Building Soil
Foundation for Success

Healthy Soils, Healthy Landscapes

Soil Strategies for a Sustainable City

City of Seattle

Green Factor seminar, 5/30/07, by:

David McDonald – Seattle Public Utilities

Shane DeWald – Seattle Department of Transportation

Beth Duncan – Seattle Center

Seminar description:

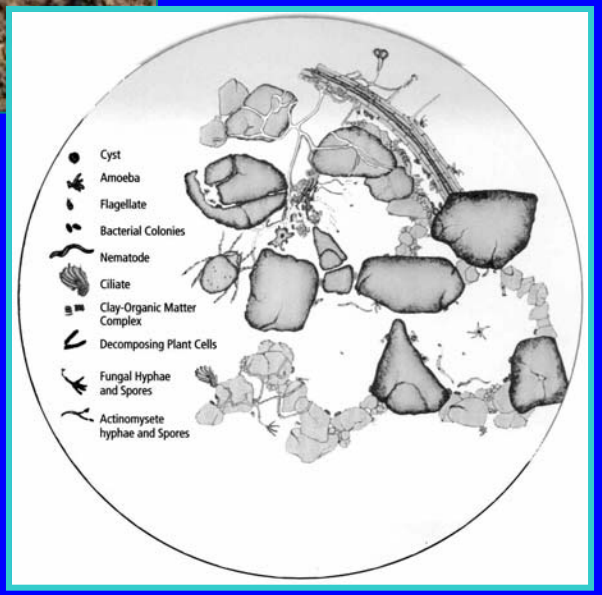
Healthy soil is the foundation of vibrant, easy-to-maintain landscapes. It's also essential to comply with recent State Stormwater Manual regulations and the upcoming revised Seattle Stormwater Code. SPU's David McDonald will cover soil requirements, site techniques, and specs for soil and compost; Shane DeWald of SDOT will discuss preserving and installing street trees and structural soils; Seattle Center's Beth Duncan will show how to build and maintain soil health for healthy plantings in an ultra-urban landscape.

Presented 5/30/07 at Seattle City Hall, as part of a training series on Seattle's new "Green Factor" code, which requires a functional equivalent of 30% lot coverage by vegetation – learn more at **www.seattle.gov/dpd/GreenFactor**

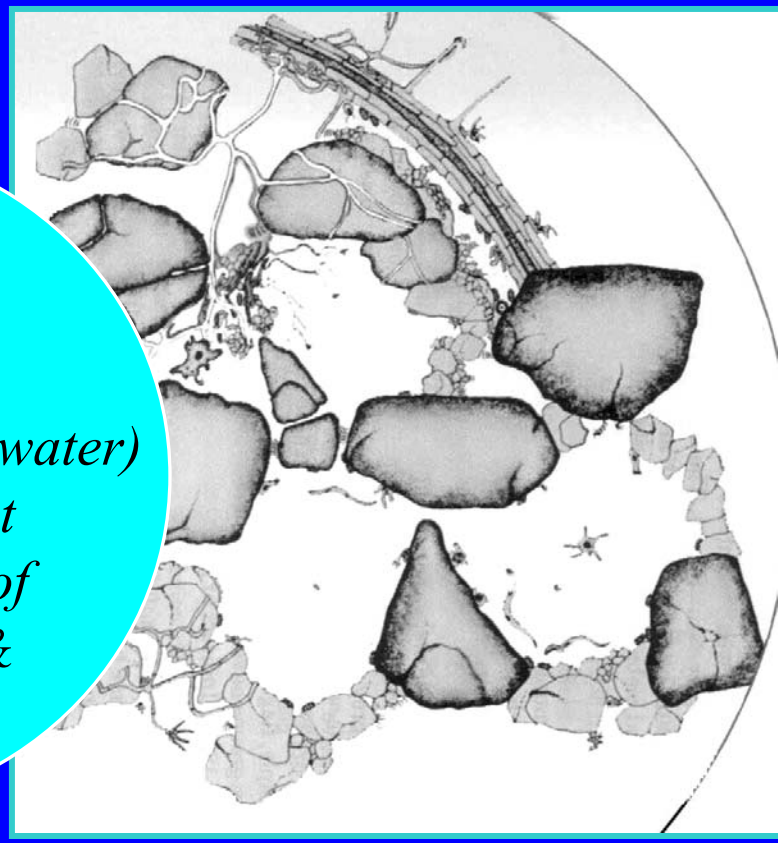
Value of Healthy Soil

Billions of soil organisms:

- Support healthy plant growth, fertilize, protect plants from disease
- Create soil structure, resist compaction
- Provide stormwater infiltration
- Filter out pollutants (oil, metals, pesticides, etc.)
- Prevent erosion
- Reduce summer water needs
- Reduce need for landscape chemicals
- Reduce maintenance costs!



Understanding soil:
texture, structure, and soil life



Soil components:

- "The Dirt" (mineral part)
  - sand
  - silt
  - clay
- Air and Water

Good soil is about
- half mineral
- half space (air & water)
- plus a smaller but essential amount of organic matter & soil life

- Organic Matter and Soil Life creates structure: aggregates, pores, resistance to compaction

Puget Sound sub-soils ("The Dirt"): Leftovers from glaciers & volcanoes

glacial till: unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders; deposited under ice, or in moraines

hardpan: till compacted under glacier

outwash soils: layers sorted by particle size by water - sand / gravel / rocks

lake/marine bed soils: clay or silt that settled out in lakes & estuaries

volcanic ash: light, fertile, holds moisture - mostly blown east of Cascades

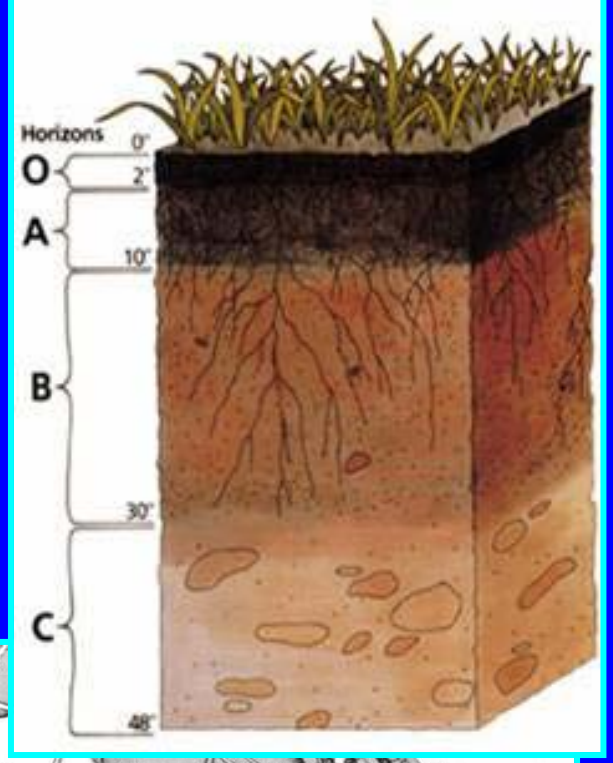
mudflows: mixed size, compact - like till

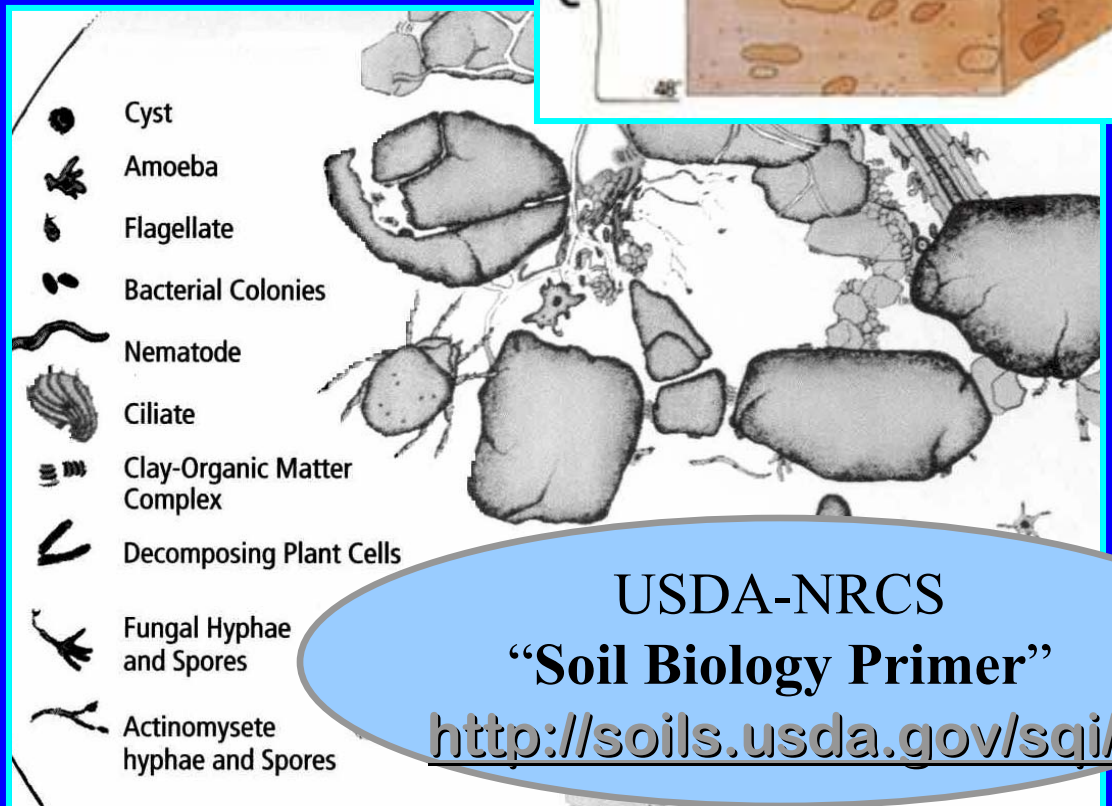
Learn about Puget Sound soils at:
www.puyallup.wsu.edu/soilmgmt/Soils.htm

From Dirt to Soil –it's alive!

