The Science of Sustainable Sites

Digging Deeper into Soil

Katie Murphy

University of Washington
College of the Environment
Center for Urban Horticulture

THE SUSTAINABLE SITES INITIATIVE™

An interdisciplinary effort to create voluntary national guidelines and a rating system for sustainable land design, construction and maintenance practices for landscapes of all types, with or without buildings

AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS
ASLA Library & Education Advocacy Fund

Lady Bird Johnson Wildflower center
THE UNIVERSITY OF TEXAS AT AUSTIN

United States Botanic Garden

Guiding Principles

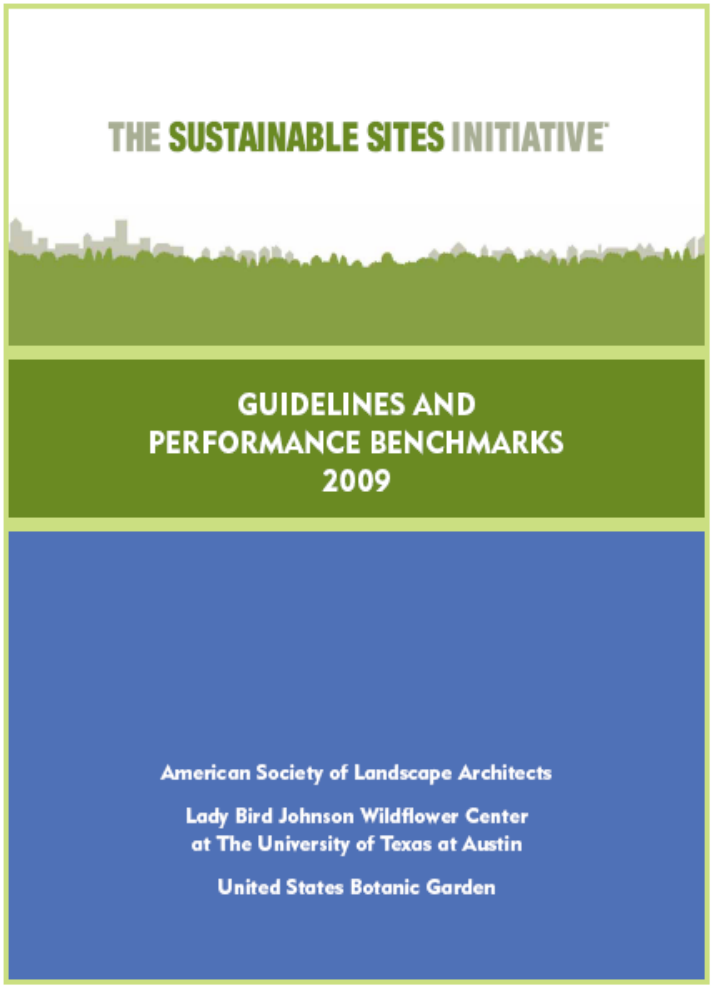
- Do no harm
- Use the precautionary principle
- Design with nature and culture
- Use a decision-making hierarchy of preservation, restoration and regeneration
- Provide regenerative systems as intergenerational equity
- Support a living process
- Use a systems thinking approach
- Use a collaborative and ethical approach
- Maintain integrity in leadership and research
- Instill a sense of stewardship


STOP
STOP

Disturbed soils in urban areas

- Topsoil layer removed
- Compaction
- Subsoil (or worse) fill layers.
- Debris or toxins?

Credit Categories



Site Selection 21 poss. points
Preserve existing resources and repair damaged systems

Pre-Design Assessment and Planning 4 poss. points
Plan for sustainability from the onset of the project

Site Design – Water 44 poss. points
Protect and restore site's processes and systems

Site Design – Soil and Vegetation 51 poss. points
Protect and restore site's processes and systems

Site Design – Materials Selection 36 poss. points
Reuse/recycle and support sustainable production practices

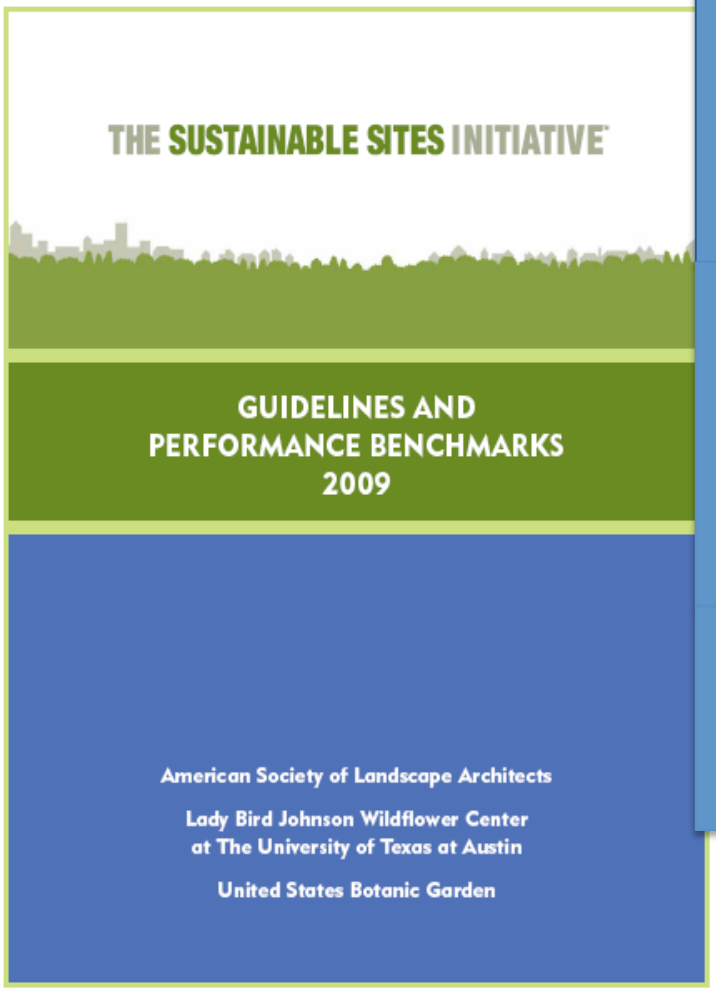
Site Design – Human Health and Well-Being
Build communities and a sense of stewardship 32 poss. points

