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Sustainable Technologies
EVALUATION PROGRAM

Improving Standards for Preserving and Restoring Soil

Construction Specifications for Implementing Compost Amended Topsoils in Ontario

Presented by: Chris Morrison

TRIECA Conference, March 22-23, 2017

STEP Water is a partnership between:

Toronto and Region Conservation for The Living City

CVC CREDIT VALLEY CONSERVATION

Lake Simcoe Region conservation authority

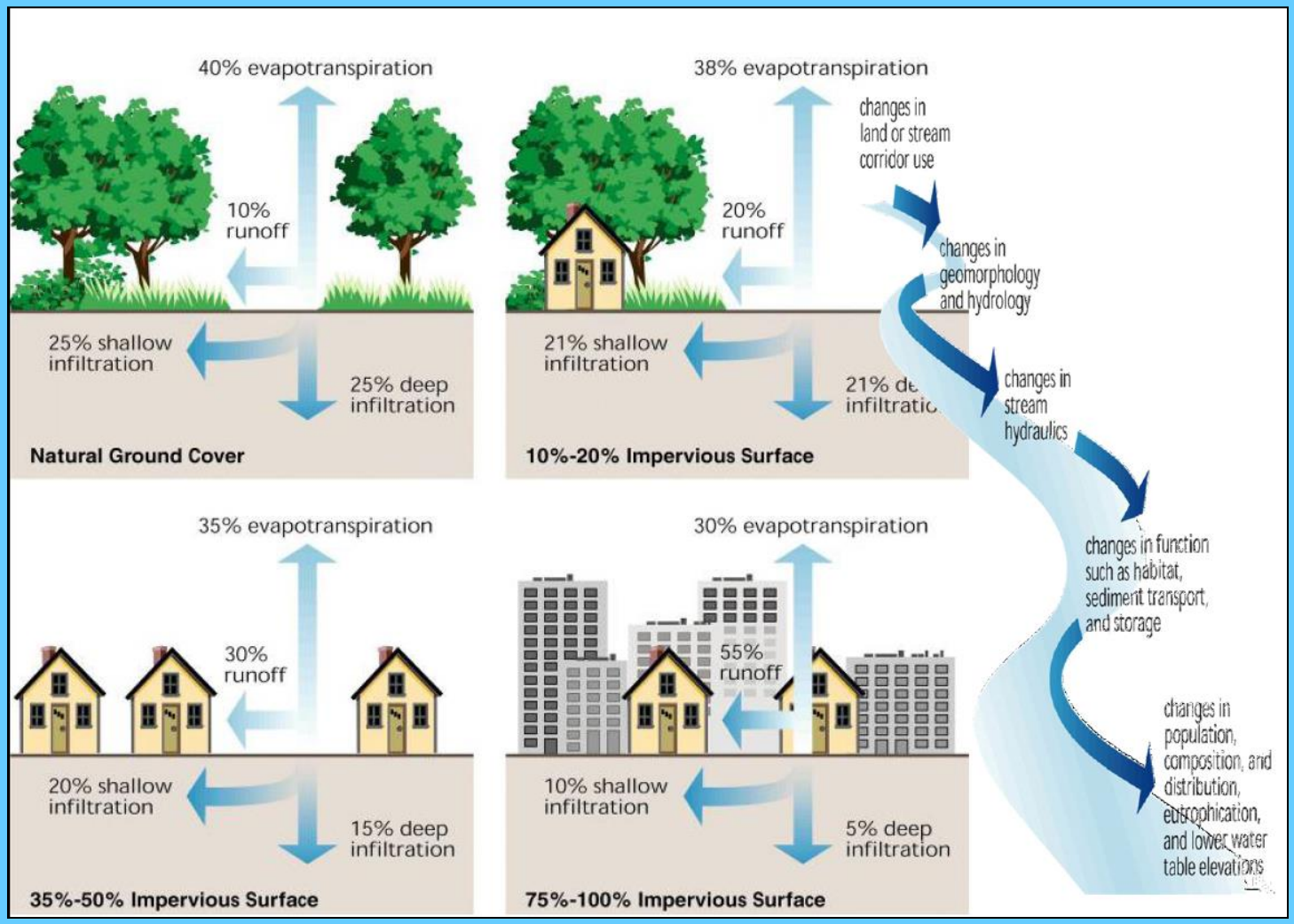
Conservation ONTARIO Natural Champions

Impacts of urbanization on the water cycle

- High infiltration and ET;
- Low runoff

vs.

- Low infiltration and ET;
- High runoff (2x to 6x)



Modern development practices Post WWII

- Vastly alter large blocks of land
- Compact subsoil to levels not possible prior to 1950

- Degrade topsoil resources through handling and storage practices
- This is actually no longer topsoil

What is expected of this site?

This site will be graded, topsoil added and the finished landscape expected to perform as a natural and pervious site

This planting site contains……

- Highly compacted fill
- “A” and “B” gravel
- Screenings
- Concrete truck washout
- Structureless topsoil
- 1% – 2% organic matter
- Compaction levels approaching 2 g/cm^3
- **This is the present topsoil specification in reality**

Post construction landscape maintenance Practices

Planting: What is the…

- Correct tree for this site?
- Correct planting procedure?
- The truth?

  Often there is no tree suitable for a site
- **What will the contribution of these trees be in 40 years?**

The value of Toronto's Urban Forest

TD Economics | www.td.com/economics

Table 1 - Annual benefits provided by Toronto's urban forest				
Benefit	**Description**	**Tangible benefit**	**$ value (millions)**	**$/tree**
Wet-weather flow	Reduced strain on water transportation and processing infrastructure from rain and wet-weather flow intercepted.	25,112,500 cubic metres	$53.95	$5.28
Air quality	Air pollutants absorbed removed and avoided by street trees.	1,905 tonnes	$19.09	$1.87
Energy savings	Energy saved through shading and climate moderation.	749,900 MBTU of natural gas 41,200 MWH of electricity	$6.42	$0.63
Carbon sequestration	Carbon sequestered from the atmosphere and emissions avoided through energy savings.*	36,500 tonnes	$1.24	$0.12
Energy emission abatement	Carbon emissions from fossil fuel power generation avoided through climate moderation.	17,000 tonnes	$0.58	$0.06
Total benefit	Sum of economic benefits provided by urban forests.	-	$81.29	$7.95
Cost benefit ratio	Benefits to citizens for every $ spent on maintenance.	-	-	$1.35 - $3.20

* Carbon avoided and sequestered is net of the emissions from the decomposition and maintenance of trees.

Source: Toronto Parks, Forestry & Recreation, TD Economics.

Source: TD Economics Special Report, June 2014

Urban tree canopy and SWM

- Trees are a major component of the hydrologic cycle
- Trees reduce runoff through processes of:
  - ✓ Interception/ Evaporation
  - ✓ Transpiration
  - ✓ Infiltration

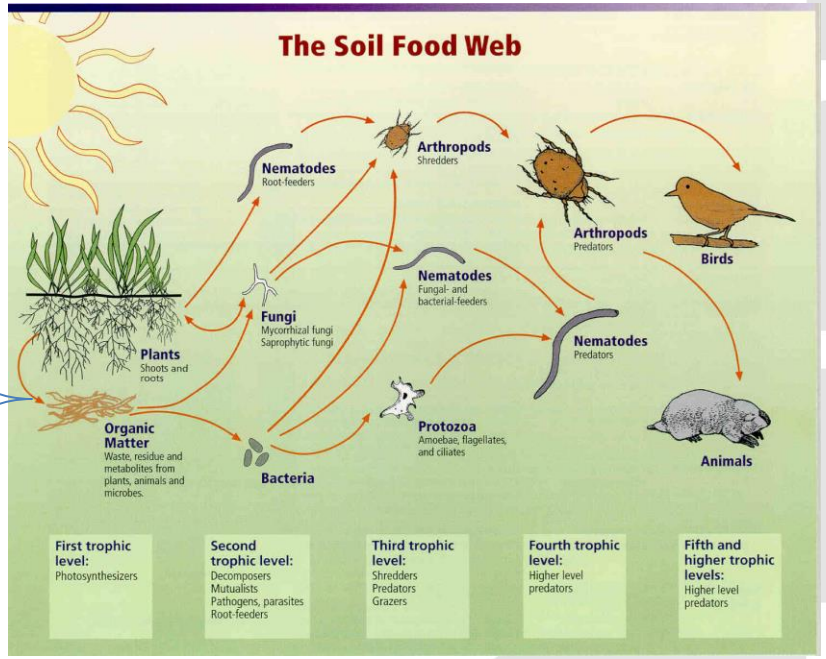
For trees to provide these benefits they require…