Soil horizons & their evolution

- Substratum (C) or bedrock (R) weathers physically & chemically to subsoil (B)
- Primarily biological processes create topsoil (A) and organic (O) horizon
- Soil life is essential for healthy plants:
  - nutrient cycling
  - cat ion exchange
  - disease protection
  - water supply
  - gas exchange
  - root space



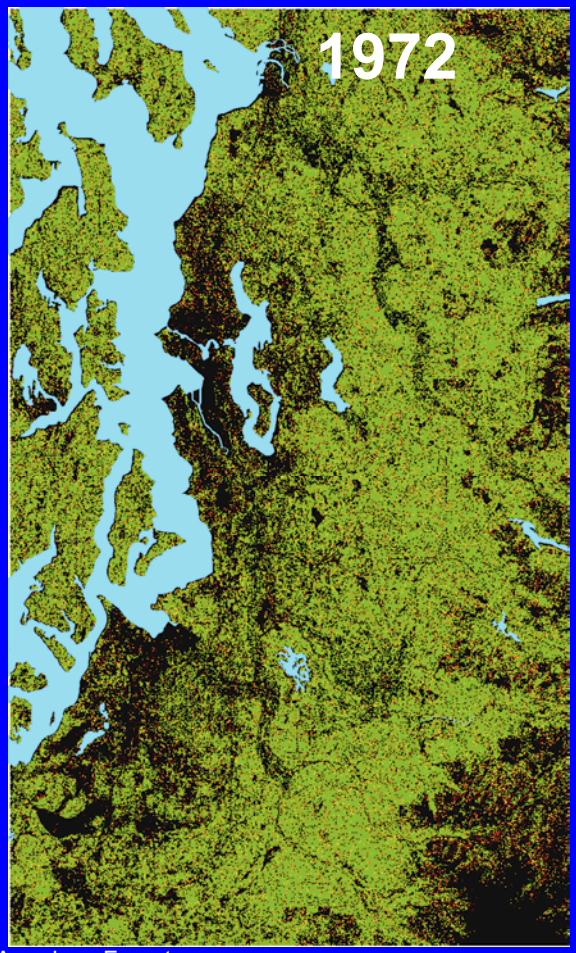


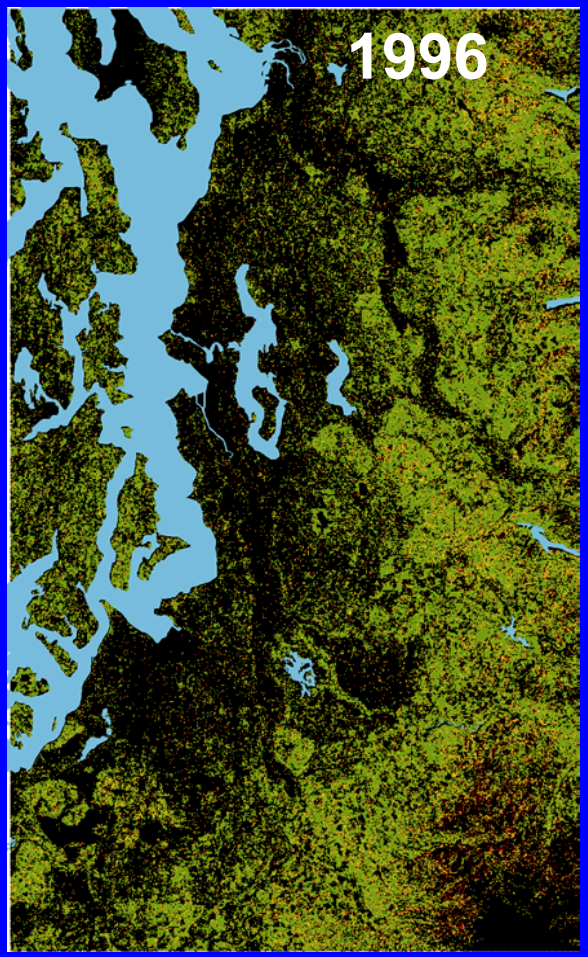
USDA-NRCS
"**Soil Biology Primer**"
http://soils.usda.gov/sqi/

The Soil – Water Connection

Impacts of turning spongy forests into cities

1972-1996: Amount of land with 50% tree cover decreased by 37% in Puget Sound region (from 42% of land down to 27%).





Impervious surface (roads, buildings) increased proportionately.

WA population doubled 1962-98.

2.7 million more people by 2020!

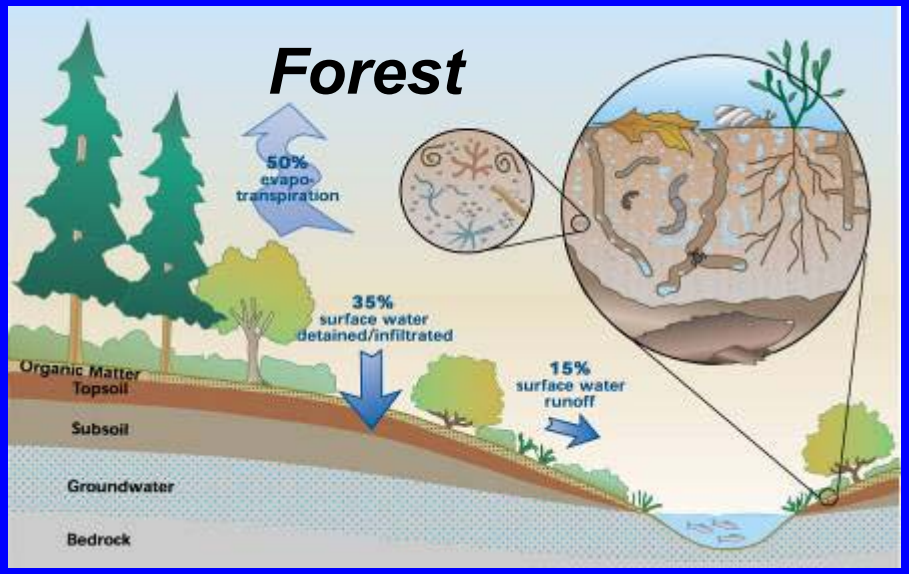
American Forests

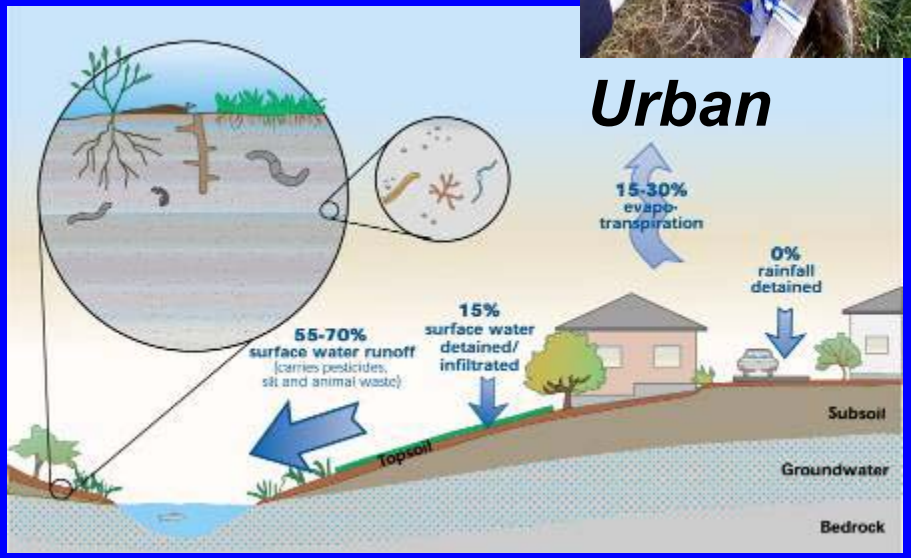
What happens to soils and soil functions as we turn forests into cities?

↑compaction
↑erosion
↑loss of topsoil
↓soil organisms
↓soil structure
↓natural fertility & disease prevention
↑impervious surface

<u>cause:</u>

↑storm runoff
↑need for irrigation & chemicals
↓biofiltration of pollutants

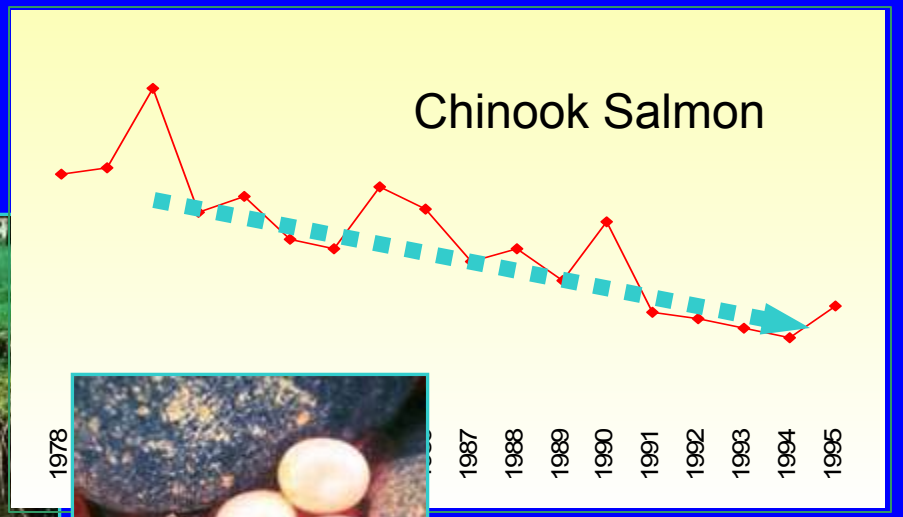




King County DNR

What are the impacts?

- Pollution
- Erosion
- Salmon decline
- Flooding & property damage
- Failing landscapes = higher costs: irrigation, chemicals, dying plants
- Unhappy customers



How can we restore soil functions, to improve plant growth, water quality, and reduce runoff?

- Prevent /reduce compaction
  - keep heavy machinery off where possible
  - rip compacted soils to loosen

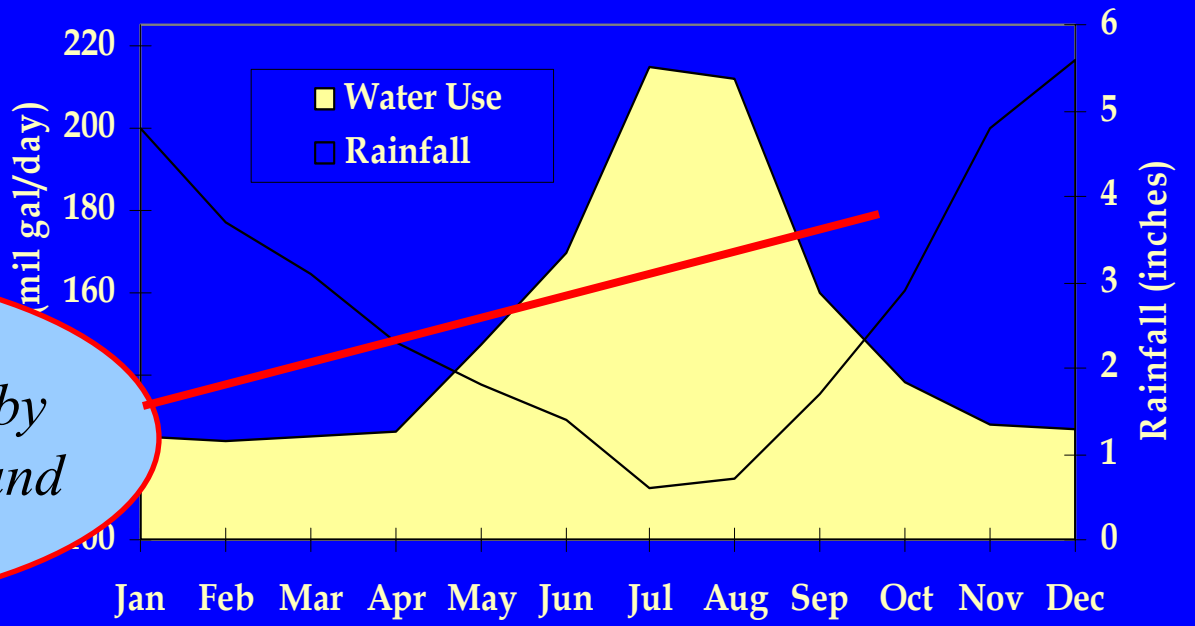
- Incorporate compost into soil to feed soil life

organic matter + soil organisms + time
creates ⇒
soil structure, bio-filtration, fertility, & stormwater detention

Added benefits of soil amendment with compost

- Bio-filtration of urban pollutants
- Improved fertility & plant vigor:
  - less need for fertilizers & pesticides
  - reduced maintenance costs
- Recycling "wastes" (yard waste etc.)
- Reduced summer irrigation needs

Cut long-term watering needs in <u>half</u>, by proper soil preparation and plant selection



Soil Best Management Practices (BMPs)

New Construction

- Retain and protect native topsoil & vegetation (esp. trees!)
  - Minimize construction footprint
  - Store and reuse topsoil from site
  - Retain "buffer" vegetation along waterways
- Restore disturbed soils by tilling 2-4" of compost into upper 8-12" of soil. Rip to loosen compacted layers.