Construction 21 poss. points
Minimize effects of construction-related activities

Operations and Maintenance 23 poss. points
Maintain the site for long-term sustainability

Monitoring and Innovation 18 poss. points
Reward exceptional performance

Credit Categories



Site Selection 21 poss. points
Preserve existing resources and repair damaged systems

Pre-Design Assessment and Planning 4 poss. points
Plan for sustainability from the onset of the project

Site Design – Soil and Vegetation 51 poss. points
Protect and restore site's processes and systems

Site Design – Materials Selection 36 poss. points
Reuse/recycle and support sustainable production practices

Construction 21 poss. points
Minimize effects of construction-related activities

Maintain the site for long-term sustainability

Monitoring and Innovation 18 poss. points
Reward exceptional performance

Pre-Design Assessment

Pre-Design Assessment and Planning — 4 possible points

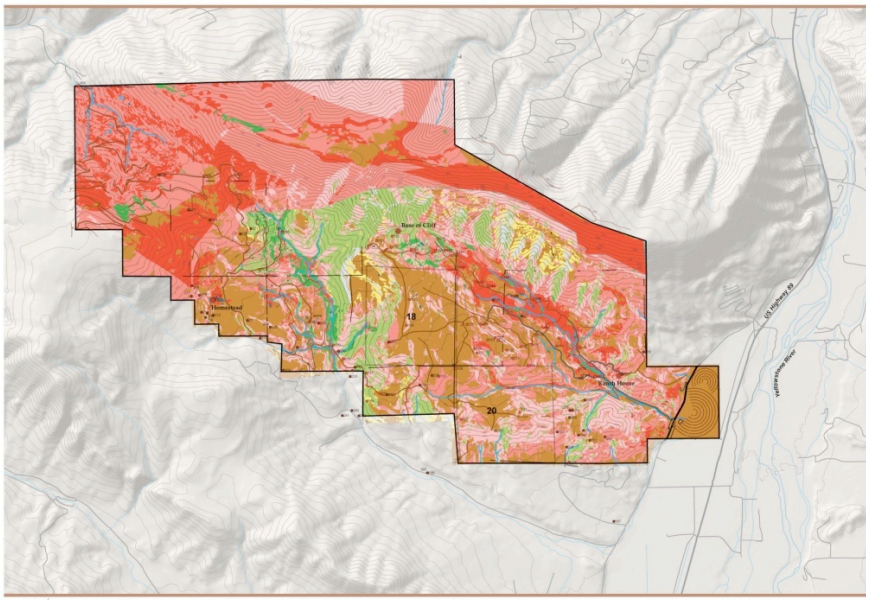
Plan for sustainability from the onset of the project

Prerequisite 2.1: Conduct a pre-design site assessment and explore opportunities for site sustainability

Prerequisite 2.2: Use an integrated site development process

Credit 2.3: Engage users and other stakeholders in site design (4 points)

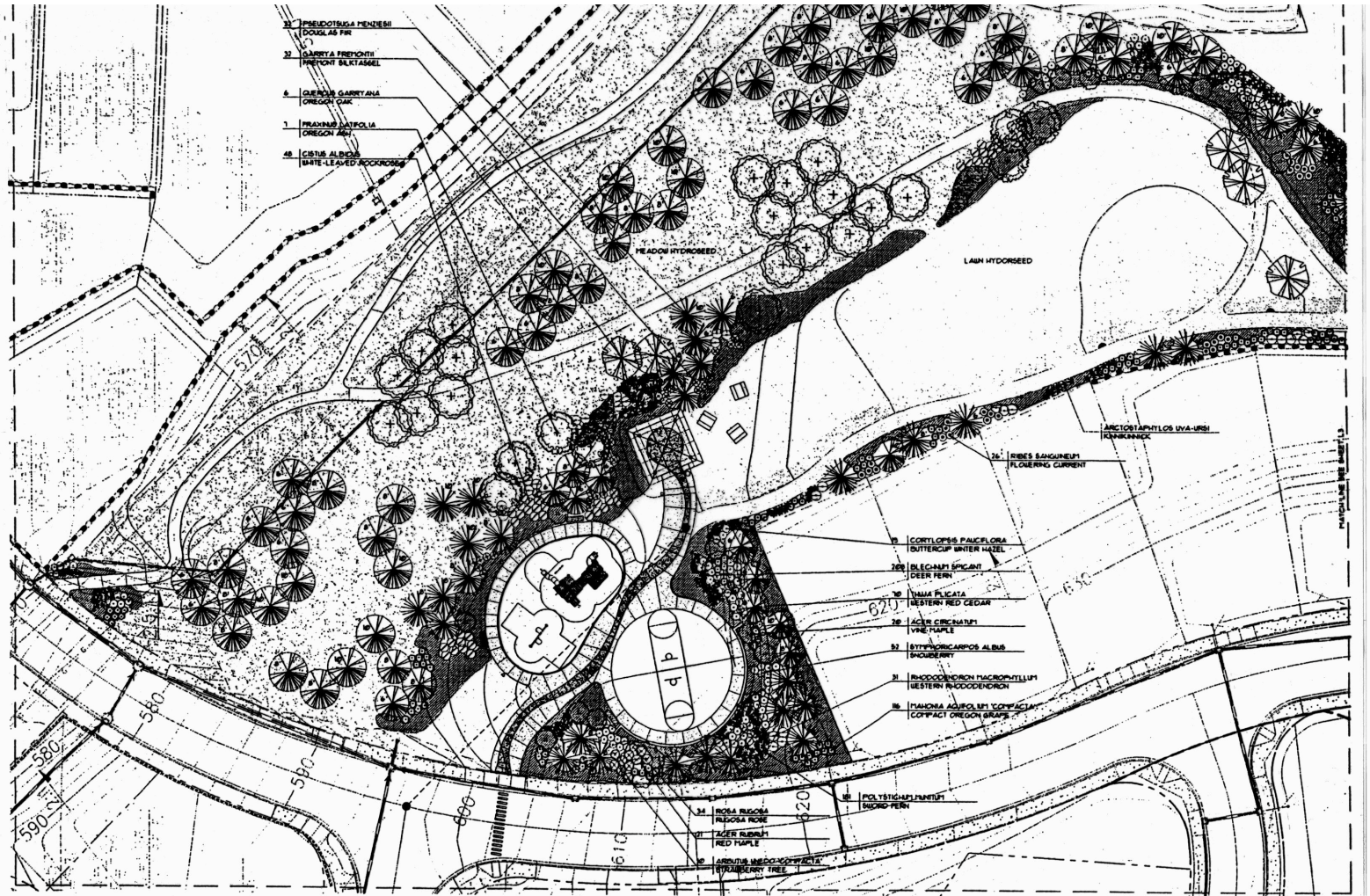
PREREQUISITE 2.1	Conduct a pre-design site assessment and explore opportunities for site sustainability