- Sufficient soil volume, depth and quality to allow them to reach maturity
- **Organic matter** and **soil structure** are key to a fully functional (healthy) soil
- Similar benefits and requirements apply to lawns and planting beds

The Soil Food Web

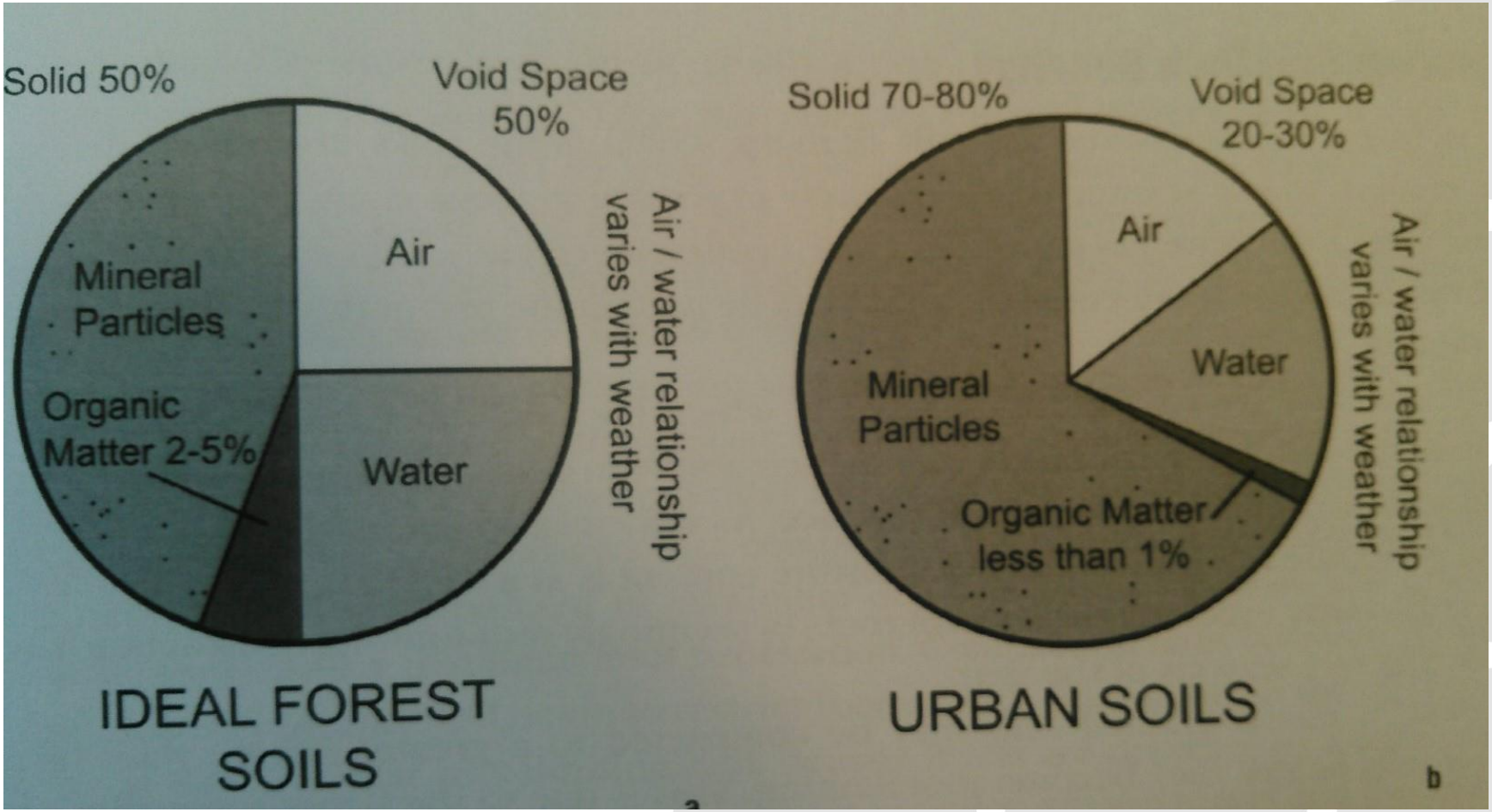
Physical and chemical soil properties depend on micro-organisms
And other soil dwellers found abundantly in healthy soils

- Structure
- Water holding capacity
- Infiltration
- Cation (anion) exchange capacity (N,P)



A compaction problem is a biological problem

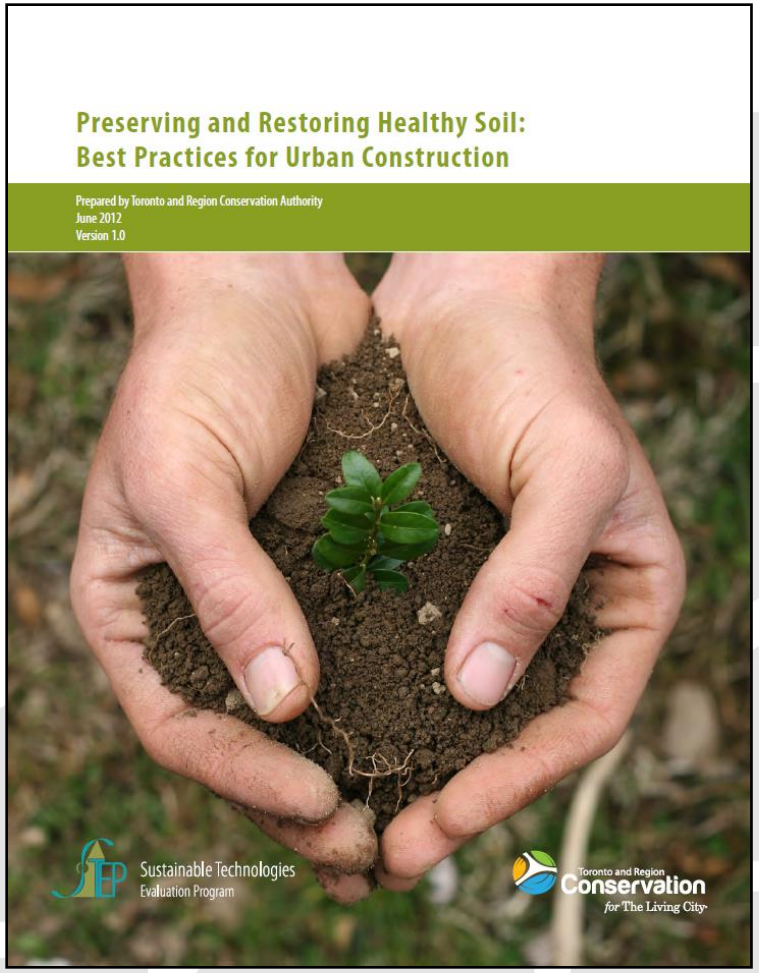
Theory versus Reality



James Urban

Key Benefits of Preserving and Restoring Healthy Soils

- Restores soil porosity and water holding capacity;
- Increases infiltration and decreases runoff;
- Improves filtration and trapping of contaminants;
- Allows for the re-establishment of vigorous vegetative cover and deep root growth;
- Creates more marketable buildings and healthier, drought tolerant and aesthetically pleasing landscapes



Available at sustainabletechnologies.ca

Soil Management Planning

- SMP states the minimum quality, depth and treatment of soil/subsoil in all pervious vegetated portions of a development site. This can be applied to the entire site.
- Directs how pre-development site soil will be stored, amended, re-applied or replaced.
- Provide a guidance and verification process for all phases of construction (pre to post development and post development maintenance).
- Provide post construction direction on maintenance of all landscaped areas