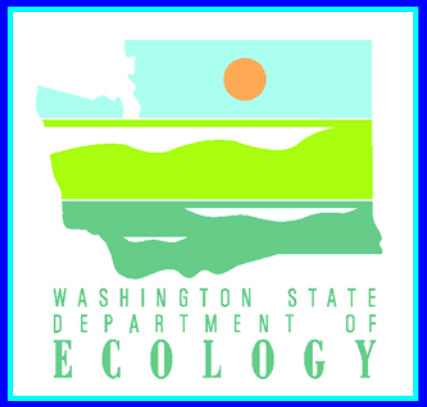
Existing Landscapes

- Retrofit soils with tilled-in compost when re-landscaping
- Mulch beds with organic mulches (leaves, wood chips, compost), and topdress turf with compost
- Avoid overuse of chemicals, which may damage soil life

Benefits of Soil Best Practices

- More marketable buildings
- Better erosion control
- Easier planting, healthier plants, fewer callbacks
- More attractive landscapes, that sell the next job
- Easier maintenance (healthier plants, fewer weeds, less need for water, fertilizer, pesticides)
- Reduced stormwater runoff, with better water quality
- Regulatory compliance (current and upcoming regs)

WA State Guidance on Soil BMPs: DOE *Stormwater Mgmt. Manual for Western WA*



- Equivalency required for NPDES Phase I (big cities, counties, WsDOT)
  - NPDES Phase II (medium-sized cities) by 2009
- Volume V, Chapter 5 - "On-Site Stormwater Mgmt."
  - **BMP T5.13 Post-Construction Soil Quality and Depth**
- Flow model credits for runoff dispersion into amended soils

  www.ecy.wa.gov/programs/wq/stormwater/manual.html
- Seattle Stormwater Code will include equivalent Soil BMP: draft Seattle code for review in 2007; to be adopted in 2008

DOE BMP T5.13
Post-Construction Soil Quality and Depth

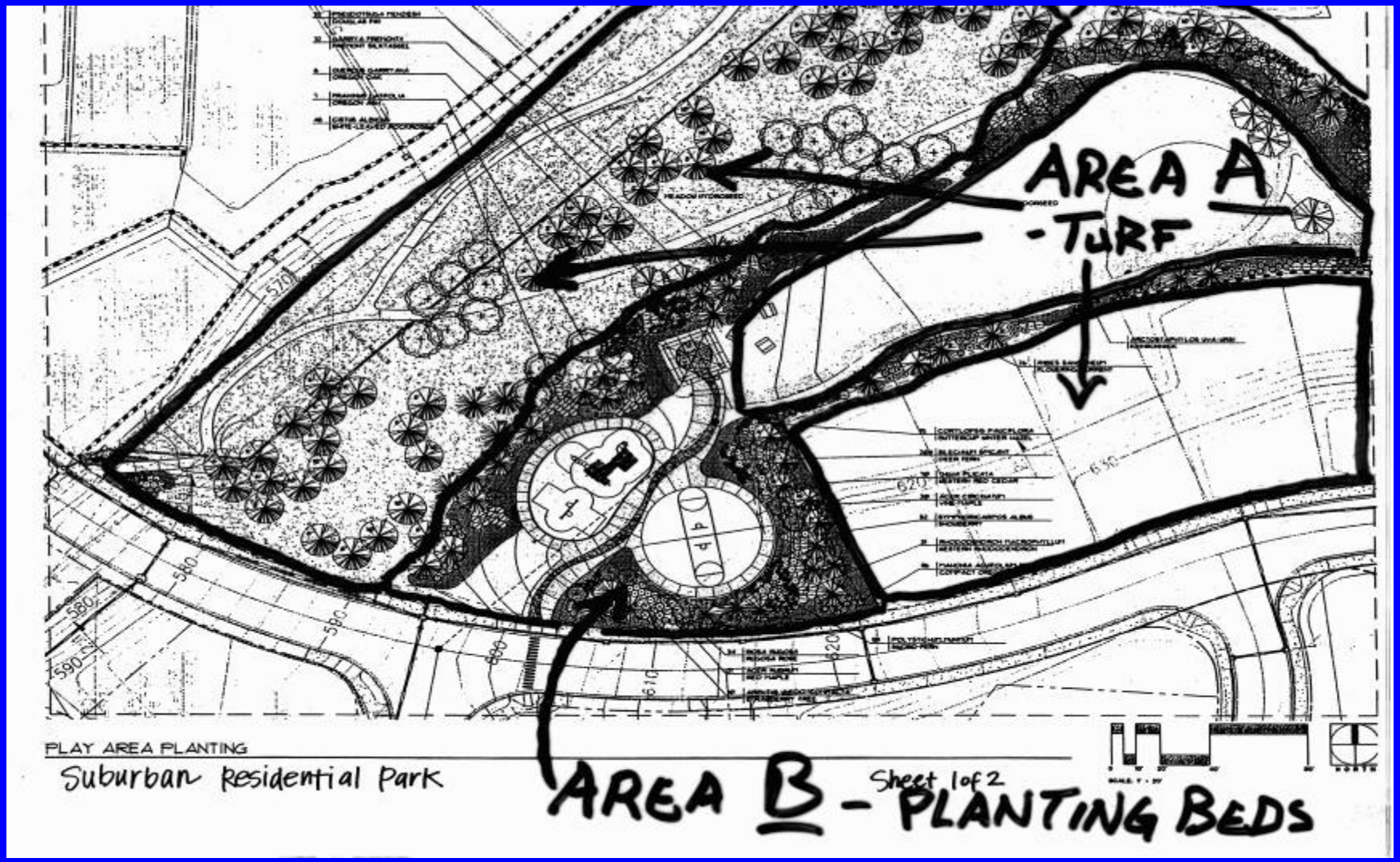
- Retain native soil and duff wherever possible
- All areas cleared and graded require 8 inch soil depth:
  - **Soil organic matter content 10% for landscape beds, 5% for turf areas**, (S.O.M. by loss on combustion method)
    - 10% S.O.M. results from roughly 25-30% compost by volume added to low-organic subsoil.
    - May use native topsoil, incorporate organic amendments into existing soil, or bring in topsoil blend to meet spec
  - pH 6-8, or original pH
  - Subsoil scarified 4 inches below 8-inch topsoil layer
  - Protected from compaction after amendment
  - Mulched after planting, & maintained by leaving organic debris

"Building Soil" Manual for Implementing BMP T5.13

- Manual developed regionally in consultation with experts
- Practical methods to achieve soil standards:
- Develop a "Soil Management Plan" for each site
- Four options for soil management in different areas of site:
  1) Leave native soil & vegetation undisturbed, protect from compaction
  2) Amend existing soil in place (with compost or other organic)
  3) Stockpile site topsoils prior to grading for reapplication
  4) Import topsoil meeting organic matter content standards
- Choose pre-approved or custom calculated amendment rates
- Simple field inspection and verification procedures
- Includes model specs written in CSI and APWA formats
- Available at: www.soilsforsalmon.org

Develop a Soil Management Plan

step 1: Identify areas needing different soil treatments



Soil Management Plan

step 2:
Compute amendment or amended topsoil and mulch needed for each area

sample forms, etc. available at
www.SoilsforSalmon.org

MODEL "SOIL MANAGEMENT PLAN" FOR BMP T5.13

PROJECT INFORMATION **Page # ____ of ____ pages**

Complete all information in this section on page 1; only site address and permit number on additional pages.

Site Address / Lot No.:	
Permit Type:	**Permit Number:**
Permit Holder:	**Phone:**
Mailing Address:	
Contact Person:	**Phone:**
Plan Prepared By:	

ATTACHMENTS REQUIRED (Check off items attached meeting requirements)

___ **Site plan showing, to scale:**
- ___ Areas of undisturbed native vegetation (no amendment required)
- ___ New planting beds and turf areas (amendment required)
- ___ Type of soil improvement proposed for each area

___ **Soil test results (required if proposing custom amendment rates)**

___ **Product test results for proposed amendments**

AREA # ___

PLANTING TYPE	___ Turf ___ Planting Beds	___ Undisturbed native vegetation ___ Other: ________
SQUARE FOOTAGE: ______		
SCARIFICATION ___ Subsoil will be scarified	___ inch scarification needed to achieve finished total 12" loosened depth.	
PRE-APPROVED AMENDMENT ___ Topsoil import ___ Amend with compost ___ Stockpile and amend	___(inches compost or imported topsoil) X 3.1 ____ = cu. yards / 1,000 sq. ft. X___ ,000s) sq.ft. ____ = cubic yards amendment	PRODUCT: ________ QUANT: ______ CU. YDS.
CUSTOM AMENDMENT ___ Topsoil import ___ Topsoil & compost lift ___ Amend ___ Stockpile and amend	Attach test results and calculations. ___(inches organic matter or topsoil import) X 3.1 ____ = cu. yards / 1,000 sq. ft. X___ ,000s) sq.ft. ____ = cubic yards amendment	PRODUCT: ________ QUANT: ______ CU. YDS.
MULCH	____ ,000 sq.ft. X 6.2 ____ = cubic yards mulch	PRODUCT: ________ QUANT: ______ CU. YDS.

TOTAL AMENDMENT/TOPSOIL/MULCH FOR ALL AREAS (total all areas/pages on page)

- ❑ **Product #1:** ________ ❑ **Quantity:** ______ **cu. yds.**
- ❑ **Test Results:** ___ **% organic matter** ___ **C:N ratio <25:1** (<35:1 for native plants) ___ **"moderately" to "very stable"**
- ❑ **Product #1:** ________ ❑ **Quantity:** ______ **cu. yds.**
- ❑ **Test Results:** ___ **% organic matter** ___ **C:N ratio <25:1** (<35:1 for native plants) ___ **"moderately" to "very stable"**
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Date:	**Inspector:**	**Approved:**	**Revisions Required:**
Date:	**Inspector:**	**Approved:**	**Revisions Required:**

COMMENTS: ________

Clearing up the confusion about "% organic"

"% Soil Organic Matter Content" (S.O.M.) in lab soil tests is by loss-on-combustion method

- Most composts are 40-60% organic content by this method

Recommended soil amendment rates (for low-organic soils):

- 5% Soil Organic Matter Content for Turf
  - produced by about 15% compost amendment by volume
- 10% Soil Organic Matter Content for Landscape Beds
  - produced by 25-35% compost amendment by volume

How to Select Compost

Know your supplier!