Development Suitability and Natural Resources Preservation Comparison

Technologies and Strategies:

- Use an integrated design team to thoroughly assess the site
- Consider sustainable design options linked to credit options
- Use SITES worksheet to ensure adequate coverage



PLAY AREA PLANTING

Suburban Residential Park

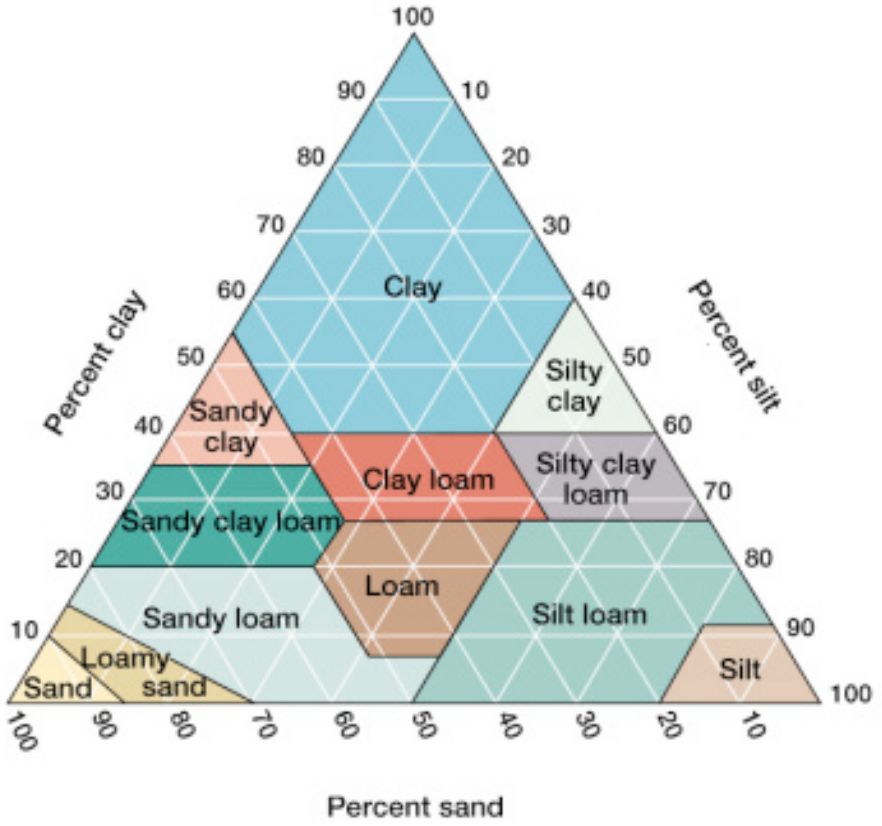
Sheet 1 of 2

Include a Soil Test !

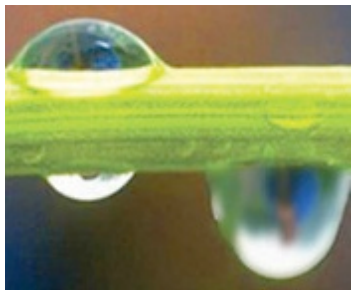
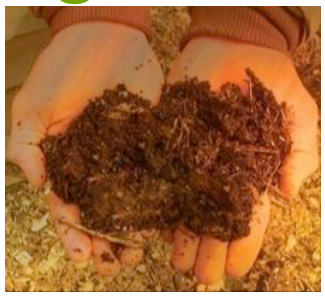
- pH
- % organic matter
- Extractable Nutrients: P, K, Ca, Mg, Fe, Mn, Zn, Cu, B
- Extractable Heavy Metals: Pb, Cd, Ni, Cr
- Extractable Aluminium
- Cation Exchange Capacity

Other Useful Soil Tests

- Soil Texture
- Total Nitrogen
- Total C, H, N
- Bulk Density



Site Design – Soils and Vegetation


Site Design—Soil and Vegetation

51 possible points

Protect and restore processes and systems associated with a site's soil and vegetation

Prerequisite 4.1: Control and manage known invasive plants found on site

Prerequisite 4.2: Use appropriate, non-invasive plants

Prerequisite 4.3: Create a soil management plan

Credit 4.4: Minimize soil disturbance in design and construction (6 points)

Credit 4.5: Preserve all vegetation designated as special status (5 points)

Credit 4.6: Preserve or restore appropriate plant biomass on site (3–8 points)

Credit 4.7: Use native plants (1–4 points)

Credit 4.8: Preserve plant communities native to the ecoregion (2–6 points)

Credit 4.9: Restore plant communities native to the ecoregion (1–5 points)

Credit 4.10: Use vegetation to minimize building heating requirements (2–4 points)

Credit 4.11: Use vegetation to minimize building cooling requirements (2–5 points)

Credit 4.12: Reduce urban heat island effects (3–5 points)

Credit 4.13: Reduce the risk of catastrophic wildfire (3 points)

PREREQUISITE 4.3	Create a soils management plan

Technologies and Strategies:

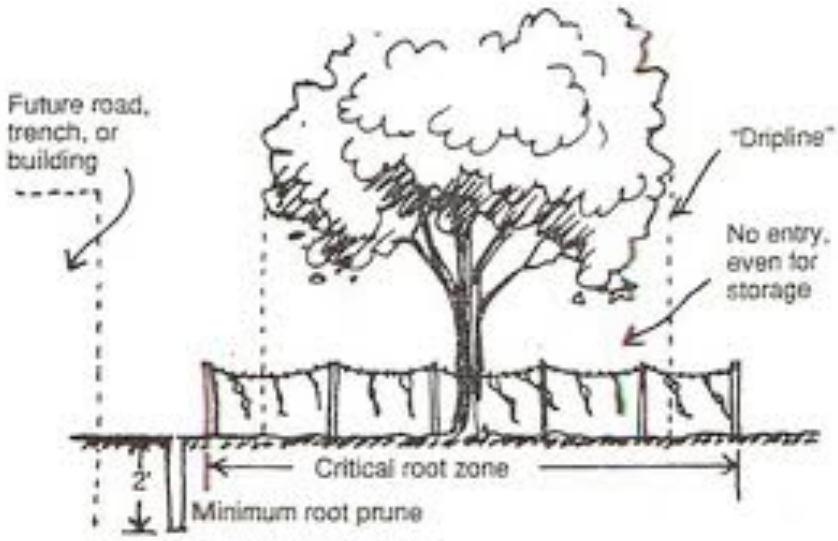
Develop and communicate to construction contractors a SMP prior to construction to:

- limit disturbance
- assist soil restoration efforts
- define the location and boundaries of all soil and vegetation and protection zones

Vegetation and Soil Protection Zones

- Construction impacts will not decrease the functionality of the protected zone
- VSPZ shall be protected with a fence or other secure boundary
- All construction personnel shall be educated about the VSPZ and the CONSEQUENCES of not respecting these areas
- VSPZ can encompass a single tree or a plant community and it's associated soils
- No more than 10% of the area shall contain minimal impact development such as a trail, picnic area or boardwalk – BE CAREFUL HERE!!!
- Provide ongoing maintenance and monitoring of these areas for long term success

We Protect Trees



Model SOIL MANAGEMENT PLAN for BMP T5.13

(available as MS Word file at www.SoilsforSalmon.org)

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

Complete all information 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 required items that are attached to this plan*)

___ **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 #_____ (*should match Area # on Site Plan*)

PLANTING TYPE ___ Turf ___ Planting Beds	___ Undisturbed native vegetation ___ Other: _____	
SQUARE FOOTAGE OF THIS AREA: _____ square feet		
SCARIFICATION ___ Subsoil will be scarified	___ inches (depth) of scarification needed to achieve finished total 12" loosened depth.	
PRE-APPROVED AMENDMENT METHOD: ___ Topsoil import ___ Amend with compost ___ Stockpile and amend (____ cu. yds. stockpiled)	____inches of compost or imported topsoil applied X 3.1 (*conversion factor, inches to cubic yards*) _____= cu. yards per 1,000 sq. ft. X ___ ,000s sq.ft. in this area ____ = cubic yards of amendment → → → → → (*needed to cover this area to designated depth*)	PRODUCT:_____ _____ QUANTITY:_____CU. YDS.
CUSTOM AMENDMENT ___ Topsoil import ___ Topsoil & compost lift ___ Amend ___ Stockpile and amend (____ cu. yds. stockpiled)	**Attach test results and calculations.** ____ inches organic matter or topsoil import X 3.1 _____= cu. yards / 1,000 sq. ft. X ___ ,000s sq.ft. in this area ____ = cubic yards of amendment → → → → →	PRODUCT:_____ _____ QUANTITY:_____CU. YDS.
MULCH	___ ,000 sq.ft. X 6.2 (*conversion, to give 2 inch mulch depth*) ____ = cubic yards of mulch → → → → → →	PRODUCT:_____ QUANTITY:_____CU. YDS.

TOTAL AMENDMENT/TOPSOIL/MULCH FOR ALL AREAS (*complete on page 1 only, totaling all areas/pages in this Plan*)

❑ **Product #1:**_____	❑ **Quantity: _____cu. yds.**
❑ **Test Results: ___ % organic matter ____C:N ratio <25:1** (except mulch, or <35:1 for native plants)	**____ "stable"** (yes/no)
❑ **Product #2:**_____	❑ **Quantity: _____cu. yds.**
❑ **Test Results: ___ % organic matter ____C:N ratio <25:1** (except mulch, or <35:1 for native plants)	**____ "stable"** (yes/no)
❑ **Product #3:**_____	❑ **Quantity: _____cu. yds.**
❑ **Test Results: ___ % organic matter ____C:N ratio <25:1** (except mulch, or <35:1 for native plants)	**____ "stable"** (yes/no)

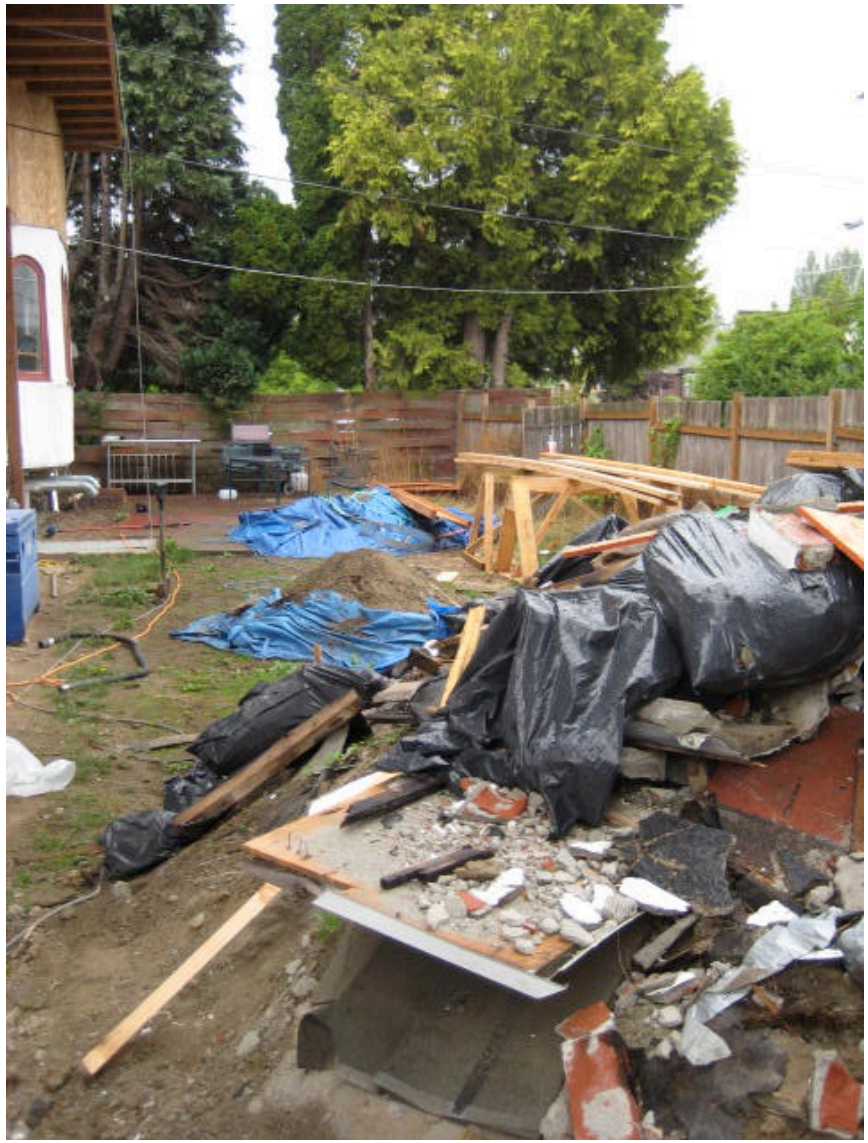
Date:	**Inspector:**	**Approved:**	**Revisions Required:**
Date:	**Inspector:**	**Approved:**	**Revisions Required:**