Soil Compaction

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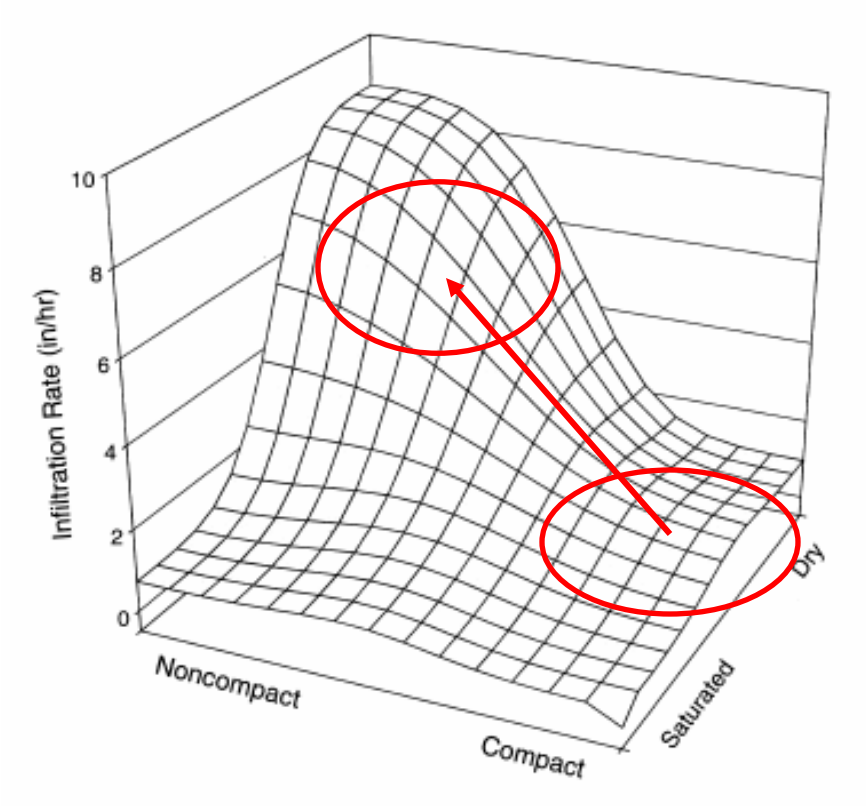

Figure 2. Three dimensional plot of infiltration rates for clayey soil conditions.

Robert Pitt, P.E.* Shen-En Chen, P.E.** and Shirley Clark, P.E.**

*Department of Civil and Environmental Engineering, The University of Alabama, Tuscaloosa, AL 35487-0205
**Department of Civil and Environmental Engineering, The University of Alabama at Birmingham, Birmingham, AL 35226

Subsoiling with bulldozers and excavators

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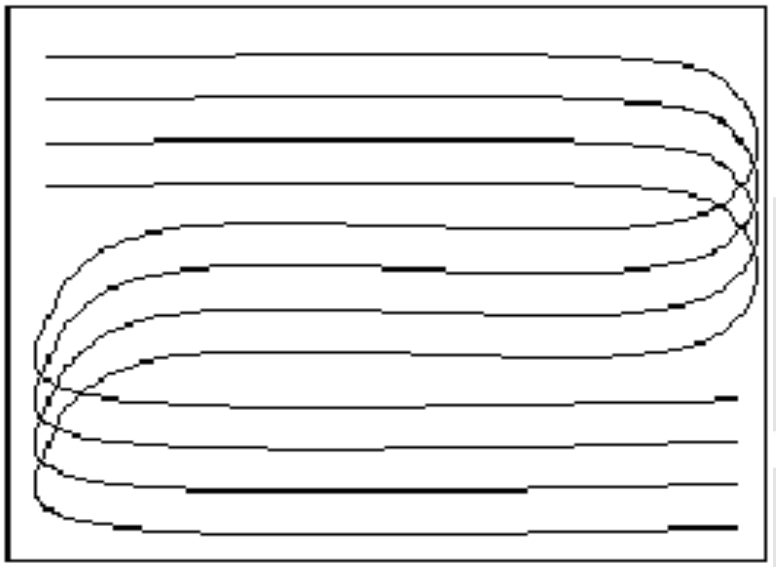
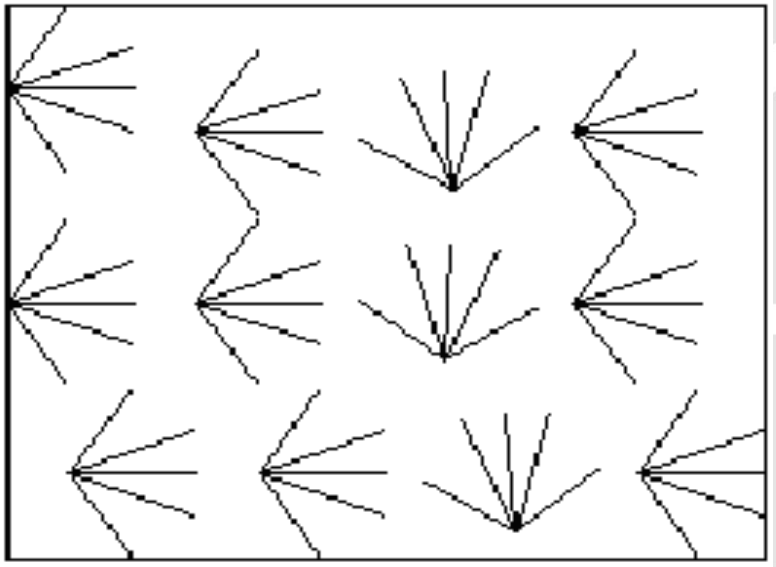


Subsoiling Patterns

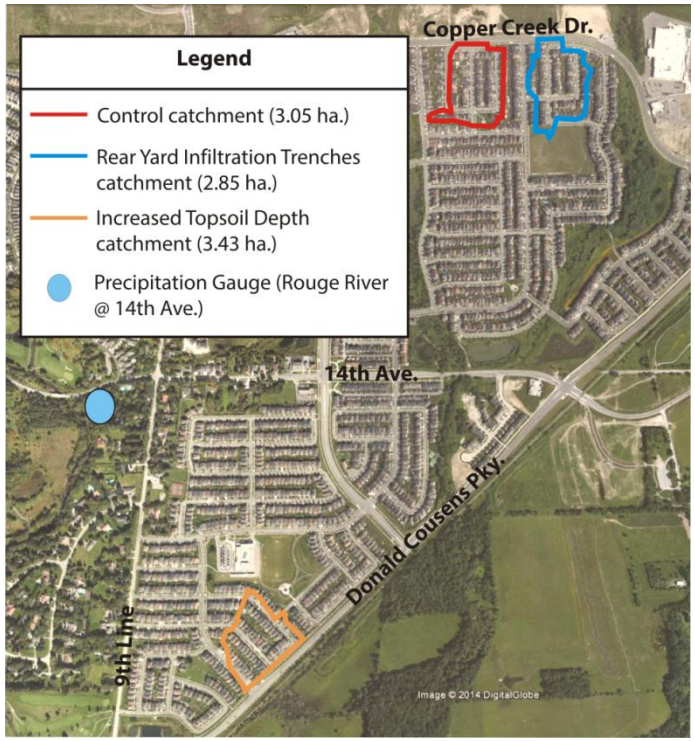


Research:
SWM effectiveness of soil restoration practices

Parameter	Malone et al., 1996	Chow et al., 2002	Balousek, 2003	Faucette et al., 2005	Reinsch et al., 2007
Native soil type	Silty loam	Gravelly loam	Silty clay loam	Sandy clay loam	Clay
Treatment	Yard waste compost (YWC) incorporation (15 cm depth)	Pulp fibre incorporation (20 – 25 cm depth)	Deep tilling, chisel plowing and YWC incorp. (15 cm depth)	Compost blankets (37.5 mm depth & 4 diff. compost sources) plus filter berms	YWC blanket; YWC incorp.; YWC incorp. plus filter berm
Runoff volume reduction*	67%	23%	88%	30 to 55%	96% (blanket) 69% (incorp.) 74% (incorp. & filter berm)
Sediment load reduction*	77%	71%	n/a	97 to 99%	>99%
Nutrient load reduction**	n/a	n/a	n/a	29 to 62%	>99%

* Values are % reductions over all events monitored relative to a bare soil control.
** Value is % reduction of dissolved reactive phosphorus load after vegetation was re-established.

