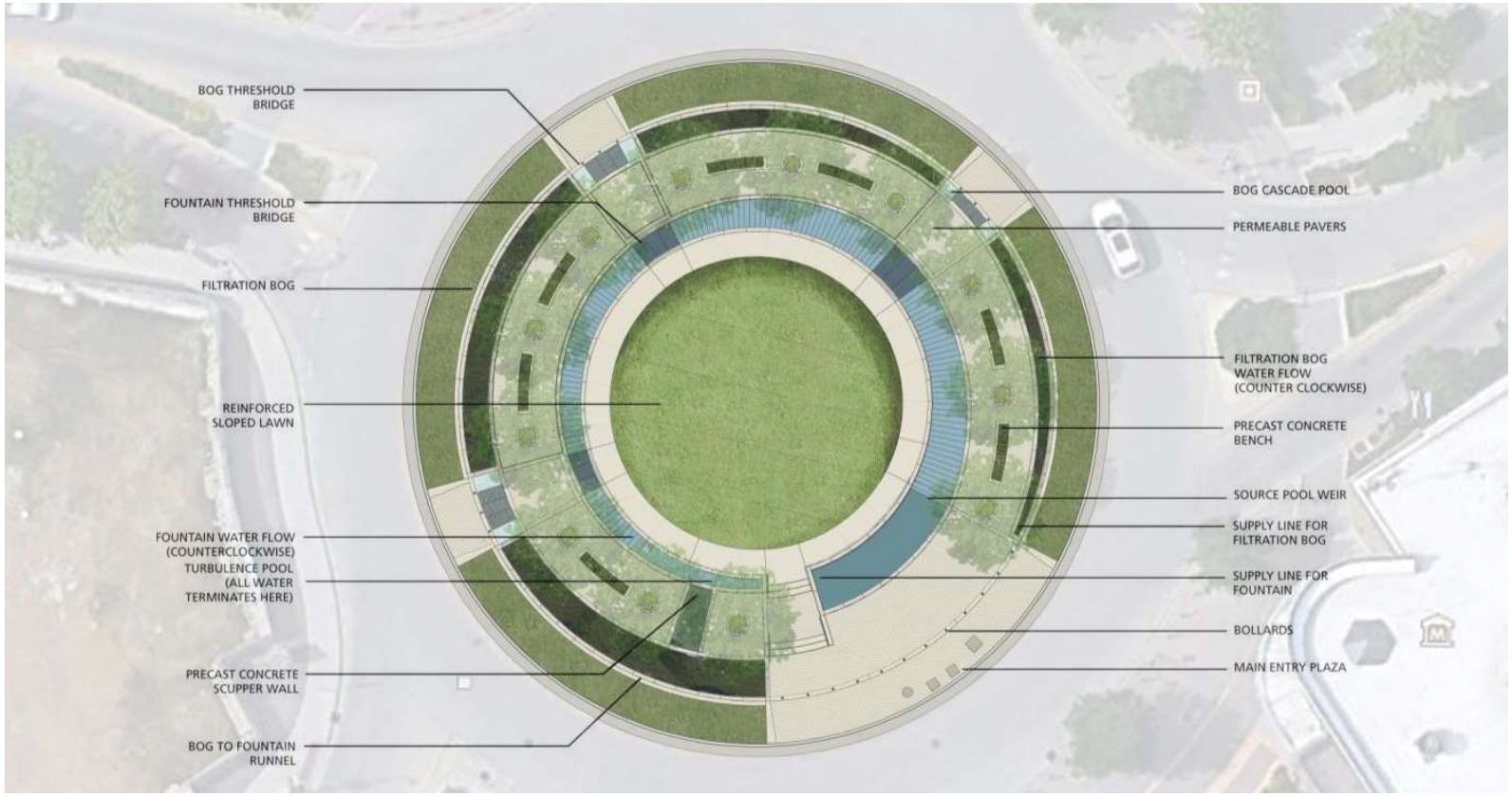
- Since the project's completion, the city has a real time combined sewer overflow monitoring site to reflect the current operational status of each CSO location.