COMMENTS:

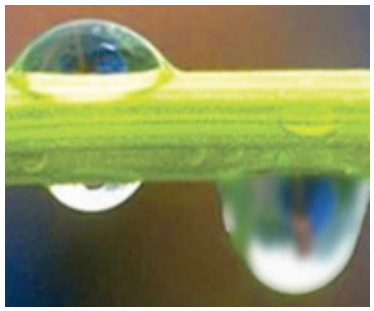
Soil Testing can help with Site Sustainability

- Over fertilizing can lead to nutrient runoff
- Too much compost or mulch can suffocate existing vegetation
- Calculating from a real baseline can save time and money

NO SOIL MANAGEMENT PLAN!!!



Site Design – Materials Selection





Site Design—Materials Selection 36 possible points

Reuse/recycle existing materials and support sustainable production practices

Prerequisite 5.1: Eliminate the use of wood from threatened tree species

Credit 5.2: Maintain on-site structures, hardscape, and landscape amenities (1–4 points)

Credit 5.3: Design for deconstruction and disassembly (1–3 points)

Credit 5.4: Reuse salvaged materials and plants (2–4 points)

Credit 5.5: Use recycled content materials (2–4 points)

Credit 5.6: Use certified wood (1–4 points)

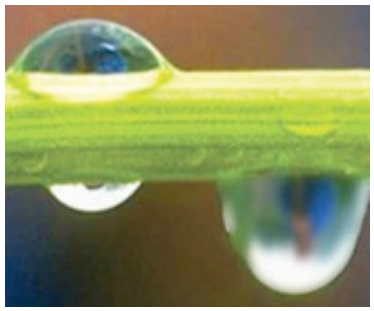
Credit 5.7: Use regional materials (2–6 points)

Credit 5.8: Use adhesives, sealants, paints, and coatings with reduced VOC emissions (2 points)

Credit 5.9: Support sustainable practices in plant production (3 points)

Credit 5.10: Support sustainable practices in materials manufacturing (3–6 points)

Site Design – Materials Selection





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Credit 5.7: Use regional materials (2–6 points)

Credit 5.8: Use adhesives, sealants, paints, and coat

Credit 5.9: Support sustainable practices in plant pro

Credit 5.10: Support sustainable practices in materia

Use these criteria when selecting topsoil, soil amendments and fertilizers. Buy from local sources when possible

Construction

Minimize the Effects of Construction Related Activities

- Create and Implement Erosion, Sedimentation and Pollution Control Measures
- Prevent loss of soil by storm water runoff or wind erosion
- Prevent polluting the air with dust and particulate matter
- Prevent runoff and infiltration of other pollutants from the construction site such as solvents, hazardous chemical runoff, sealants – DISPOSE OF PROPERLY

Minimizing Soil Loss

- Use compost blankets, berms and socks

Construction

Restore Soils Disturbed during Construction

- If soil reserved for later use it must be used for the same purpose
- Add organic matter for optimal plant growth and water retention
- Amend at least the top 12” of soil with organic matter
- Ensure that bulk density (soil compaction) does not inhibit plant growth

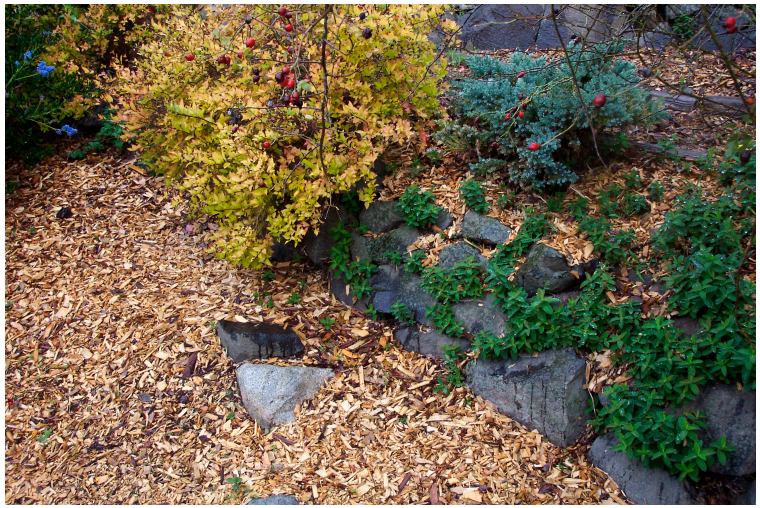
Organic matter additions

Know your source!