Runoff Reduction Evaluation of Increased Topsoil Depth (ITD)



Box Grove community, Markham, ON

Runoff Reduction Evaluation of Increased Topsoil Depth (ITD)

- ITD catchment consistently produced less runoff than CTL;
- Benefits observed primarily during large storm events (≥ 15 mm);
- Runoff reduction of ITD approx. 5% over the monitoring period;
- During intense storms, ITD provided substantial reduction in runoff depth and peak flows (20 to 60%);
- Soil moisture at 10 cm depth was consistently higher for ITDCB boxes;
- Compost blanket amendment would create more drought-tolerant lawns.

Evaluation of Residential Lot Level Stormwater Practices

TECHNICAL BRIEF

Low Impact Development Series

Low Impact Development (LID) designs attempt to mimic pre-development hydrology through improved site design and distributed lot level practices that treat runoff at the source. Lot level practices include engineered structures such as rain gardens, soakaways and permeable pavements that filter, infiltrate and evaporate runoff. They can also include non-structural practices such as directing roof downspouts to gently sloping landscaped areas that contain topsoil of sufficient permeability, depth and quality to absorb and evaporate runoff during and after wet weather events.

Although draining roof downspouts to landscaped areas is standard for new residential developments in the Greater Toronto Area, not much is known about the effectiveness of this practice to manage runoff. Furthermore, there is little known about how much more effective it could be by increasing topsoil depth and quality in landscaped areas receiving roof drainage. This study (Young et al., 2013) helps to address this knowledge gap by evaluating at the catchment scale, the hydrologic benefits of widespread application of two types of lot level stormwater management practices in newly constructed residential developments:

- Increased topsoil depth; and
- Rear yard infiltration trenches with grass swale pretreatment.

To verify conclusions drawn from the catchment scale evaluation of increased topsoil depth and to characterize what further benefits could be achieved with addition of a compost blanket amendment (i.e. increased topsoil depth and quality), evaluations of test boxes designed to simulate turf grass landscaped areas exposed to natural precipitation were also conducted.

'Pervious' landscaped areas such as yards, gardens, parks and sports fields that provide aesthetic and functional benefits, have been shown to generate 40-60% of residential runoff when constructed on compacted poor quality soil (Wignosta et al., 1994)

Sustainable Technologies Evaluation Program
www.sustainabletechnologies.ca

An Initiative of: Toronto and Region Conservation for The Living City

Available at sustainabletechnologies.ca

Evaluating the Effectiveness of Soil Amendments - Topsoil Depth & Quality

Presently underway

- Evaluating the runoff reduction performance of roof downspout disconnection to a lawn & effectiveness of compost amendments (incorporation & blanket applications);
- Constructed 4 test plots (4 x 5 m ea.) that receive roof runoff from 33 m^2 roof areas + 4000 L cistern;
- Monitoring inflow, outflow (interflow & runoff), interflow quality (nutrients), and soil moisture.

Developing Standard Specifications for Compost Amended Topsoil in Ontario

- Toronto RAP 2015/16 project to accelerate implementation of compost amended topsoil on landscape construction projects;
- Collaboration btwn. provincial & municipal governments, CAs, landscape design & composting industries, and researchers;
- A series of template documents formatted for easy incorporation into contract tender documents;
- Update of 2012 guide, Preserving and Restoring Healthy Soil: Best Practices for Urban Construction.

COMPOST AMENDED TOPSOIL SPECIFICATIONS

USE THIS SECTION TO ADAPT NATIONAL MASTER SPECIFICATION OR CSI MASTERFORMAT® SECTION 32 91 19.13 TOPSOIL PLACEMENT AND GRADING CONTENT TO REFLECT RECOMMENDED STANDARDS AND BEST PRACTICES FOR INSTALLING COMPOST AMENDED TOPSOIL AS PLANTING SOIL IN PREPARATION FOR PLANTING OF LAWNS, GARDEN BEDS AND TREE PITS.

**This document provides recommended standards and best practices for installing Compost Amended Topsoil as Planting Soil as part of landscaped area construction projects. It should be used to guide the writing of project-specific specifications for construction of lawns, garden beds and tree pits where enhancing the capacity of the soil to infiltrate and retain water and reducing chemical fertilizer inputs are desirable. Since each construction project is unique the recommended material specifications and installation practices detailed below should be used as guidance for developing a project-specific specification that reflects local conditions, constraints, design standards and available materials.

PART 1 – GENERAL

1.1 SCOPE

.1 This section addresses the labour, materials, and equipmer
Amended Topsoil for use as Planting Soil.

1.2 REFERENCE

.1 Agriculture and Agri-Food Canada. 1998. The Canadian Sy
Press, Ottawa, ON. http://sis.agr.gc.ca/cansis/publications/

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http://www.alcanada.com/index_htm_files/compost_handbc

.3 American Society of Agricultural Engineers (ASAE). 1999. F
Penetrometer. ASAE Standard EP542. American Society o
MI. http://elibrary.asabe.org/

.4 ASTM International. 2014. ASTM D2974-14, Standard Test
Other Organic Soils, West Conshohocken, PA. https://www

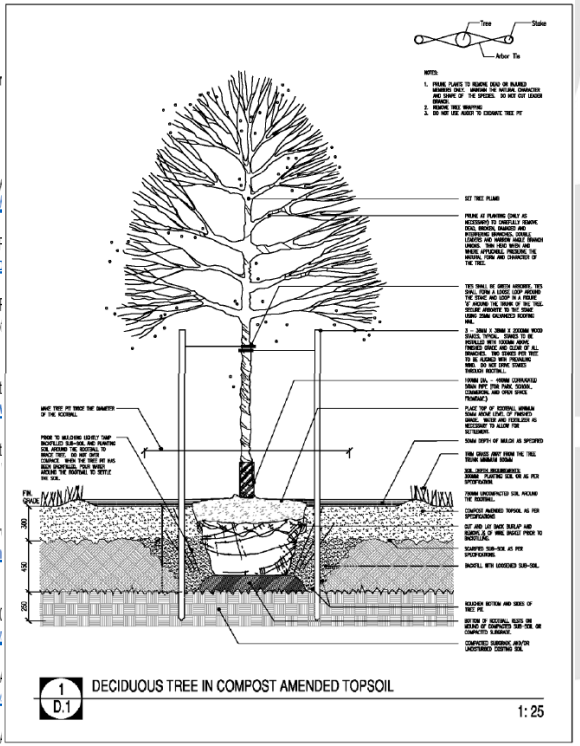
.5 ASTM International. 2015. ASTM D7380-15, Standard Test
Depths Using a 5 lb (2.3 kg) Dynamic Cone Penetrometer,
https://www.astm.org/Standards/D7380.htm

.6 Bureau de Normalisation de Québec (BNQ). 2016. Standar
Québec, QC. https://www.bnq.qc.ca/en/certification/environ

.7 Canadian Council of Ministers of the Environment. 2005.
Guidelines for Compost Quality. PN 1340-2005/PN 1341-2(
http://www.ccme.ca/files/Resources/waste/compost_quality

.8 Ontario Ministry of Agriculture, Food and Rural Affairs (OM
http://www.omafra.gov.on.ca/english/crops/resource/soillab

.9 Ontario Ministry of Agriculture, Food and Rural Affairs (OM



Compost Amended Topsoil Highlights

Final Organic matter content: 5 – 10% (base topsoil 2 – 5%)
Organic matter calculator (spreadsheet)

Final compaction limits:
Surface resistance for all soil textures:
110 PSI (7.7 kg/cm^2; 758 kPa);
Sub-surface resistance (texture dependent):
225 PSI (15.8 kg/cm^2; 1551 kPa to 260 PSI (18.3 kg/cm^2: 1793 kPa)
measured by a cone penetrometer

Minimum topsoil screen size ≥ 50 mm

Topsoil depth: 300 mm compost amended topsoil
Sub-soil: 450 mm depth scarification
Total depth: 750 mm