Construction Cost: $3,402,583.60

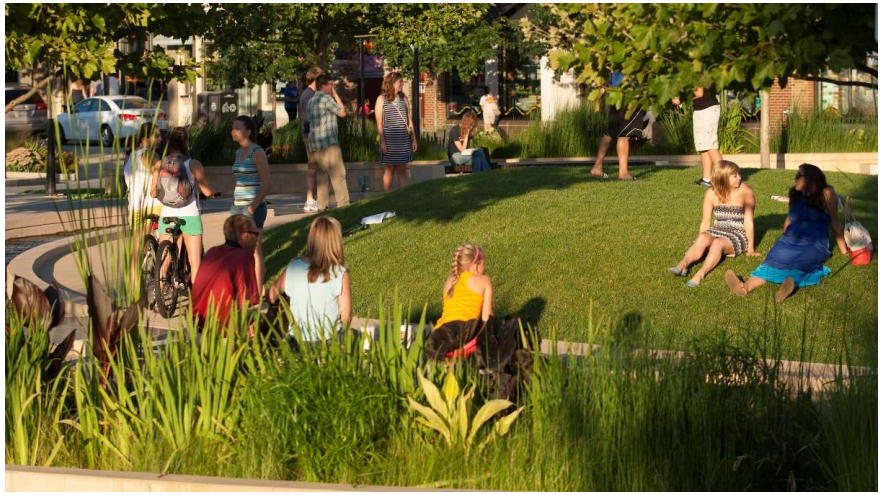
Uptown Normal Redevelopment, 2009



The Circle


BOG THRESHOLD BRIDGE
FOUNTAIN THRESHOLD BRIDGE
FILTRATION BOG
REINFORCED SLOPED LAWN
FOUNTAIN WATER FLOW (COUNTERCLOCKWISE)
TURBULENCE POOL (ALL WATER TERMINATES HERE)
PRECAST CONCRETE SCUPPER WALL
BOG TO FOUNTAIN RUNNEL
BOG CASCADE POOL
PERMEABLE PAVERS
FILTRATION BOG WATER FLOW (COUNTER CLOCKWISE)
PRECAST CONCRETE BENCH
SOURCE POOL WEIR
SUPPLY LINE FOR FILTRATION BOG
SUPPLY LINE FOR FOUNTAIN
BOLLARDS
MAIN ENTRY PLAZA


ROAD
CLOSED



2010-2017

2010-2017

Leadership in Environmental and Economic Design, New Construction (LEED-ND), Silver- 2009

President's Award for Illinois ASLA Chapter, Urban Category, 2010

US UPA National Award for "Smart Growth Achievement", 2011

U.S. FTA/FHA "Transportation Planning Excellence Award," 2012

Urban Open Space Award Finalist, 2020:

Thank you!

Ridge Hill Road, Yonkers, NY

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Growth Rates & Performance of Trees in Suspended Pavement

- **Case study of nearly 400 trees at 10 locations, after 3 to 7 years**

- Research by James Urban, FASLA and Leda Marritz

Surveyed projects

NAME	LOCATION	INSTALLATION DATE	DESIGN FIRM	# OF TREES	# OF DEAD/ DYING TREES	# OF TREES INCLUDED IN GROWTH RATE ANALYSIS
South East False Creek Olympic Village	Vancouver, BC	Fall 2009	PWL Partnership	180	4	176
Ft. Saskatchewan Phases 1 & 2	Ft. Saskatchewan, AB	Fall 2010 (Part 1)	DIALOG	66	5	61
Marquette and 2nd	Minneapolis, MN	Fall 2009	SEH, Inc.	36	3	33
Sugar Beach	Toronto, ON	Spring 2010	Claude Cormier + Associates	33	4	29
North Tucker Boulevard	St. Louis, MO	Fall 2011	HDR	28	0	28
Sundance Plaza	Fort Worth, TX	Fall 2013	Michael Vergason Landscape Architecture	18	0	18
Martin Luther King, Jr. Memorial	Washington DC	Fall 2011	Oehme van Sweden	16	0	16
Haas Business School	Berkeley, CA	Spring 2013	GLS Landscape Architecture	12	0	12
UNC Bell Tower	Chapel Hill, NC	September 2011	Cole Jenest & Stone	12	0	12
Neyland Stadium	Knoxville, TN	August 2010	Carol R. Johnson Associates	7	0	7
TOTAL				408	16	392

10 projects, 2 countries, over 400 trees

Evaluation process

EXAMPLES OF TREE HEALTH RATINGS

A tree rated "1" (Excellent) at Haas School of Business in Berkeley, CA.