- Field tests:
  - earthy smell - not sour, stinky, or ammonia
  - brown to black color
  - uniform particle range
  - stable temperature (does not get very hot if re-wetted)
  - moisture content
- Standards & Specs
  - US Compost Council "Seal of Testing Assurance" (STA)
  - State & DOT specs
- Mfr.-supplied info:
  - Meets state std. or USCC STA
  - C:N ratio
  - Weed-seed trials
  - Nutrients, salinity, contaminants
  - Size: "screen", % fines
- Soil/compost lab test info:
  - Nutrients
  - Salinity
  - pH
  - % organic content (OM)

Carbon to Nitrogen ratio of composts

- For turf & most landscapes
  C:N ratio of 20:1 to 25:1 - good nutrient availability for first year of growth (no other fertilizer needed)

- For native plants and trees
  C:N ratio of 30:1 to 35:1, and coarser (1” minus screen)
  - less Nitrogen better for NW natives, discourages weeds
  - for streamside, unlikely to leach nitrogen

Compost Application Methods

Four options for soil management in different areas of site:

- 1) Leave native soil & vegetation undisturbed, protect from compaction
- 2) Amend existing soil in place (with compost or other organic)
- 3) Stockpile site topsoils prior to grading for reapplication
- 4) Import topsoil meeting organic matter content standards

Compost application & incorporation methods:

- Blowing
- Spreading
- Tilling / ripping
- Blending off-site

Blowing & spreading

- Blower trucks

- Various construction grading equipment

- Other equipment : golf course & farm spreaders

Incorporating amendments into soil

- Range of equipment for different-sized sites
- Till in to 8” depth
- If compacted, rip to 12” depth before/while amending

Stockpile site soils & amend, (or import amended topsoil) after road & foundation work

- Allows mass grading
- Can reduce hauling & disposal costs
- Set grade to allow re-addition of topsoil & allow for settling
- Amend to spec offsite
- Spread after concrete work
- Rip in first lift,
  to reduce sub-grade compaction

Erosion Control Compost Applications

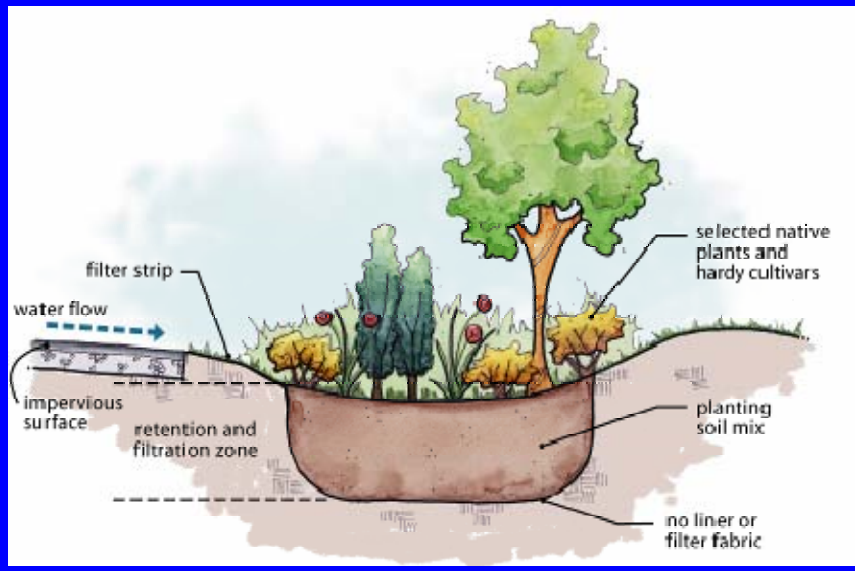
- Compost berms or blankets – slow water, bind surface soil, reduce erosion immediately
- Enhance survival/growth helps to stabilize slopes over long term.

"**Bio-retention" soils** – high infiltration mixes for stormwater swales, planters, and raingardens

- Generally 1/3 compost in coarse sand, few fines, for highest infiltration rates
- Existing soil specs at

www.seattle.gov/util/NaturalSystems

- Revised soil spec coming soon; will be required for flow-control projects in upcoming Seattle stormwater code



Combine methods as needed for best water quality and flow control

WsDOT - Protecting Wetland Area from I-5 Runoff

Soil Amendment: A cost-effective solution for new development

- Much better plant survival = fewer callbacks

- Easier planting

- Can cut irrigation needs by 50% = 3-7 year payback on irrigation savings alone

Selling healthy soil to customers:

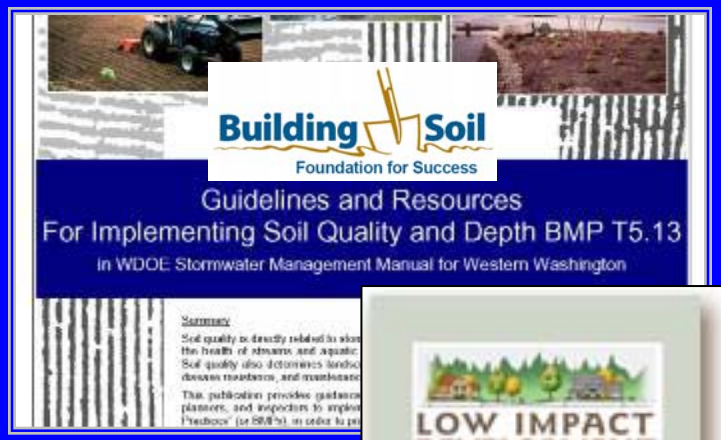
Value to builder/contractor

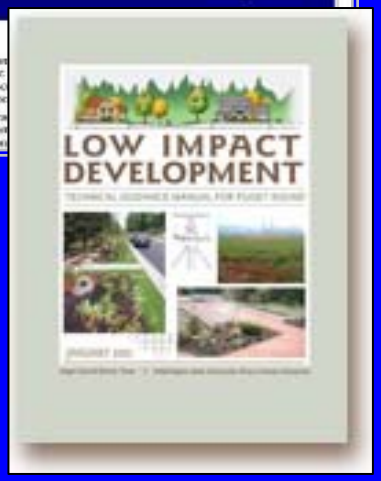
- Less plant loss = fewer callbacks
- Making money on materials and labor
- Quicker planting in prepped soil
- Easier maintenance
- Better appearance sells next job

Sell quality & savings to customer

- Better plant survival/ health/ growth/ appearance
- Lower water bills, easier care
- Reduced chemical needs = better for family health
- Better for salmon: reduces storm runoff, improves water quality

Links to useful soil BMP specifications:





"Building Soil" Guidelines Manual for Implementing WDOE Soil Quality & Depth BMP (includes APWA & CSI specs)
www.soilsforsalmon.org

Puget Sound Action Team, LID Technical Manual
www.psat.wa.gov/Programs/LID.htm

WsDOT "Soil Bioengineering" specs
http://www.wsdot.wa.gov/eesc/design/roadside/sb.htm

Seattle "Natural Drainage Systems" specs
www.seattle.gov/util/NaturalSystems

Soils for Urban Trees

Shane DeWald
Senior Landscape Architect
Seattle Department of Transportation

Structural Soils – where trees meet pavement

Images from
Cornell University
CU-Structural Soil™

www.hort.cornell.edu/uhi
go to Outreach>Structural Soil

Using CU-Structural Soil™ in the Urban Environment

Cornell University

Urban Horticulture Institute
Cornell University
Department of Horticulture
134A Plant Science Building
Ithaca, NY 14853
www.hort.cornell.edu/UHI

Structural Soil Benefits

- Maintains spaces (macro-pores) for air and water, and root growth
- Provides foundation for paving
- Prevents/reduces root heaving of pavement

The Case for CU-Structural Soil™:

Why do we need it, what is it, and how is it used?

Urban trees experience a litany of environmental insults: soil and air pollution, heat loads, deicing salts, and impacts from utilities, vehicles, and buildings. The most significant problem that urban trees face, however, is lack of useable soil volume for root growth, since trees are often an afterthought in city planning and streescape design. (Fig. 1.1)

Fig. 1.1 Tree root ball prior to being planted in a 4' x 5' tree pit in NYC.

Fig. 1.2 Compaction is necessary to create a load-bearing surface on which to lay pavement.

Soil Compaction

Ongoing construction, including sidewalk and road repair, disturbs and compacts soil (Fig. 1.2), crushing macropores (Fig. 1.3). Loss of macropores has three negative consequences, restricted aeration, diminished water drainage, and creating a dense soil that is difficult for roots to penetrate. These effects limit useable rooting space.

Fig. 1.3 Macropores are spaces between soil aggregates that allow water, air and subsequently root growth.

Fig. 1.4 Surface rooting of trees growing in compacted soils

What happens when roots encounter dense, compacted soil?

When roots encounter dense soil, they change direction, stop growing, (Fig 1.5) or adapt by remaining abnormally close to the surface (Fig. 1.4) This superficial rooting makes urban trees more vulnerable to drought and can cause pavement heaving. However, if a dense soil is waterlogged, tree roots can rot from lack of oxygen.

How Structural Soils improve tree health, stability

- Increase soil volume/area accessible to tree roots

image from ***CU-Structural Soil™***

The role of soil volume on tree growth

The soil in urban tree lawns or parks can be improved by amendment or soil replacement. Where soil volume is limited by pavement, tree roots suffer (Fig 1.6). The highly compacted soils required for constructing pavements do not allow root penetration, resulting in the declining trees, all too common in cities. Yet it is precisely these paved areas such as parking lots and streets that most need the mitigating effects of shade trees.

Healthy trees need a large volume of non-compacted soil with adequate drainage and aeration and reasonable fertility. CU-Structural Soil™ meets these needs while also fulfilling engineers' load-bearing requirements for base courses for pavement..