- Earthy smell - not sour, stinky, or ammonia
- Brown to black color
- Uniform particle range
- Stable temperature (does not get very hot if re-wetted)
- Not powdery or soaking wet

Mulches

- Retains soil moisture
- Helps moderate soil temperature
- Feeds the soil nutrient pool
- Helps prevent some weed germination



Construction

Restore Soils from previous development

- Extra credit for restoring soil functions on site
- Contribute to Soil Regeneration
- Increase soil functional area for increased healthy plant growth
- Many extra points given for soil and habitat restoration in the Sustainable SITES framework

Sustainable Sites Initiative Summary

- Conduct a thorough site analysis to guide construction and restoration practices
- Identify Vegetation and Soil Protection Zones
- Communicate all goals and procedures to construction contractors and crew
- Restore soil disturbed during construction
- Restore soils disturbed in previous development

Current Soil Research

Method of Soil Evaluation developed in Torino, Italy at the Università di Torino

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A method for soil environmental quality evaluation for management and planning in urban areas

Borut Vrščaj[a,b,*], Laura Poggio[a], Franco Ajmone Marsan[a]

[a] Università di Torino, Dipartimento di Valorizzazione e Protezione delle Risorse Agroforestale, (DI.VA.P.R.A.), settore Chimica Agraria, Via Leonardo da Vinci 44, 10095 Grugliasco, Torino, Italy

[b] Agricultural Institute of Slovenia, Centre for Soil and Environment, Hacquetova 17, SI1001 Ljubljana, Slovenia

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ABSTRACT

Soil represents a complex medium, which makes it difficult to evaluate its quality. In the past, soil quality evaluation was biased towards agricultural production rather than for purposes related to the broad range of functions and services that it performs. Soil function and soil quality in the urban environment differ due to the different needs and roles of soil within the diversity of urban land uses. The quality of urban soil should be evaluated to support public services for good environmental quality management. Planners should also adjust their decisions towards more sustainable urban design. Simple and applicable soil quality evaluation methods accompanied by an operations toolkit that could be used by laypeople are needed.

This paper discusses soil functions, soil quality indicators, pedotransfer functions, and urban soil quality. It presents an urban soil quality evaluation method for different land uses within one particular evaluation system. The calculation of three one-value measures of soil quality are introduced: index of soil quality (expresses soil quality/suitability for a particular land use), soil environmental quality index (environmental value of soil) in terms of performing the crucial ecological functions of soil, and land use change index (land use planning impact assessment on soil resources). The use of the method is described in two procedures: urban soil quality control and soil evaluation for urban planning.

1. Introduction

Soil is a vital natural resource which performs key environmental, economic, and social functions. It is non-renewable within human time-scales. It develops slowly and changes gradually over time, showing great spatial variability. Soil resources are under increasing pressure and its quality is decreasing. Erosion, a decline in organic matter content and biodiversity, contamination, sealing, compaction, salinisation, and landslides have been identified as the main threats to soil (Andrews and Carroll, 2002; Commission of the European Communities [EC], 2002). Of these threats, sealing and contamination predominate in urban and adjacent areas. Urban sprawl and land consumption is recognised as one of the major threats to soil in Europe.

Urban planning practices should integrate soil quality evaluation procedures to achieve rational urban planning with regards to soil consumption and to ensure less destructive methods with regards to the capacity of the soil to perform its environmental functions. To achieve effective management of the quality of the urban ecosystem, it is important to develop soil quality evaluation methods adapted for use by laypeople. The methods should facilitate effective soil evaluation, and enable planners to recognise the environmental quality of soil, its properties, spatial location, and extent in urban and suburban areas. The outputs of the methods should be developed to the level where they can be easily integrated in existing planning procedures and used in local communities with little adaptation by local experts. The application of the method should yield information applicable to actions that will be required by national and forthcoming European legislation.

The aim of this paper is to present a method for the evaluation of soil quality in city environments to achieve: (i) adequate performance of environmental functions of soil in cities, (ii) healthier environmental and pleasant living conditions for citizens; and (iii) more sustainable spatial planning and development of cities. An additional, but still important, goal is to contribute information that will help bridge the communication gap between soil scientists, urban planners, and decision makers.

* Corresponding author at: Agricultural Institute of Slovenia, Centre for Soil and Environment, Hacquetova 17, SI1001 Ljubljana, Slovenia. Tel.: +386 1 2805290.
E-mail address: Borut.Vrscaj@kis.si (B. Vrščaj).

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- This method takes many soil quality indicators into consideration and gives soil a ‘report card’
- Urban planners and gardeners can understand the soils they have and try to fit land uses to those soils
- It is a way to conserve ‘good soils’ and avoid potentially harmful land uses on degraded soils

Appendix D. Predefined set of required SQI quality class values and IW values for different urban land uses (an example)

Land use	SQI1 Heavy metal contamination	IW1 Weight: Heavy metal contamination	SQI2 Contamination with organic	IW2 Weight: Contamination with organic pollutants	SQI3 Soil pH	IW3 Weight: Soil pH	SQI4 Soil organic matter content	IW4 Weight: Soil organic matter content	SQI5 Soil texture	IW5 Weight: Soil texture	SQI6 Buffering, filtering and
Residential areas	3	2	3	2	3	2	4	3	3	2	4
Family house areas	4	2	3	2	3	2	4	3	3	2	4
Children's playgrounds	5	3	5	3	4	3	5	3	4	3	5
Sport and leisure areas	4	3	4	3	3	2	4	3	4	3	4
Urban agriculture, allotment gardens	5	3	5	3	4	3	5	3	4	3	5
Parks	3	2	3	2	3	2	3	2	3	2	4
Ornamental gardens	2	2	2	2	3	3	4	3	3	3	4
Commercial areas	2	2	2	2	4	3	4	3	4	3	3
Shopping centres	2	2	2	2	4	3	4	3	3	2	3
Low emission industry	2	2	2	2	4	3	3	2	3	2	4
High emission industry	1	1	1	1	3	2	3	2	2	3	5
Roadsides, crossroads	1	1	1	1	3	3	4	3	3	1	4
General agriculture	4	2	4	2	4	2	4	3	4	3	4
Good agricultural area	5	3	5	3	5	2	5	3	5	3	5
Medium quality agricultural area	4	3	4	3	4	2	4	3	4	3	4
Low quality agricultural area	3	3	3	3	3	2	3	3	4	3	3
Meadows/grassland area	3	3	3	3	3	2	3	2	3	2	3