Root Limiting Compaction Levels

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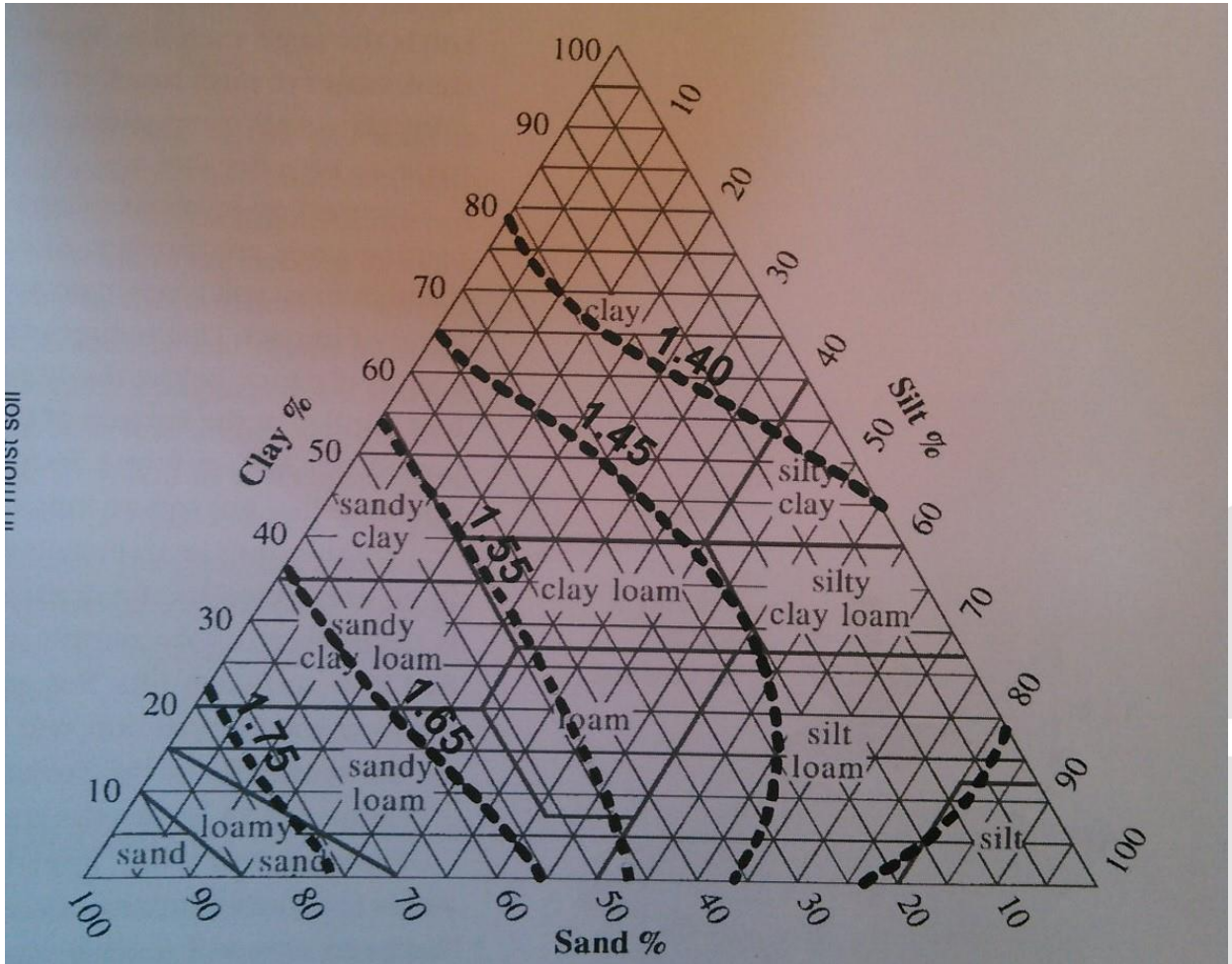
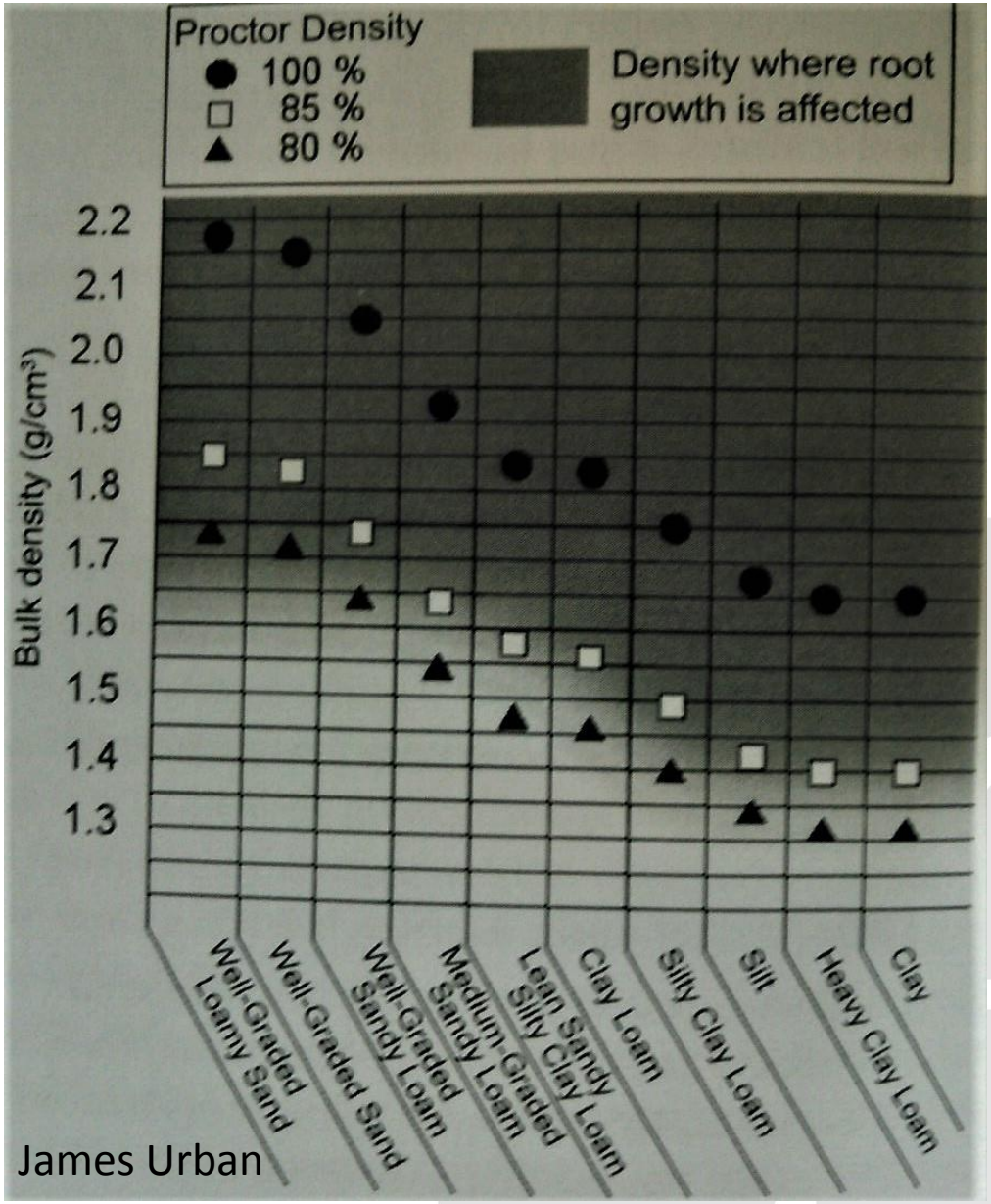