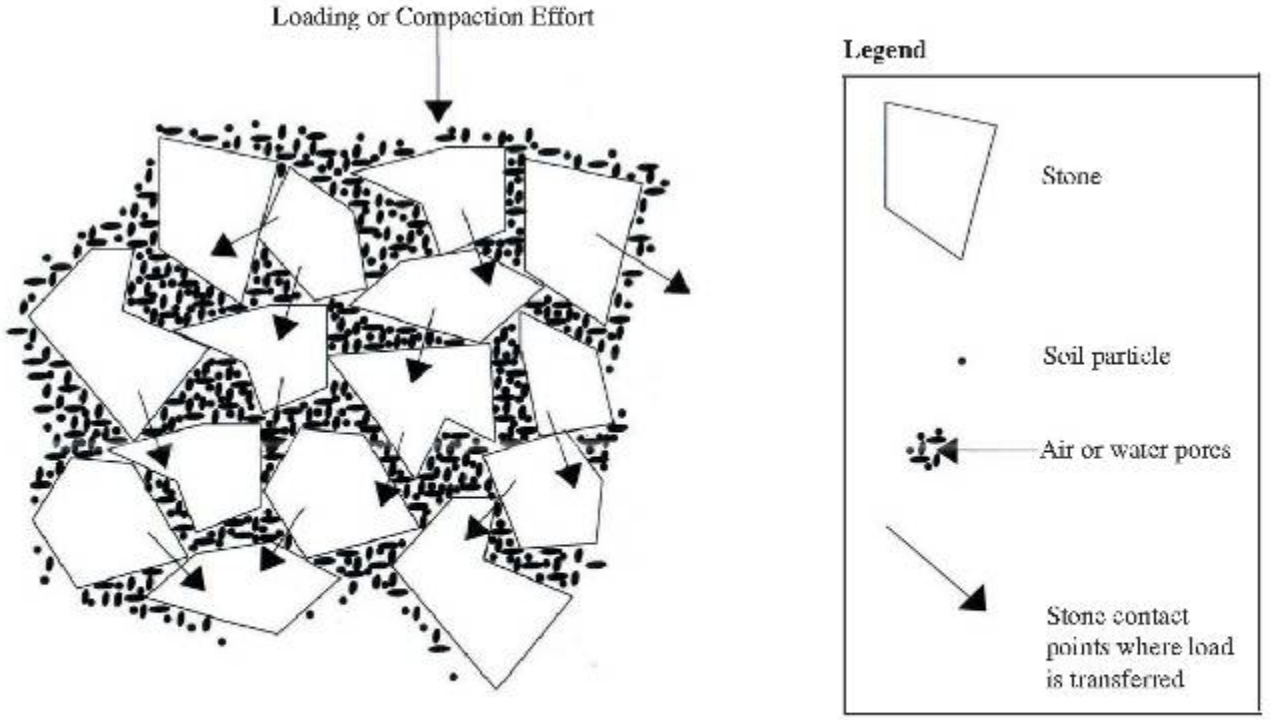


Fig.1.7 Conceptual diagram of CU-Structural Soil™ including stone-on-stone compaction and soil in interstitial spaces used as a base course for pavements.

Structural Soil components

- Angular crushed rock (maximum spaces under load)
- Clay or clay loam (nutrient holding)
- Organic (compost)
- Stabilizers, etc. (proprietary mixes)

image from ***CU-Structural Soil™***

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. 1.7). 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.

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. 1.8). 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.

Fig. 1.8 From upper left, clockwise: uniformly-graded crushed stone of 3/4" - 1 1/2" diameter, pile and close-up; CU-Structural Soil™ after mixing; clay loam.

Street tree installations with CU-Structural Soil™

image from ***CU-Structural Soil™***

Using CU-Structural Soil™ for Street Trees

CU-Structural Soil™ is intended for paved sites to provide adequate soil volumes for tree roots under pavements (Fig. 1.9). It can and should be used under pedestrian mall paving, sidewalks, parking lots, and low-use access roads. The Urban Horticulture Institute is currently conducting trials of its use under turf and porous asphalt to provide more porous parking areas. Research at Cornell has shown that tree roots in CU-Structural Soil™ profiles grow deep into the base course material, away from the fluctuating temperatures at the pavement surface. One benefit of this is that roots are less likely to heave and crack pavement than with conventional paving systems (Fig. 1.10).

Planting a tree into CU-Structural Soil™ is much like conventional planting. If possible, the pavement opening should be expandable (via removable pavers or using a mulched area) for the sake of the anticipated buttress roots of maturing trees (Fig. 1.11). CU-Structural Soil™ should be used at a depth of at least 24" but preferably 36" (Fig.1.12). CU-Structural Soil™ can be used right up to the surface grade where there is a pavement opening that is large enough to allow for tree installation.

Fig.1.9 Installing CU Structural Soil™ in Ithaca, NY in 1997

Fig. 1.10 Sidewalk heaving caused by superficial tree root growth, Ithaca, NY

Fig. 1.11 Lindens in CU Structural Soil™ in Boston, 2002

Typical street tree detail

Fig. 1.12a Example of street tree planting using CU-Structural Soil™ under conventional concrete sidewalk in Brooklyn, NY

image from ***CU-Structural Soil™***

Fig. 1.12 Typical street tree planting using CU-Structural Soil™ under a sidewalk

Root access under pavement

image from ***CU-Structural Soil™***

Trees in Parking Lots and Plazas:

CU-Structural Soil™ may also be used to enlarge a 'tree island' within a parking lot. With a large tree planting area, good, well draining top soil can be used in the island and CU-Structural Soil™ added as an unseen rooting media under the asphalt (Figs. 1.13 - 1.15).

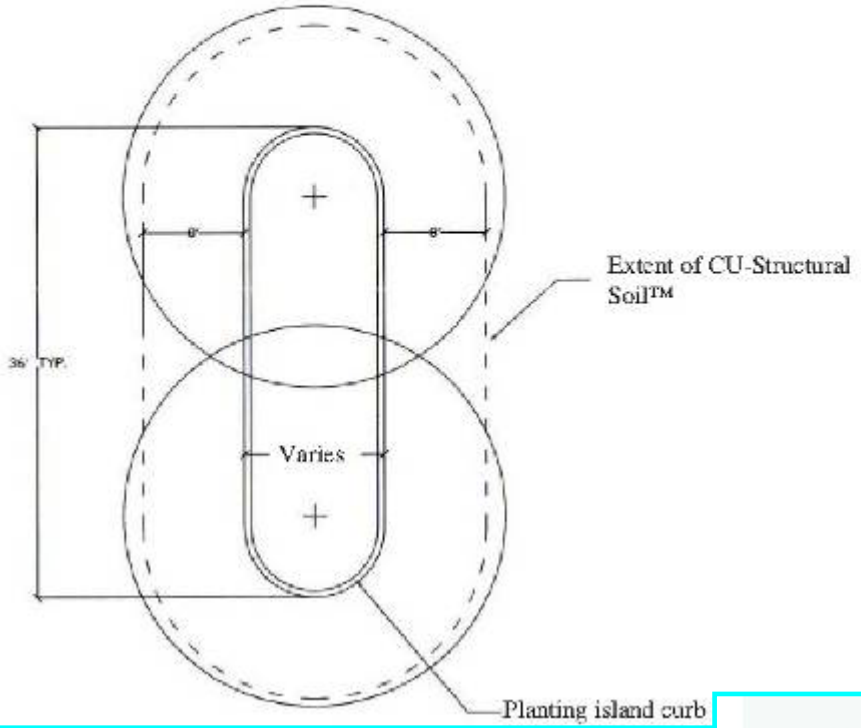
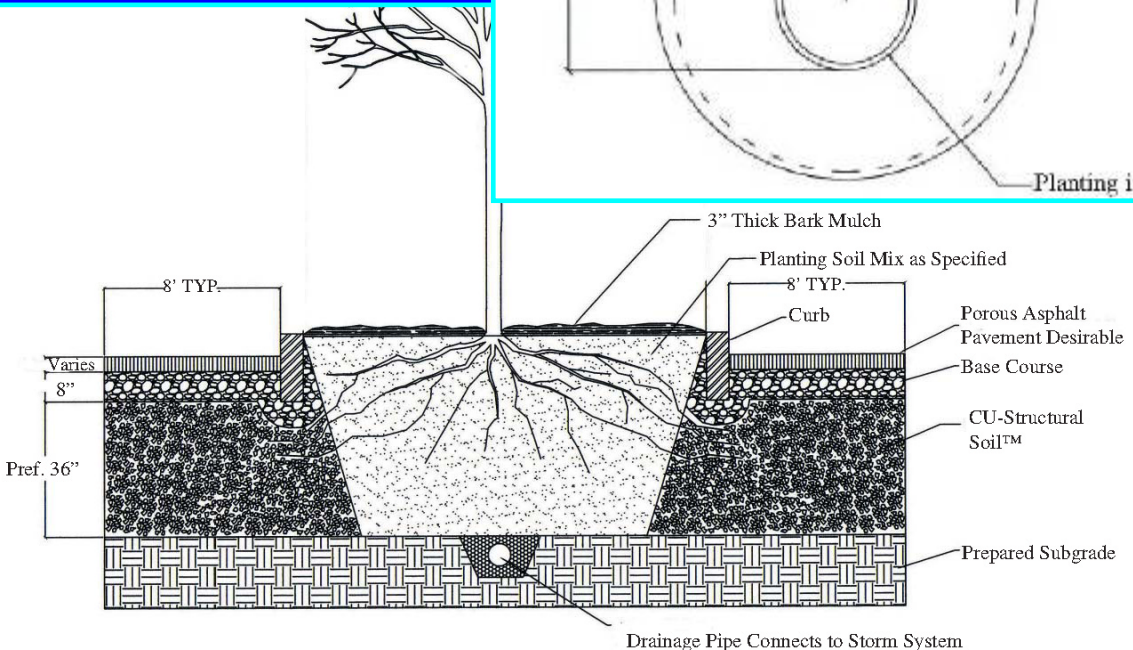


Fig. 1.14 Potential use of CU-Structural Soil™ to enlarge planting islands in parking lots without taking up parking space



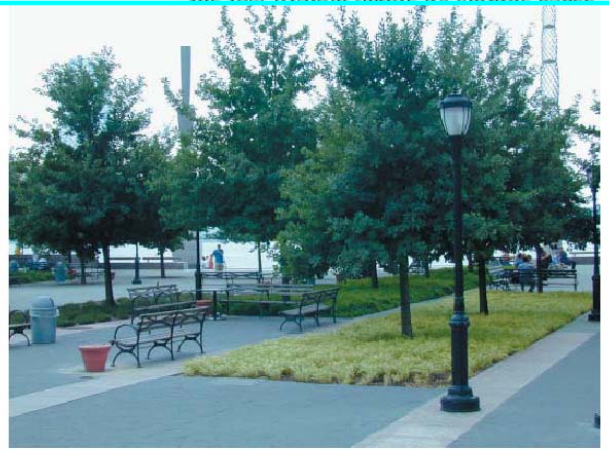


Fig. 1.17 English oaks planted in a plaza at Battery Park City,

Confined sites (such as planters)

Where root space is limited, create root accesses out of planter, under pavements