A tree rated "2" ("Good") at South East False Creek in Vancouver, BC.

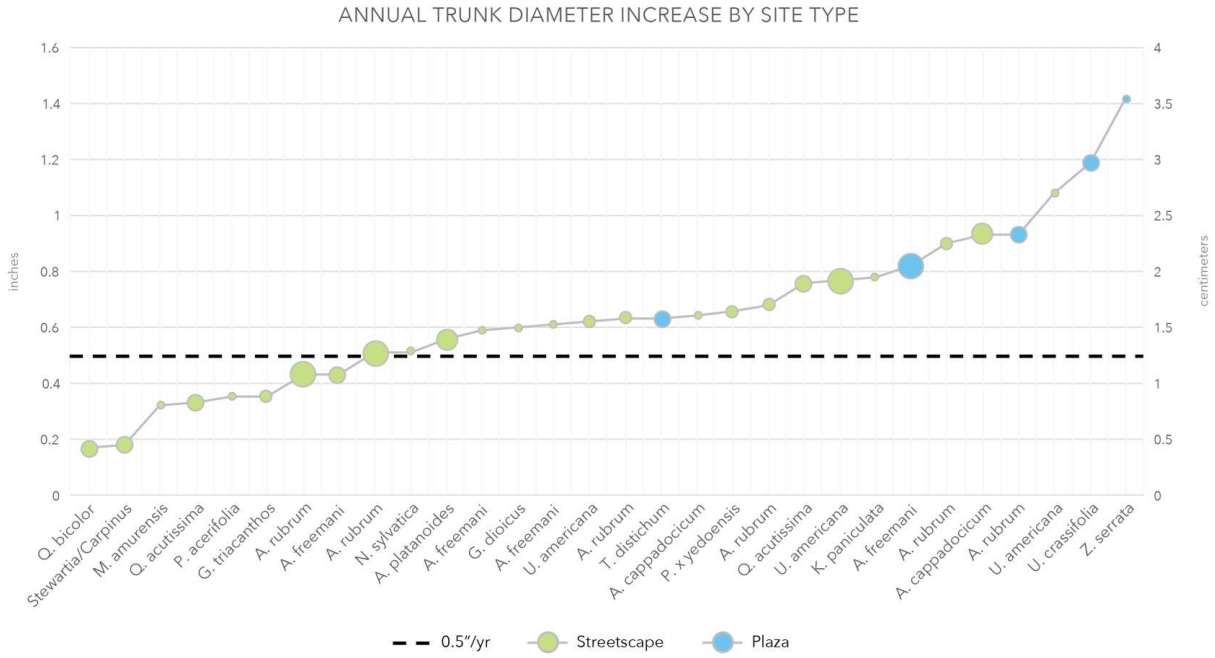
A tree rated "3" ("Poor") at North Tucker Boulevard in St. Louis, MO.

A tree rated "4" ("Dead or dying") at Marquette and 2nd in Minneapolis, MN.

Local collaborators visited each tree to record:

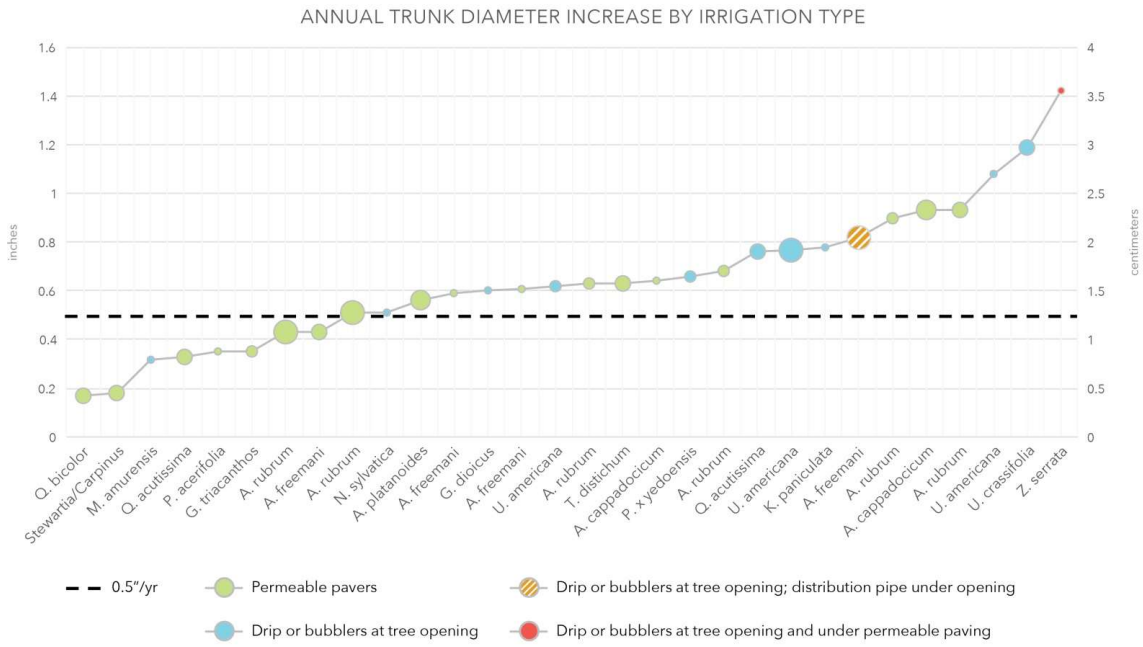
- diameter at breast height
- tree condition (rating 1-4)

Streets are a much tougher urban condition



All trees planted in plazas performed well above the 0.5” (1.27 cm) per year reference rate.

Irrigation type didn’t appear to make a difference



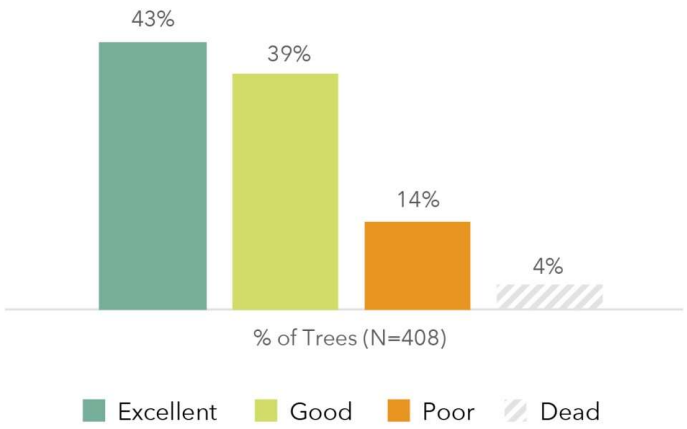
The data doesn’t show a strong relationship between irrigation type and tree performance. Projects with drip or bubblers at the tree opening seemed to perform better overall, as did drip or bubblers at tree opening with a distribution, although the latter was only present at one project.

Annual trunk diameter increase

68% of trees performed at or above the reference rate of 0.5 inches (1.27 cm) of trunk growth per year, with 29% growing faster than 0.8 inches (2.03 cm) per year.

27% of the trees grew less than the reference rate, with 11% between 0.4 and 0.5 inches (1.01 and 1.27 cm). Of these, 20 (5%) were the slow-growing species of stewartia, carpinus, and maackia.