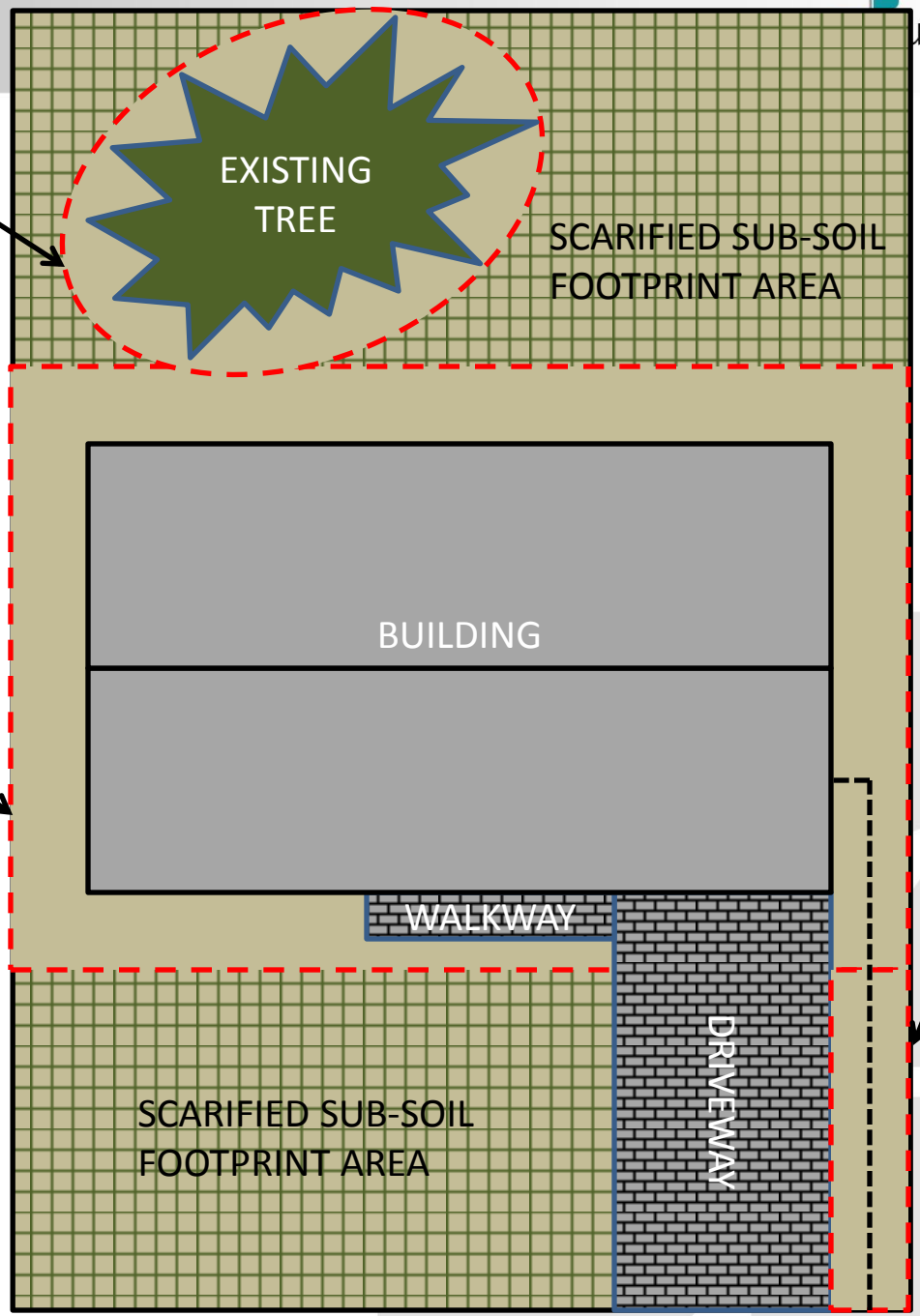
b. Root-limiting soil densities. A reasonable specification for compacting planting soil by bulk density would be between 0.1 g/cm³ and 0.25 g/cm³ below the value predicted as root-limiting with some settlement expected at that range. *(Source: Adapted from Daddow and Warrington 1983)*


Proctor Density
100 %
85 %
80 %
Density where root growth is affected
Bulk density (g/cm³)
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
Well-Graded Loamy Sand
Well-Graded Sand
Well-Graded Sandy Loam
Medium-Graded Sandy Loam
Lean Sandy Silty Clay Loam
Clay Loam
Silty Clay Loam
Silt
Heavy Clay Loam
Clay

James Urban

Compaction Thresholds for root growth

Compaction	Cone Penetrometer (PSI)	Proctor Density Method (%)	Bulk Density (g/cm³)
Acceptable	≤ 260	75 - 85	1.10 – 1.60
Root Limiting	260 - 400	85 - 90	1.10/1.60 – 1.47/1.80
Root Restricting	≥ 400	≥ 90	≥ 1.47 – 1.80


NO SCARIFICATION OF SUB-SOIL WITHIN TREE PROTECTION AREA
EXISTING TREE
SCARIFIED SUB-SOIL FOOTPRINT AREA
BUILDING
NO SCARIFICATION OF SUB-SOIL WITHIN 3 m OF BUILDING FOUNDATION
WALKWAY
DRIVEWAY
NO SCARIFICATION OF SUB-SOIL WITHIN 1 m OF SHALLOW UNDERGROUND UTILITIES
SCARIFIED SUB-SOIL FOOTPRINT AREA

SCARIFY SUB-SOIL IN PERPENDICULAR PATTERN

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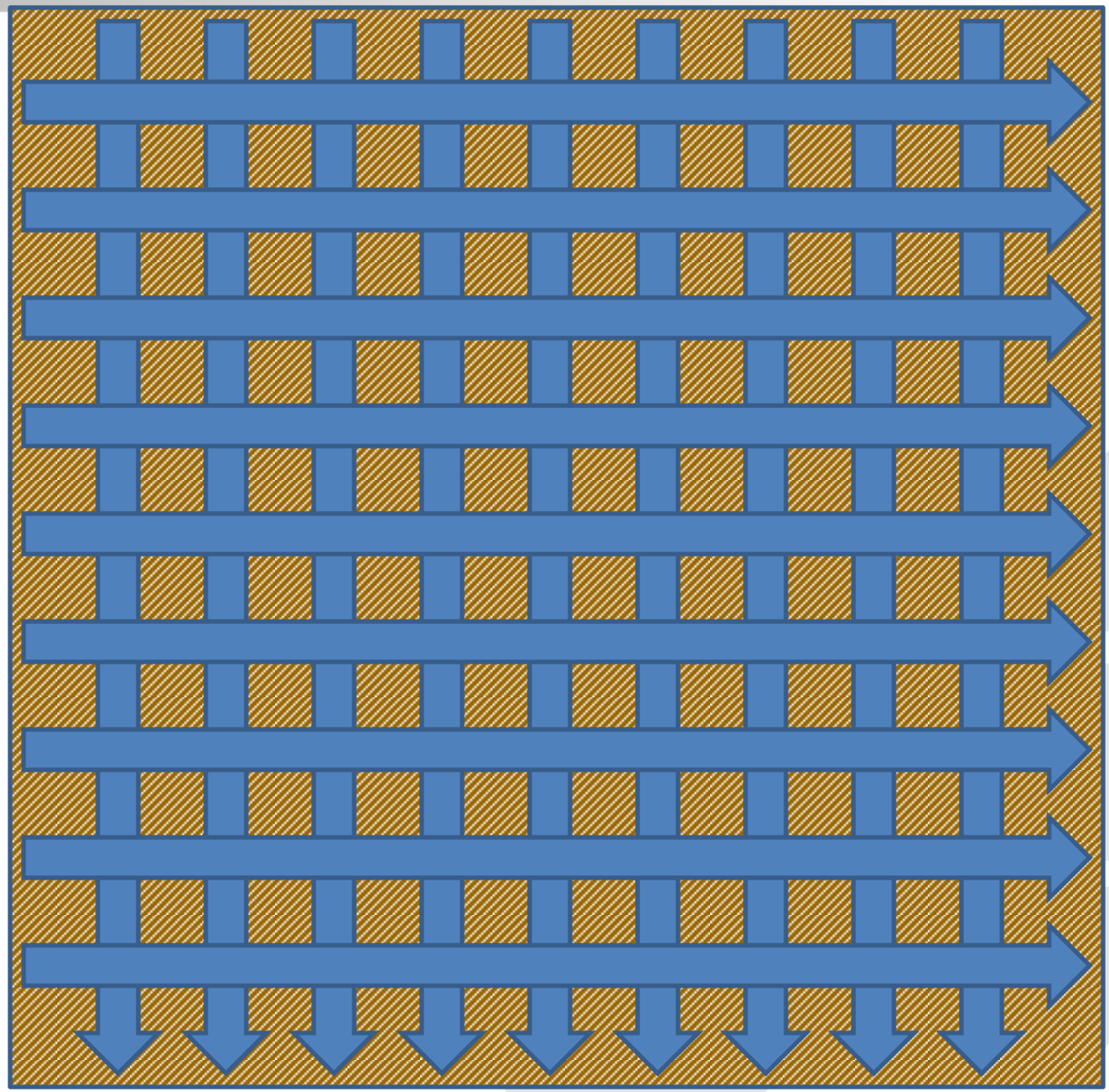