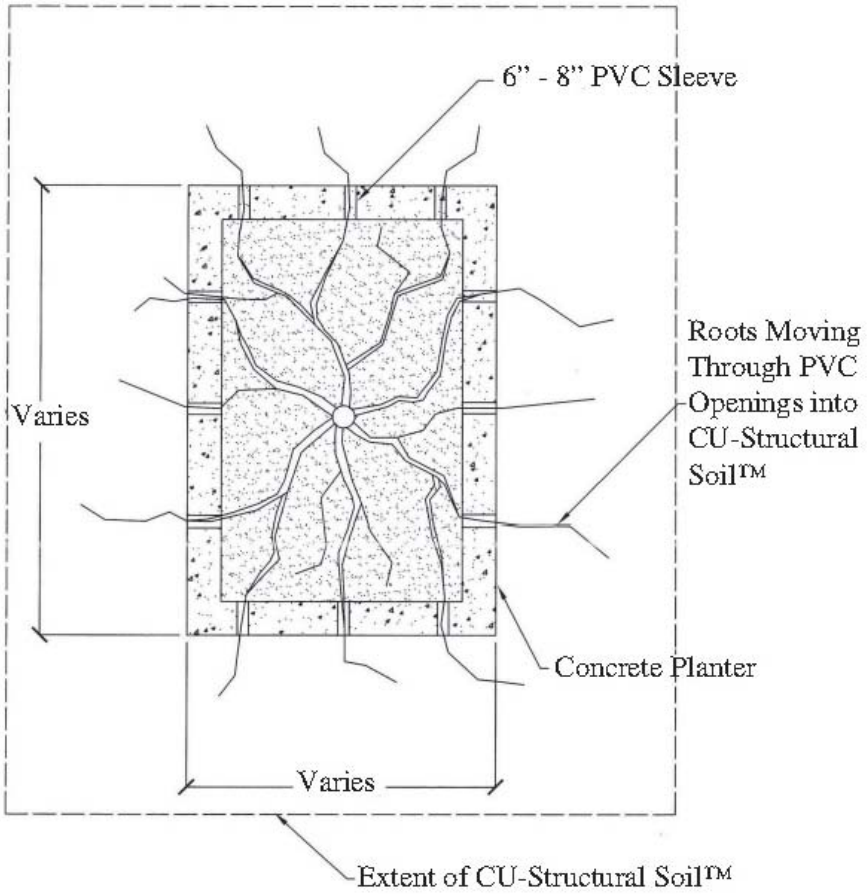


Fig. 1.19 Plan view of limited soil volume planter

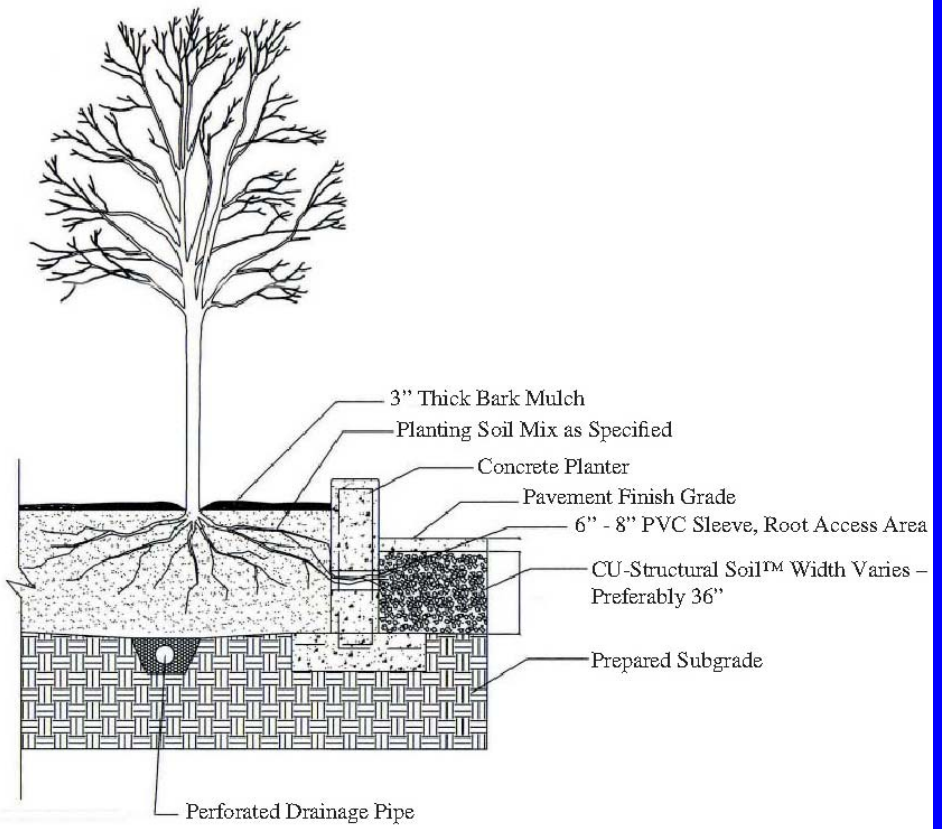


Fig. 1.18 Limited soil volume planter with root access into CU-Structural Soil™ under plaza pavement

image from ***CU-Structural Soil™***

Under permeable pavers

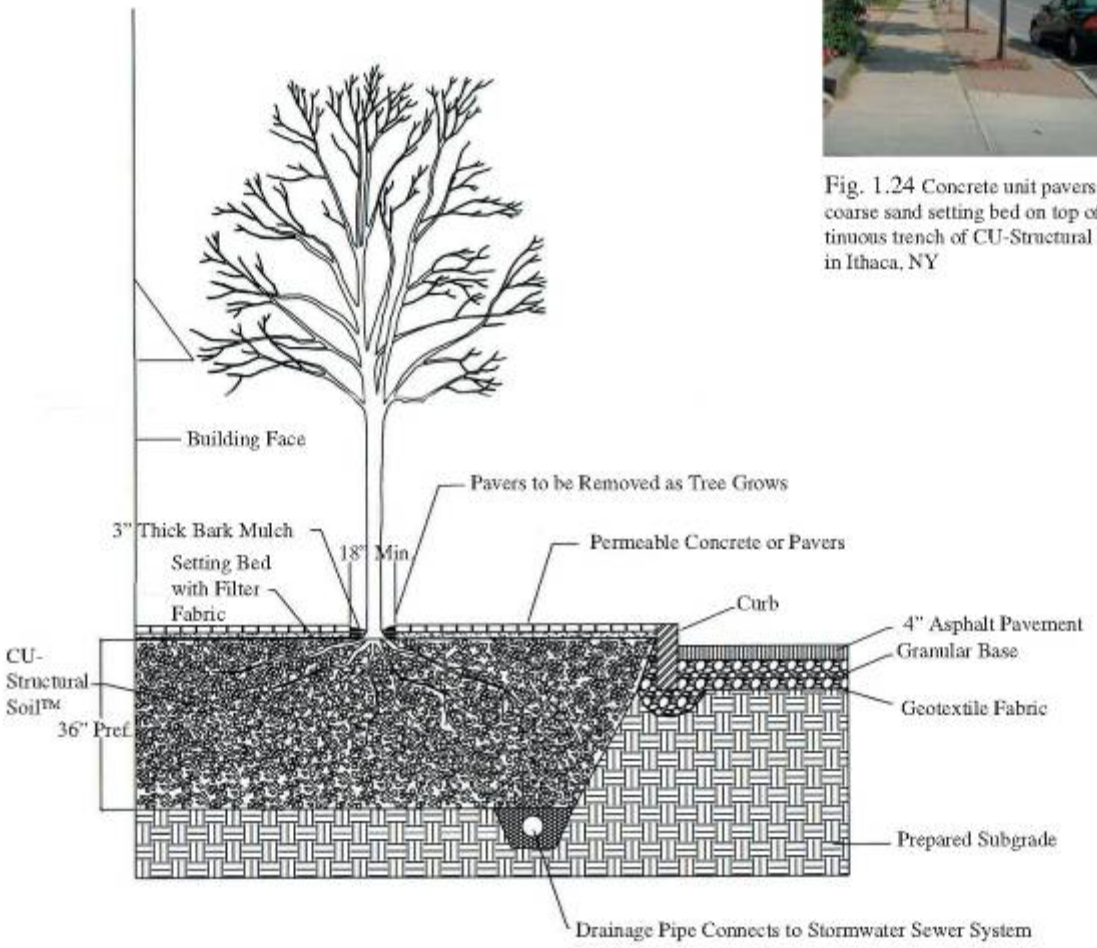
Being tested in Seattle in the "planting strip" area.

image from ***CU-Structural Soil™***

CU-Structural Soil ™ use with permeable pavers

If non-mortared pavers are used, a setting bed of uniformly-graded coarse sand should be used, to a depth specified by paver manufacturer specifications. To discourage rooting in this layer, a geo-textile—one that does not restrict water movement—can be used between this material and the CU-Structural Soil™ (Figs. 1.24 - 1.25).

Fig. 1.24 Concrete unit pavers on a coarse sand setting bed on top of a continuous trench of CU-Structural Soil™ in Ithaca, NY



CU-Structural Soil™ – *requirements for use*

CU-STRUCTURAL SOIL® SPECIFICATIONS

PART 1 - DESCRIPTION AND SPECIFICATION

1.1 GENERAL

A. The work of this section consists of all Structural Soil work and related items as indicated on the drawings or as specified herein and includes, but is not limited to, the following:

1. CU Soil™ is a proprietary material patented by Cornell University (US Patent # 5,849,069). Only licensed producers are allowed to supply this material, meeting the specifications described in this text. For a list of licensed CU-Soil™ producers, call AMEREQ, INC. at 1-800-832-8788.

for more information: **www.hort.cornell.edu/uhi**
go to Outreach>Structural Soil

Other, non-patented structural soil specifications:

- City of Abbotsford, BC
- City of Seattle (based on standards developed by the City of Olympia)

City of Abbotsford Structural Soil:
Short Specification

STRUCTURAL SOIL: A growing medium for trees installed in hard surface situations

1.1 GENERAL:

Structural Soil is in to be utilized where trees are installed in hard surface paved areas where additional growing medium is required to provide adequate space for tree root development. Do not place Structural Soil in planting beds or planting pits

1.2 STRUCTURAL SOIL MATERIAL MIX:

1.2.1 Structural Soil is a consistent even distribution of its components. The ratio of components may vary and may require adjustment to ensure soil volume is adequate to fill all voids in the stone.

1.2.2 The following is a recommended base ratio of materials for structural soil:

cu metre of aggregate stone
.5 cu metre of Growing Medium
kg Stabilizer
Water as required
The amount of water required will vary according to moisture resent in Growing medium.

1.2.3 The stone, growing medium and stabilizer product are to be combined into a homogeneous mixture.

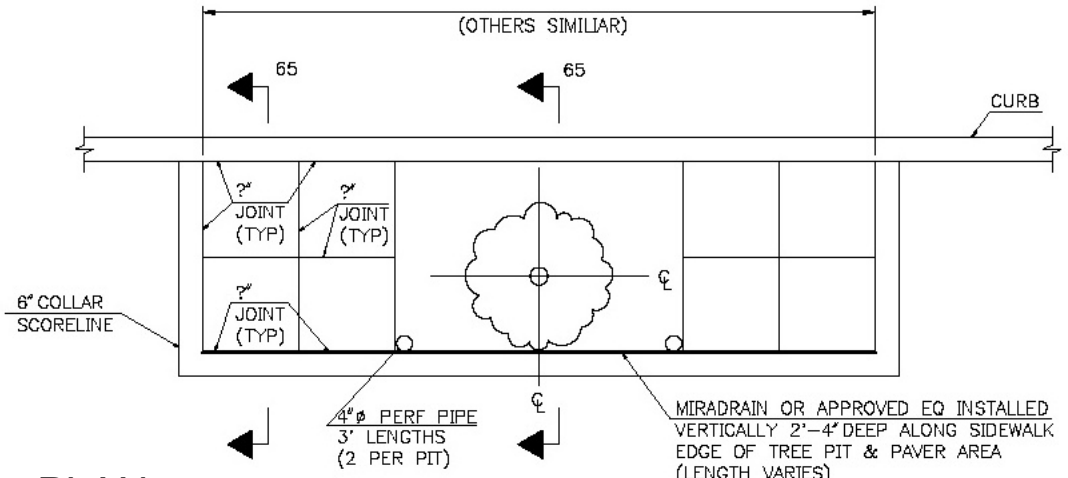
1.3 GROWING MEDIUM:

1.3.1 TABLE ONE: The growing medium within the structural soil mix to meet the requirements of the table following:

TABLE ONE - PROPERTIES OF GROWING MEDIUM FOR 'STRUCTURAL SOIL'	
TEXTURE: Particle size Classes by the Canadian System of Soil Classification	
Gravel: greater than 2 mm - less than 75 mm	0
Sand: greater than 0.05 mm - less than 2 mm	maximum 60%
Silt: greater than 0.002 mm - less than 0.05 mm	maximum 35%
Clay: less than 0.002 mm	maximum 15%
Clay & Silt Combined	maximum 40%
ACIDITY (Ph):	6.0 -7.0
SALINITY: Saturated extract conductivity shall not exceed;	3.0 millimhos/cm at 25°C.
ORGANIC CONTENT: Percent of Dry Weight (%)	8-12%

University Ave. project

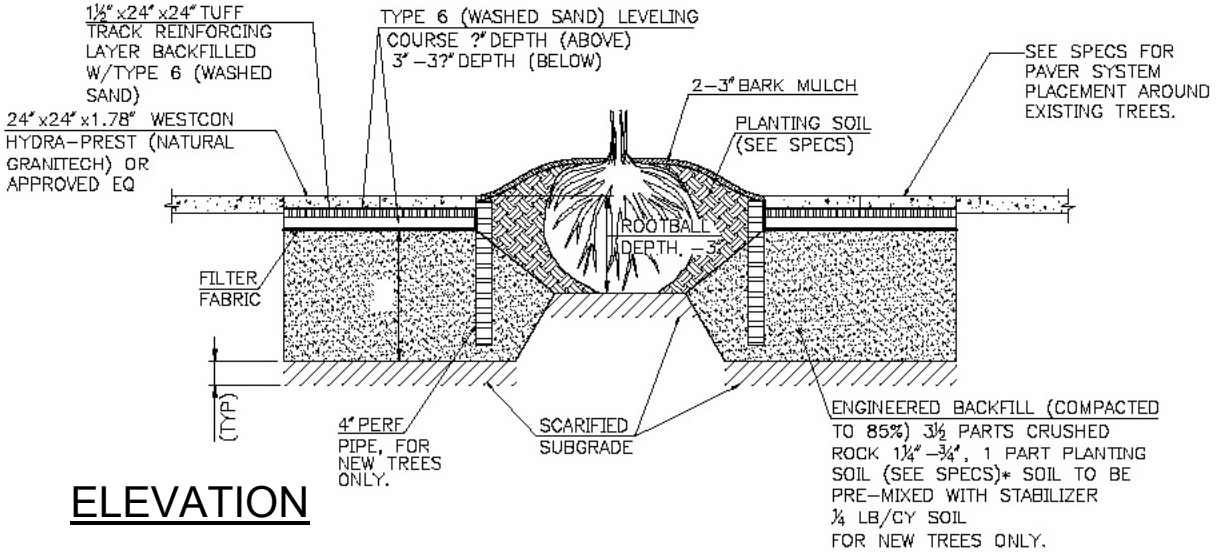
New trees in NDS soils and structural soils



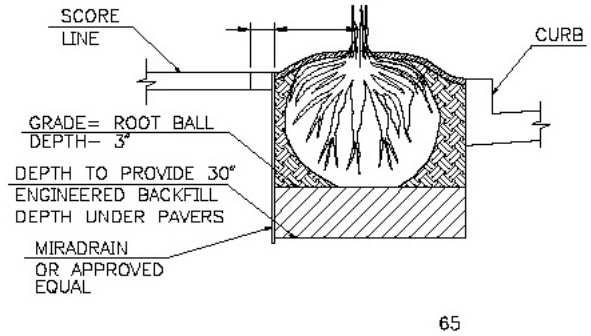
PLAN

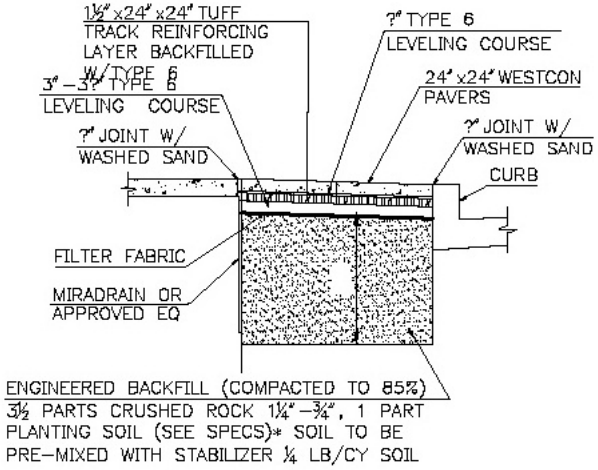
NTS

1
60-65



ELEVATION





Trees fight for their lives in the urban environment

Tree… & Soil preservation

Wrong!

Right – fence to protect roots

- not ideal (grading cuts into root zone at Right of Way line) but a lot better!

Street tree protection measures in action

Tree protection at High Point – fence to protect root zone

Tree protection at High Point

ARTICLE IN PRESS

Pergamon

doi:10.1016/S0264-2751(02)00117-8

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www.elsevier.com/locate/cities

Working proactively with developers to preserve urban trees

Bill Ames*Shane Dewald

Seattle Department of Transportation, Key Tower, Suite 3800, 700 5th Avenue700, Seattle, WA 98104, USA

To address the challenge of preserving street trees as an element of urban project design and construction, two City of Seattle Departments have developed a joint program to provide early communication and guidance, before building plans become firm or permits have been issued.

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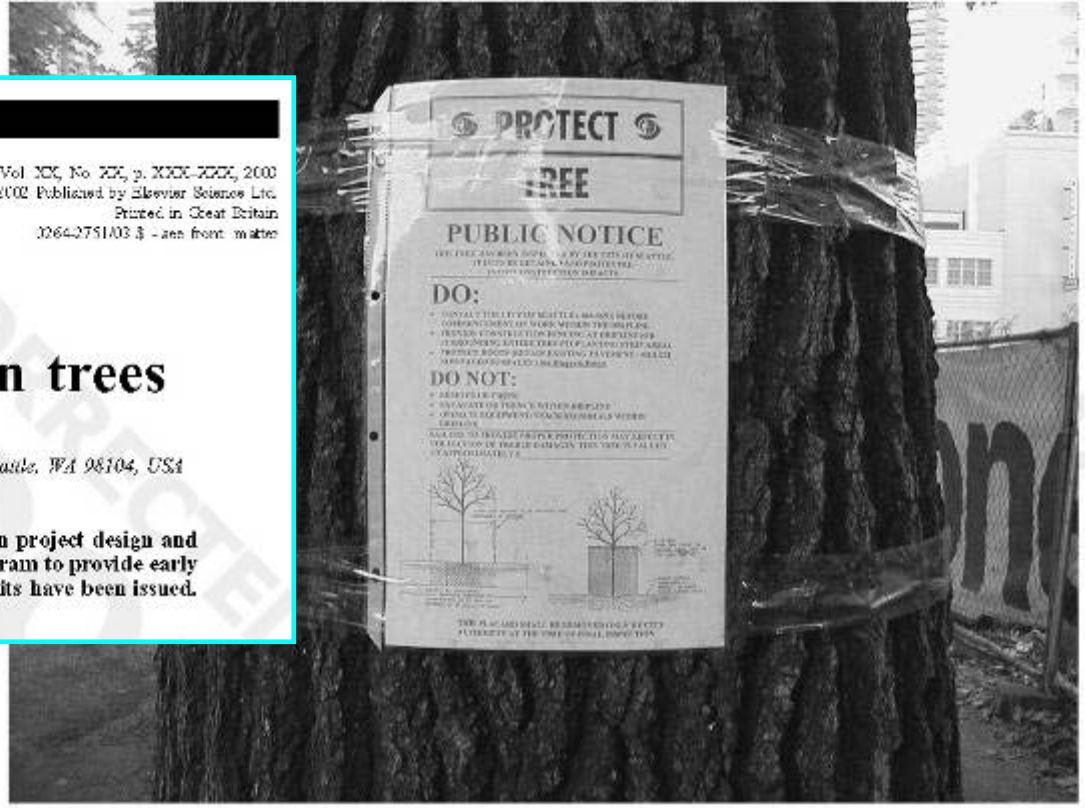

Figure 1 A "PROTECT TREE" placard taped to a street tree at a construction site. Photo by Bill Ames

Article on Seattle's tree preservation methods

Published in *Cities*,
Vol. 20, No.2.P. 95-100, 2003,
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www.elsevier.com/locate/cities

Figure 4 Creating a route for new conduit. Roots exposed by an Air-Spade® and soil removed using a Vactor truck. Photo by Scott D. Baker

Running conduit through roots (carefully!)

A successful project: healthy trees!

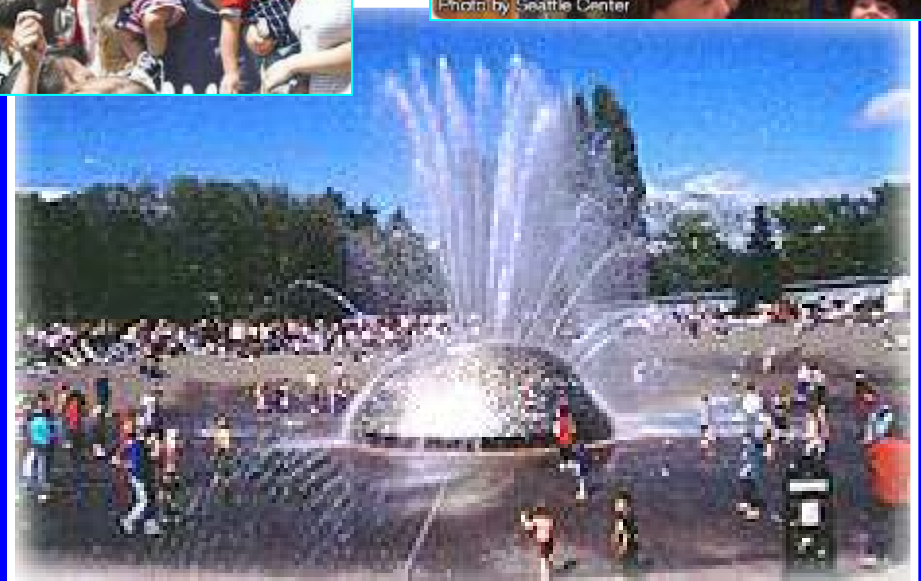
Working proactively with developers to preserve urban trees: Bill Ames and Shane Dewald

successful project completed. A new 16-story building and mature street trees. Photo by Bill Ames

www.seattle.gov/transportation/forestry.htm

Installing and maintaining healthy soils in high-use urban environments

Beth Duncan
Landscape Supervisor
Seattle Center



Value of good soil in the urban environment

- Reduces short and long term maintenance costs
- Improves short and long term plant health and performance
- Weed problems will be reduced
- Water needs often decreased
- Improves aesthetics and supports success of design

Seattle Center relies on soil-building practices

Soil specs

(City standard specifications, used at Seattle Center)

- **Planting soil**

City of Seattle
Standard Specification

February 21, 2001

PLANTING SOIL

The **Planting Soil** shall consist of 67% sandy loam and 33% composted organic material by volume. The **sandy loam** shall meet these specifications, with reasonable variation:

Screen Size	Percent Retained	Percent Passing
6.35mm	5%	95%
#10	15	85
#30	50	50
#60	60	40
#100	80	20
#200	90	10

- **Playfield soil** – intended for growing turf on sports fields or other heavily used turf areas

- "Off the shelf" products

City of Seattle
Standard Specification

February 21,2001

PLAYFIELD SOIL

The **Playfield Soil** mix shall consist of 85% sand and 15% composted organic material by volume.