Land use	IW6 Weight: Buffering, filtering and decomposing capacity	SQI7 General soil fertility/productivity	IW7 Weight: General soil fertility/productivity	SQI8 Soil permeability	IW8 Weight: Soil permeability	SQI9 Infiltration capacity	IW9 Weight: Infiltration capacity	SQI10 P, K nutrient status	IW10 Weight: P, K nutrient status	SQI11 Ground water recharge	IW12 Weight: Ground water recharge
Residential areas	3	3	2	4	3	4	3	4	3	4	2
Family house areas	3	3	2	3	2	3	2	3	2	4	2
Children's playgrounds	3	3	2	3	3	3	3	3	3	5	2
Sport and leisure areas	3	3	2	4	3	4	3	4	3	5	2
Urban agriculture, allotment gardens	3	4	2	4	2	4	2	4	2	4	2
Parks	3	3	2	3	2	3	2	3	2	3	2
Ornamental gardens	3	3	3	3	3	3	3	3	3	3	2
Commercial areas	2	2	2	4	2	4	2	4	2	3	2
Shopping centres	3	3	2	4	3	4	3	4	3	3	2
Low emission industry	3	2	1	2	3	2	3	2	3	2	2
High emission industry	3	1	1	1	3	1	3	1	3	1	3
Roadsides, crossroads	3	3	2	2	2	2	2	2	2	2	1
General agriculture	3	4	3	5	2	4	2	4	2	4	2
Good agricultural area	3	5	3	5	2	4	2	5	2	5	2
Medium quality agricultural area	3	4	3	4	2	4	2	4	2	4	2
Low quality agricultural area	3	3	3	4	2	4	2	4	2	3	2
Meadows/grassland area	2	3	3	4	2	3	2	3	2	3	2

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Children's playgrounds	5	3	5	3	4	3	5	3	4	3	5
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Commercial areas	2	2	2	2	4	3	4	3	4	3	3
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Low quality agricultural area	3	3	3	3	3	2	3	3	4	3	3
Meadows/grassland area	3	3	3	3	3	2	3	2	3	2	3

Land use	IW6 Weight: Buffering, filtering and decomposing capacity	SQI7 General soil fertility/productivity	IW7 Weight: General soil fertility/productivity	SQI8 Soil permeability	IW8 Weight: Soil permeability	SQI9 Infiltration capacity	IW9 Weight: Infiltration capacity	SQI10 P, K nutrient status	IW10 Weight: P, K nutrient status	SQI11 Ground water recharge	IW12 Weight: Ground water recharge
Residential areas	3	3	2	4	3	4	3	4	3	4	2
Family house areas	3	3	2	3	2	3	2	3	2	4	2
Children's playgrounds	3	3	2	3	3	3	3	3	3	5	2
Urban agriculture, allotment gardens	3	4	2	4	2	4	2	4	2	4	2
Ornamental gardens	3	3	3	3	3	3	3	3	3	3	2
Commercial areas	2	2	2	4	2	4	2	4	2	3	2
Shopping centres	3	3	2	4	3	4	3	4	3	3	2
Low emission industry	3	2	1	2	3	2	3	2	3	2	2
High emission industry	3	1	1	1	3	1	3	1	3	1	3
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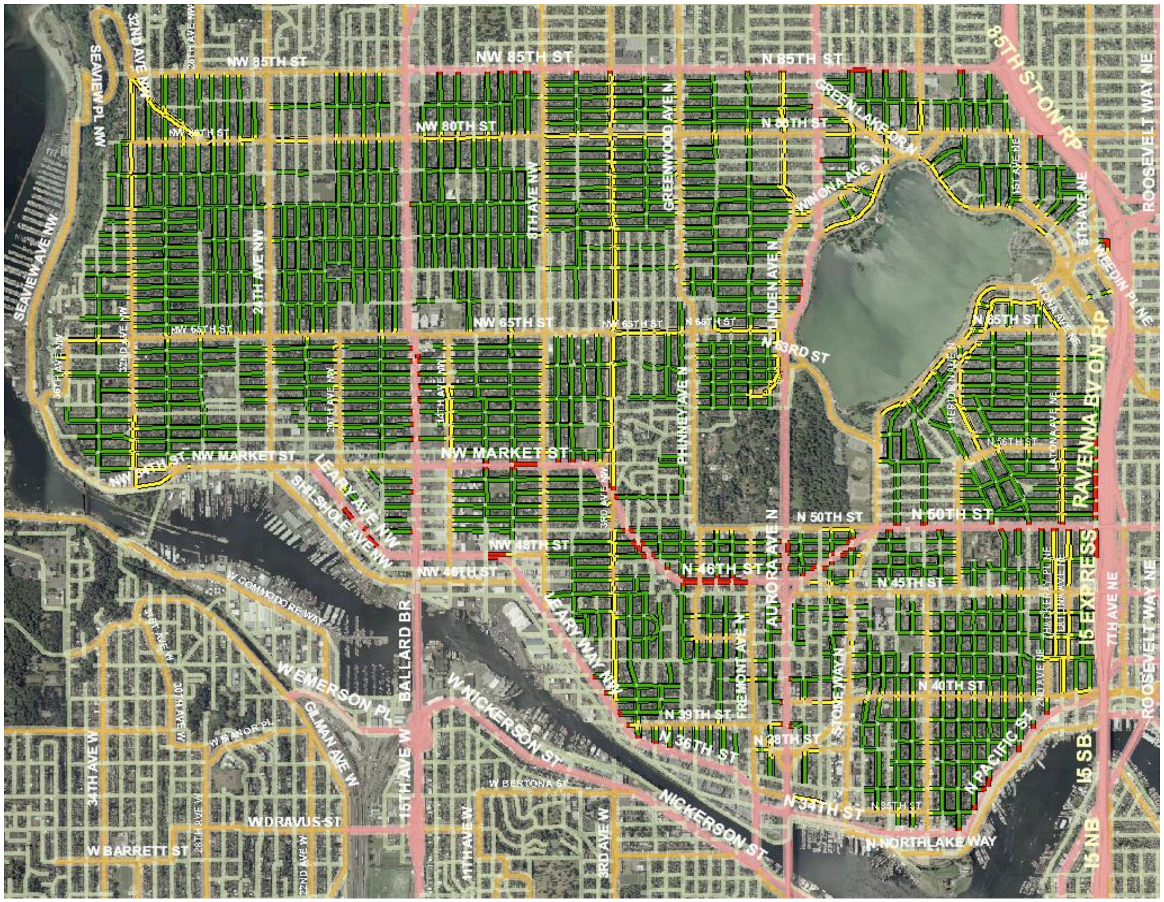
General agriculture	3	4	3	5	2	4	2	4	2	4	2
Good agricultural area	3	5	3	5	2	4	2	5	2	5	2
Medium quality agricultural area	3	4	3	4	2	4	2	4	2	4	2
Low quality agricultural area	3	3	3	4	2	4	2	4	2	3	2
Meadows/grassland area	2	3	3	4	2	3	2	3	2	3	2

Evaluation of Seattle Planting Strip Soil for Urban Agriculture Land Use and Urban Food Production

- Is the Parking Strip an appropriate place to grow vegetables for human consumption?