METHOD 1: PLACE IMPORTED COMPOST AMENDED TOPSOIL

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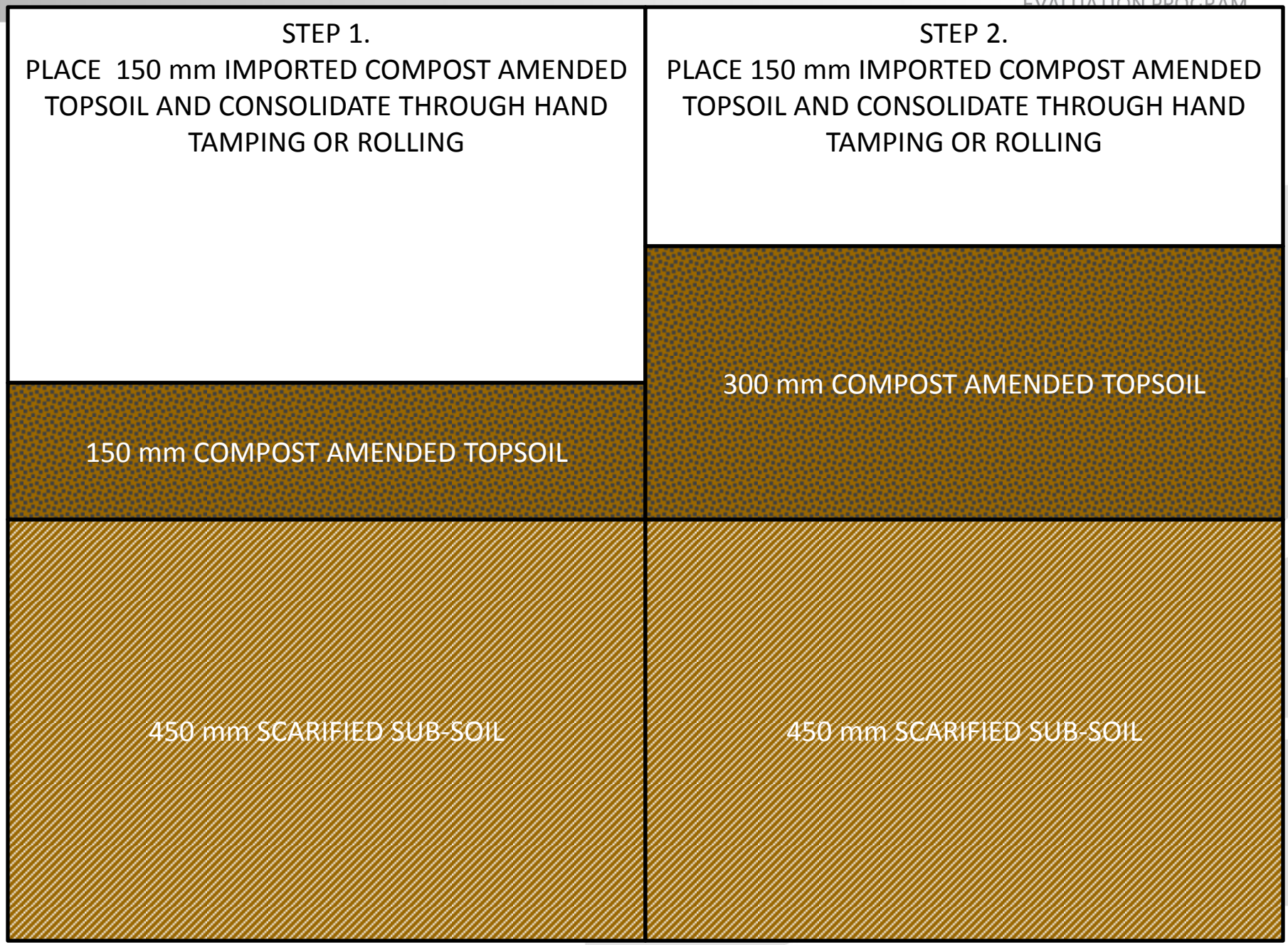

METHOD 2: PLACE BASE TOPSOIL AND COMPOST LAYERS AND INCORPORATE

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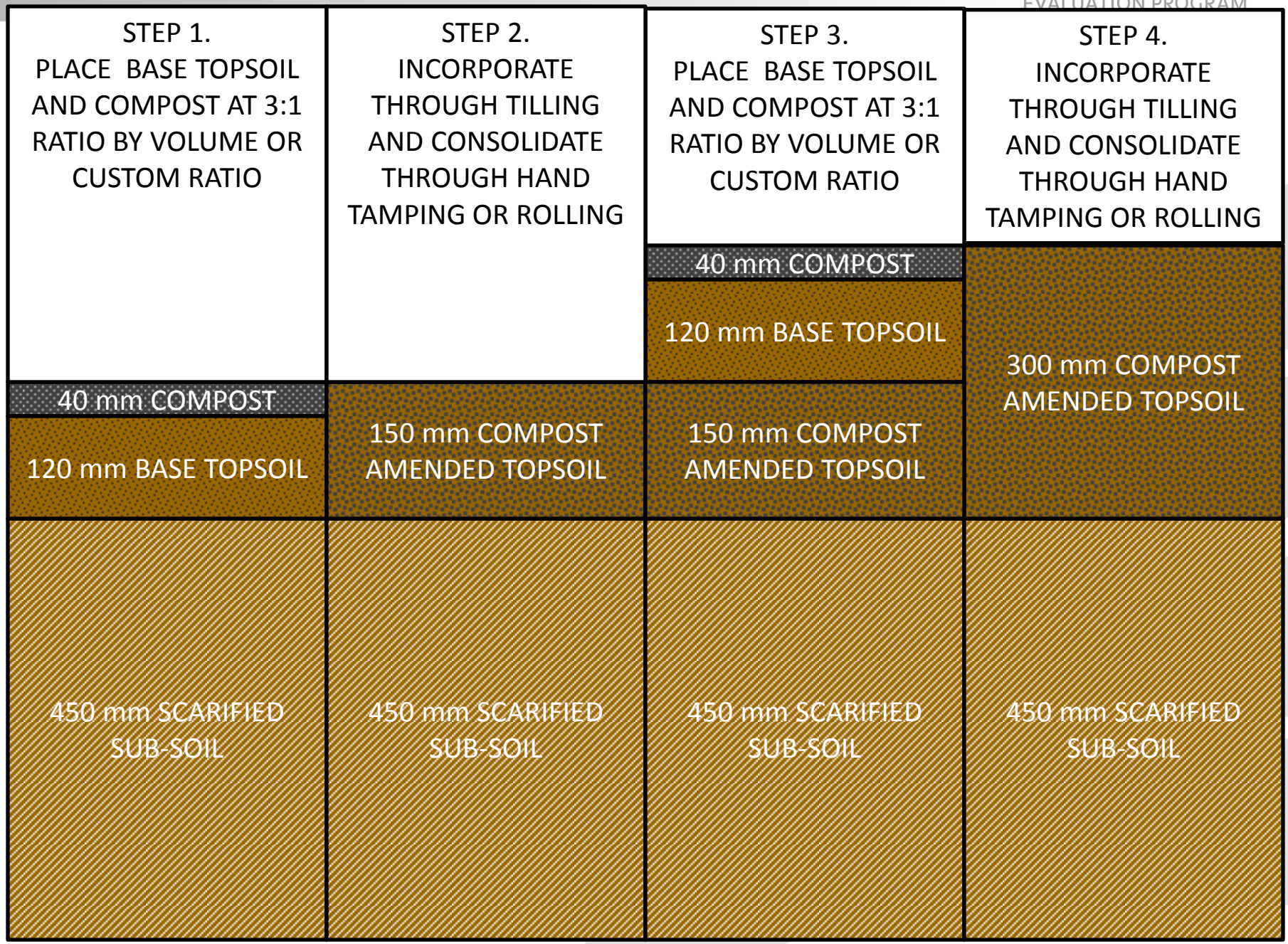