The **Sand** component shall meet the following specifications within reasonable variations:

Sieve Size	Percent Passing
6.35mm	100%
# 10	85%
# 40	50%
# 60	40%
# 100	20%
# 200	0-10%

How to increase the likelihood of a specified soil actually being installed

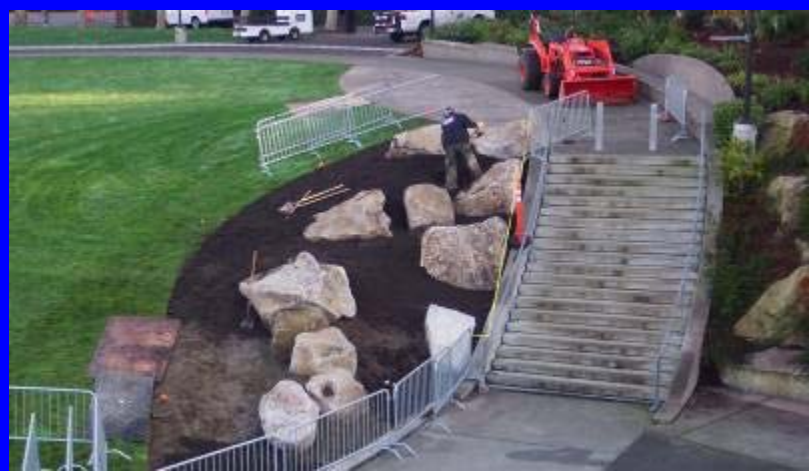
- Use a vendor with a good reputation
- Inspect & test soil sample before delivery
- Have a soil sample tested by an independent soil and plant laboratory, with report explaining the analysis and any recommendations for remedial action
- Make sure recommendations are implemented
- Retain soil sample and visually compare to the delivered product
- Have someone present at time of delivery with knowledge of soils and authority to stop delivery if necessary

Proper drainage & irrigation

- Automated irrigation system critical to the success of most urban landscapes in Seattle (dry summers)
- Conventional spray heads or drip, depending on the situation
- Moisture sensors and/or ET based system is best for efficient water use
- Avoid layering different soil types. Incorporate new materials into existing subsoil.
- Drain lines critical behind retaining or seat walls associated with planters. Also may be necessary at base of slopes and interface between planter beds & turf areas.
- Drain lines are essential in all heavily used turf areas

How to maintain healthy soil

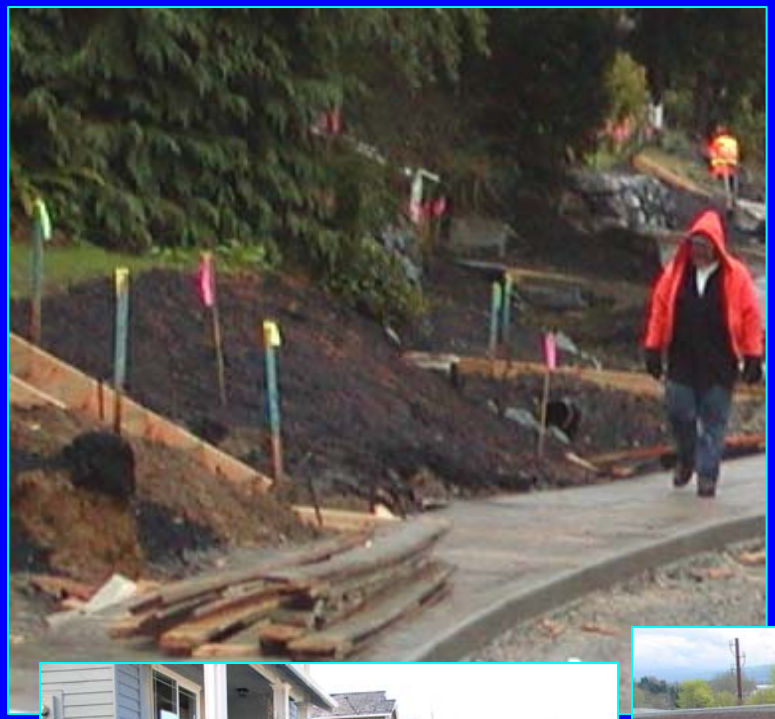
- Yearly soil test is the best practice, to determine pH or nutrient deficiencies
- Occasional (every 1-2 years) fertilization with all-purpose slow release product, if needed. (Trees & shrubs usually just need nutrients slowly supplied by mulch.)
- Organic-based fertilizers are a good choice for slowest release, micronutrients
- Other amendments such as lime may be required infrequently
- Mulch every 1-2 years to restore organic soil component, retain moisture, prevent weeds, and protect root zones of plants
- Mulch planters and tree pits with wood chips, ground bark, or fertile mulch depending on the site, planting regime and aesthetic considerations



Turf soil maintenance

- Yearly soil test is essential on sand-based turf
- Must have a fertilization program based on soil tests
- Use slow release products
- Organic fertilizers and amendments (e.g. fine compost/sand topdressing) should be applied occasionally in very light applications to avoid drainage problems
- Regular aeration essential to maintain vigor of turf (reduce compaction in high traffic areas, improve water and air penetration, rooting depth, & density.

Case Studies: putting soil BMPs to work



Redmond Ridge: current method

- Grade site 12 in. below finish
- Install foundation, along with driveway & walkway rock pads
- Spread 14 in. amended soil mix, (will settle to 12 inches) rip in first lift to mix with subsoil
- Soils blended offsite from native duff plus compost
- Soil organic matter controlled to ~10%, pH and C:N ratio for optimal plant growth

Putting organics to work -SEA Streets

Street Edge Alternative onsite detention demo, Seattle Public Utilities and SDOT.

- "Bioretention" soil mix: 1/3 compost, 2/3 sandy soil
- **98% reduction in runoff.**

www.seattle.gov/util/NaturalSystems/

Broadview Green Grid, Seattle
(right after Oct. 2004 "100 year" storm)

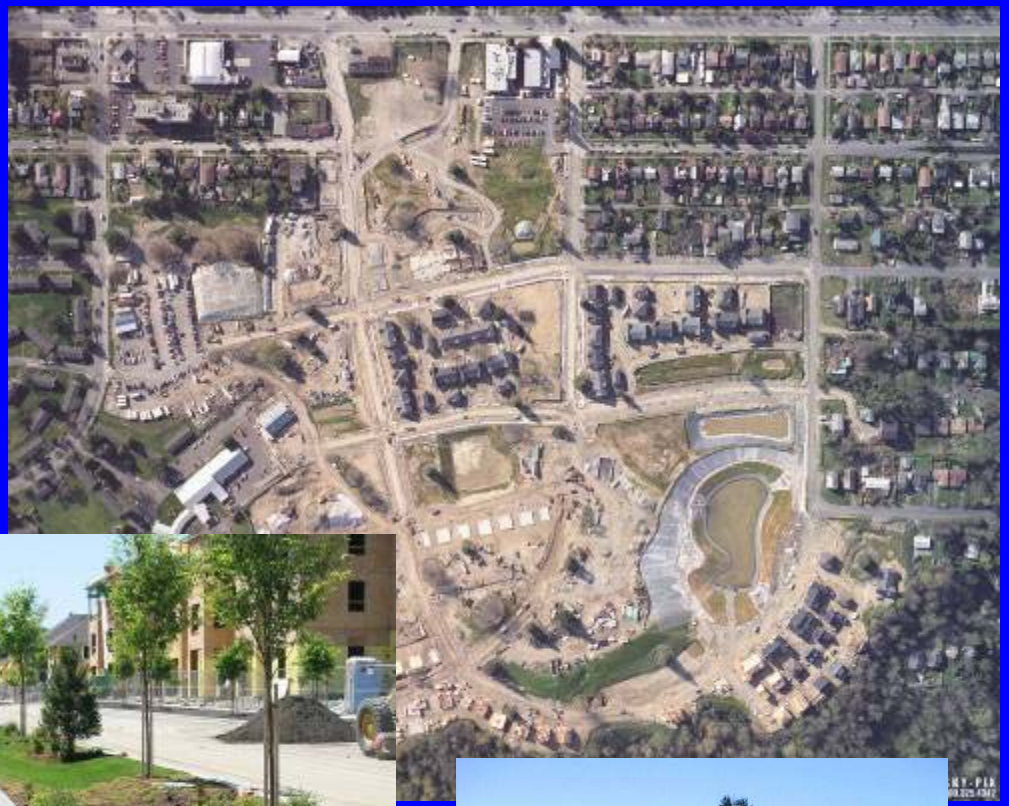
- Compost-amended soil in bio-retention swales
- Erosion control with compost blankets, berms, and socks

Issaquah Highlands – compost use at a big scale

PB
PORT BLAKELY
COMMUNITIES
Integrity and Innovation

High Point, urban redevelopment

- Swale drainage system
- Compost-amended soils on entire site
- Tree preservation



www.seattle.gov/util/NaturalSystems/

WsDOT projects

Chelan: Erosion control & plant establishment on steep site using compost blankets

SR 14, Vancouver:

Coarse compost, blown in

Note erosion where not applied

Photos courtesy of Sandy Salisbury, WSDOT

WsDOT: Erosion control, water quality, successful landscapes with lower mtce. costs

SR 14, Vancouver
Coarse compost, blown in
Note erosion where not applied

Compost amendment,
ripped in

Extensive soil bio-engineering info at:

http://www.wsdot.wa.gov/eesc/design/roadside/sb.htm

WsDOT
10 ft wide compost strip treats stormwater from 2 lanes of roadway

Parameter	Untreated Runoff	Compost filter strip treated	% Concentration Reduction	% Load Reduction
	mg/l			
TDS	52.7	55.5	-5	63
T. Phosphorus	0.089	0.26	-192	-2
COD	73.5	49.6	33	76
TSS	81	23	72	90
	ug/l			
Total Copper	28.18	9.14	68	89
Dissolved Copper	7.85	5.77	26	74
Total Lead	12.62	3.54	72	90
Dissolved Lead	0.5	0.05	90	97
Total Zinc	129.70	31.57	76	91
Dissolved Zinc	64.22	20.71	68	89

TDS=Total Dissolved Solids, COD=Chemical Oxygen Demand, TSS=Total Suspended Solids

Compost

No Compost

Which site is selling the next job?

Building Soil
Foundation for Success

A natural solution – for healthier watersheds, happier customers, and more successful landscapes

- Conserve existing soils and vegetation where possible.
- Restore natural functions in disturbed soils by reducing compaction and using organic amendments.

more information: **www.SoilsforSalmon.org**