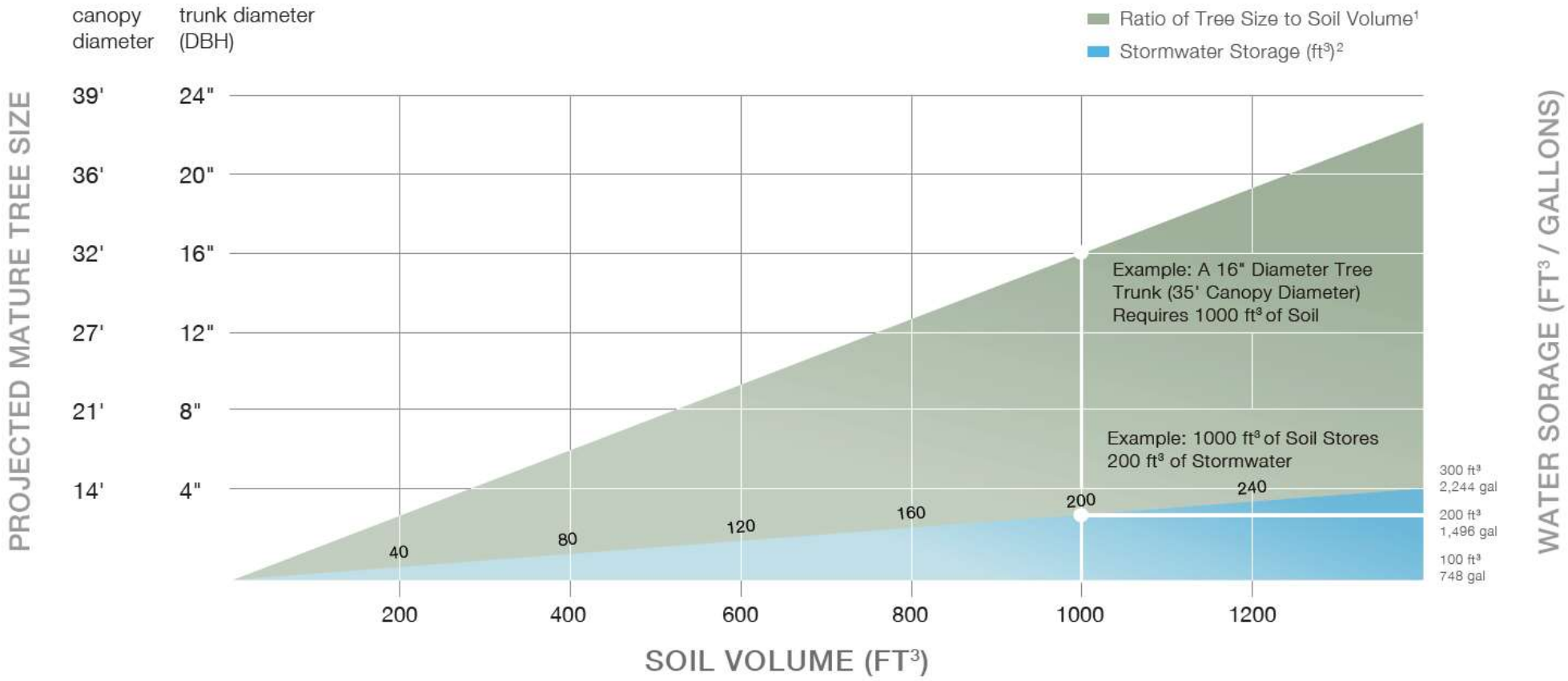
82% of trees in excellent or good condition



The average health condition across all 10 projects was 1.4, indicating that the trees are in a healthy condition.

Tree condition is significantly associated with average trunk growth per year, when controlling for type of tree species. On average the trees that were rated “good” grew 0.1 inches less than the trees in the “excellent” group ($P=0.003$), and trees in the “poor” group grew 0.2 inches less than those in the “excellent” group ($P<0.001$).

How Much Soil to Grow a Big Tree?



Lincoln Center Bosque, New York City

In April of 2009, 970 Silva Cell frames and 620 Silva Cell decks were installed at the Lincoln Center Bosque (Barclay Capital Grove) in New York City, New York to support 30 new trees that were planted that spring. Each tree receives a total of 450 cubic feet (12.7 cubic meters) of soil. The project site, formerly known as the North Plaza, rests entirely on a parking garage.

Approx Cost:
$7,500.00/tree

Sundance Square, Fort Worth, TX

The trees of Sundance Square plaza after three growing seasons. In October of 2013, 960 Silva Cell frames and 480 Silva Cell decks were installed beneath the Sundance Square Plaza in Fort Worth Texas to support the 18 Cedar Elm trees that were planted later that autumn. Each tree receives 800 cubic feet of soil, and water efficient irrigation techniques were employed in the design to ensure that the trees would thrive in the often arid desert climate.

Approx Cost:
$12,000.00/tree

Sugar Beach Toronto, ON

The trees at Sugar Beach in Toronto, Ontario after 5 growing seasons. These trees are supported by 3,150 Silva Cell frames and 1,960 Silva Cell decks, which help them to receive over 1,236 cubic feet (35 cubic meters) of soil each. The Silva Cell system was installed in winter 2010, and the trees planted in spring 2010 as part of the Waterfront Toronto revitalization project.

Approx Cost: $18,000.00/tree (US$)