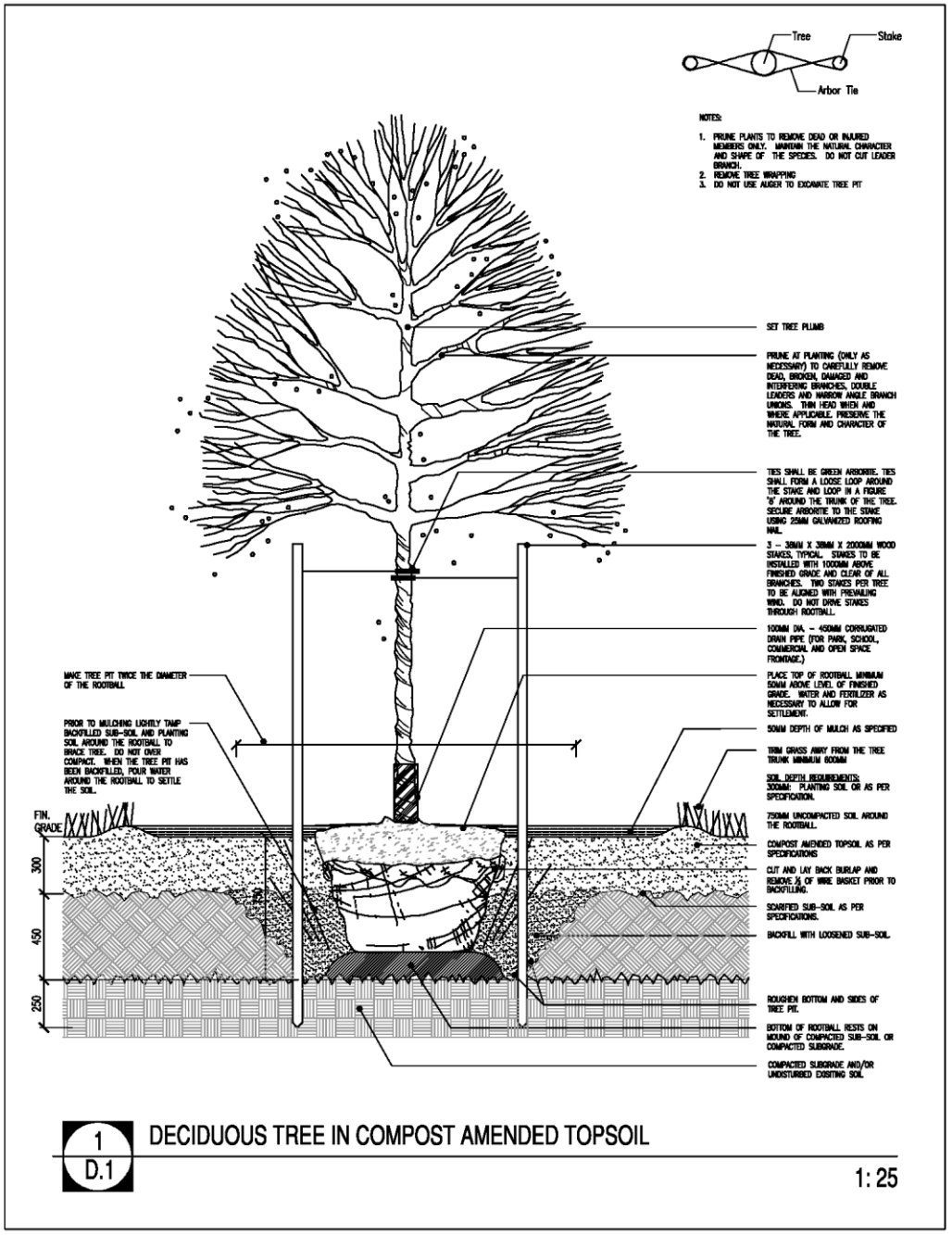

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DECIDUOUS TREE IN COMPOST AMENDED TOPSOIL

1: 25

Who's implementing Soil Management Plans?

- **Halton Regional Conservation Authority**
- "That the Owner [retain the services of a qualified landscape architect or landscaping designer to] prepare and implement a Soil Management Plan in accordance with the document 'Preserving and Restoring Healthy Soils: Best Practices for Urban Construction' as prepared by the Toronto Region Conservation Authority, dated June 2012, and post securities with the [municipality] to ensure the effective implementation of the plan;"

Corktown Commons & Lauren Harris Square, Don River, Toronto ON

$135 Million G.I. Project

Organic Landscape Maintenance Guidelines

Corktown Common & Lawren Harris Square
Waterfront Toronto | City of Toronto - Parks, Forestry & Recreation Division

9 September 2014

PREPARED BY
Michael Van Valkenburgh Associates, Inc
Landscape Architects
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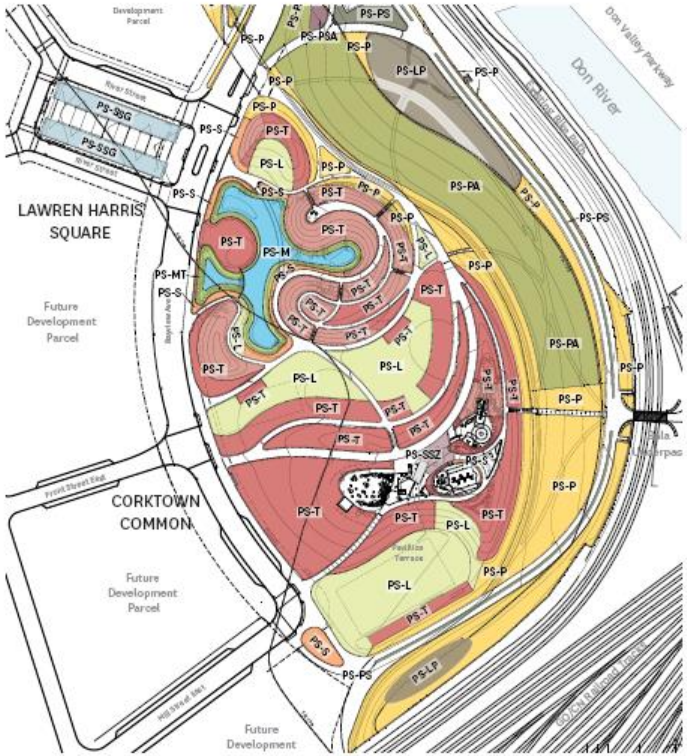
Cambridge, MA 02138
617.864.2076
www.mvvainc.com

Planting Soil

PLAN SOUTH



Sunnybrook Health Sciences Centre
Toronto ON

Soil Management Maintenance Program 2007

The Green Sward - Fall 2016

- Significant reduction in weed populations
- Fewer grass clippings/reduced mowing cycle
- Lower fertilizer inputs (organic vs. synthetic)
- Noticeable drop in insect and disease problems
- Visually healthier trees, shrubs, perennials, turf
- Increased bird and pollinator populations
- Reduced storm runoff and flooding

- How it was done:

- Staff training in Organic Land Care Practices
- Switch from synthetic to organic fertilizer
- Compost top dressing of turf every 2 years

- Organic Land Care Standard for Canada is used as a guidance document by both Corktown Commons and Sunnybrook Health Sciences Centre

Key Resources

- **Preserving and Restoring Healthy Soil: Best Practices for Urban Construction**, *Toronto and Region Conservation Authority, 2012*
- **Low Impact Development Stormwater Management Planning and Design Guide,** *Credit Valley Conservation & Toronto and Region Conservation Authority, 2010*
- **Evaluation of Residential Lot Level Stormwater Practices,** *Toronto and Region Conservation Authority, 2013)*
- **Organic Landscape Maintenance Guidelines** *Corktown Commons and lauren Harris Square, City of Toronto*
- **Organic Land Care Standard for Canada** *www.organiclandcare.org*
- **Up by Roots**: *Healthy Soils and Trees in the Built Environment James Urban*
- **Sustainable Technologies Evaluation Program (STEP)** *www.sustainabletechnologies.ca*

THANK YOU

For more information:

www.sustainabletechnologies.ca

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