- Is soil contamination linked to traffic density and busy roads?

Study Area


NW 85TH ST
N 85TH ST
NW 80TH ST
N 80TH ST
85TH ST ON RP
ROOSEVELT WAY NE
GREENLAKE DR N
GREENWOOD AVE N
SEAVIEW PL NW
SEAVIEW AVE NW
32ND AVE NW
24TH AVE NW
8TH AVE NW
NW 65TH ST
N 63RD ST
LINDEN AVE N
PHINNEY AVE N
NW MARKET ST
NW 54TH ST
LEARY AVE NW
SHILSHOLE AVE NW
NW 48TH ST
NW 46TH ST
N 50TH ST
N 46TH ST
N 45TH ST
AURORA AVE N
RAVENNA BV ON RP
I5 EXPRESS
7TH AVE NE
W EMERSON PL
BALLARD BR
15TH AVE W
W NICKERSON ST
NICKERSON ST
LEARY WAY NW
FREMONT AVE N
N 40TH ST
N 39TH ST
N 36TH ST
N 38TH ST
N 34TH ST
N PACIFIC ST
N NORTHLAKE WAY
I5 SB
I5 NB
GILMAN AVE W
W DRAVUS ST
W BARRETT ST
34TH AVE W
11TH AVE W
3RD AVE W

Preliminary Results

- All soil samples are adequate in Phosphorus
- Parking strips do contain many ‘healthy soil’ examples
- Current soil best management practices can remediate poor soils
- 18 of 39 sites samples do show Pb levels over 250 ppm, the Washington State level for unrestricted land use
- TEST SOIL before planting a food garden

Acknowledgements

- Thank you to:
  - David Mc Donald at Seattle Public Utilities
  - The team at the Sustainable Sites Inatitive
  - The University of Washington Botanic Gardens

Links to Useful Soil Specifications:

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

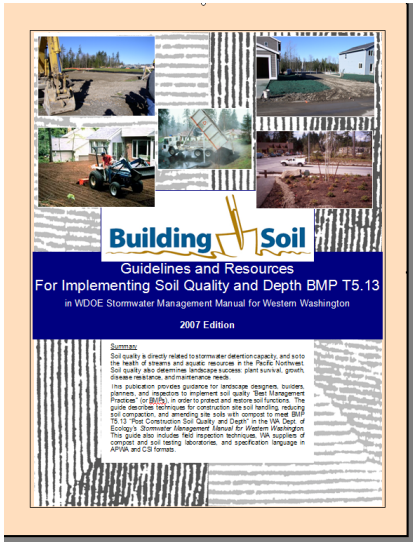
Puget Sound Partnership, LID Technical Manual
www.psp.wa.gov/documents

WsDOT "Soil Bioengineering" specs
http://www.wsdot.wa.gov/Design/Roadside/

Seattle "Natural Drainage Systems" projects & "Green Stormwater Infrastructure" specs
www.seattle.gov/util/GreenInfrastructure

King County soil regs (in Grading code)
http://your.kingcounty.gov/solidwaste/greenbuilding/site/soil-standard.asp

City of Seattle soil regs (in Stormwater code)
http://www.seattle.gov/dpd/Codes/StormwaterCode/CAMs/default.asp



Links to Useful Soil Specifications:

www.sustainablesites.org

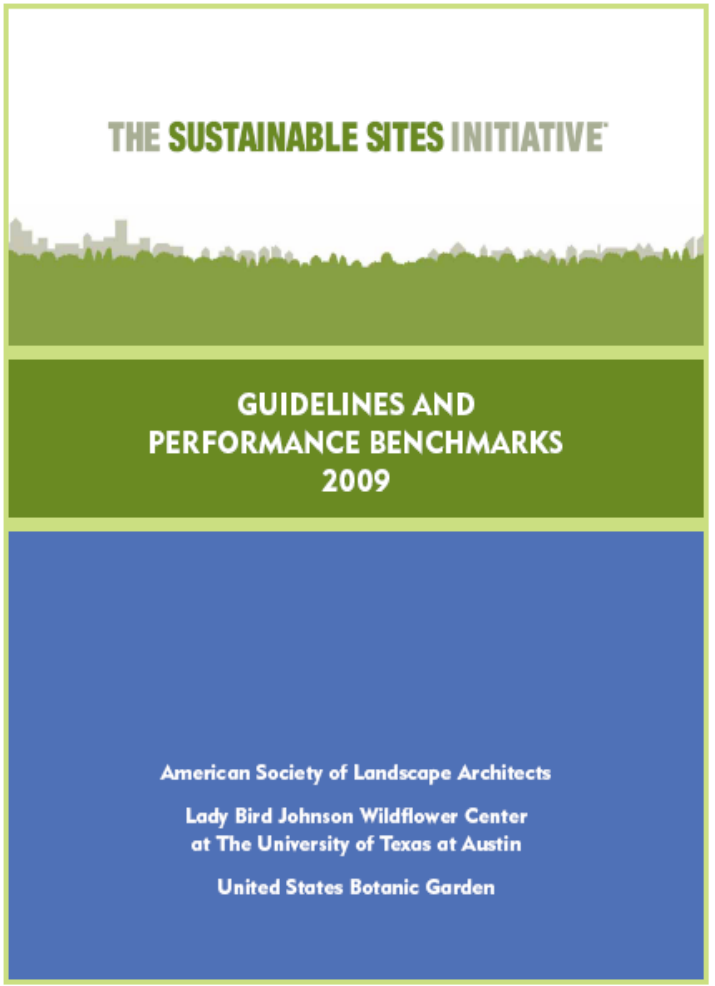
www.BuildingSoil.org

www.SoilsforSalmon.org

B. Vsrcaj, et al. A Method of Soil Quality Evaluation for management and planning in urban areas.

Landscape and

Urban Planning 88(2008)81–94



Questions?