Building Healthy Soil:

Making Urban Landscapes More Absorbent to Stormwater

Urban development fundamentally changes the ways by which water flows through the local environment. Without the application of best management practices to control stormwater runoff and improve its quality, the health of natural ecosystems that our urban streams, lakes and wetlands support declines. We typically think of these changes to the local water cycle as being caused by the spread of hard surfaces across the land like roofs and pavements that prevent rain and snowmelt from soaking into the ground or being intercepted and evaporated by plants. Yet, studies have shown that landscaped areas, like the yards, gardens, parks and sports fields that make our towns and cities beautiful and healthy places to live, can contribute 40 to 60% of the total runoff from residential developments when constructed on compacted, poor-quality soil.

Compost amended topsoil.

Healthy soil provides important stormwater management functions including infiltration and storage, adsorption of nutrients, filtration of sediments, decomposition of pollutants, and moderation of stream flows and temperatures. In addition, healthy soil supports vigorous plant and tree growth that intercepts rain, returning much of it to the atmosphere. The health of the soil, vegetation and the rivers, lakes and wetlands they drain to are intrinsically related. These relationships should be better recognized in land development planning and urban construction processes in order to produce more functional landscaped areas. Implementing best practices to preserve and restore healthy soil in landscaped areas also qualifies for credits in green building certification programs like Leadership in Energy and Environmental Design (LEED®) and The Sustainable Sites Initiative™.

The way in which landscaped areas are constructed and managed affects how absorbent they are to stormwater, in addition to the level of effort that will be required to re-establish and maintain healthy vegetation and the lifespan of the plantings. Today, conventional construction practices involve mass stripping and stockpiling of site topsoil in large mounds for periods of six months to a year or more until a portion, typically less than 30% of what is stripped, is reapplied to landscaped areas. This process compacts the topsoil, radically changing its structure and water holding capacity, and depletes it of beneficial soil organisms that cannot survive the anoxic conditions experienced in the topsoil mounds.

Often the only living portion of topsoil stockpiles is limited to the top 30 centimeters. This produces stockpiles that are either poor or highly variable in quality. Standard practice is to apply 10 to 15 centimeters of the stockpiled site topsoil to landscaped areas, without taking any measures to reverse compaction of the underlying subsoil caused by construction equipment traffic and storage of building materials.

How topsoil is stripped and stockpiled affects its composition, structure and moisture holding capacity.

Residential lawns in newly developed areas have been shown to produce significantly larger runoff volumes than older lawns due to higher soil bulk density (i.e. loss of soil structure) and lower organic matter content. While many natural processes act to loosen up soil, such as freeze-thaw cycles, activity of soil organisms and plant root penetration, they can take decades to substantially decrease soil bulk density. In addition, many of these processes are ineffective when soil compaction becomes severe (i.e. bulk density greater than 1.7 g/cm$^{3)}$ because water, roots and soil fauna simply cannot penetrate the dense soil matrix.

If best practices to preserve or restore healthy functioning soil in landscaped areas are not applied during construction, changes to soil structure, biology and organic matter content and the effects of compaction can cause them to function more like impervious surfaces. This makes the standard practice of directing roof drainage to them less effective than it could be at reducing urban runoff and contaminant loads to receiving waters. Furthermore, poorer quality planting environments are produced that require more irrigation, fertilizer and effort to re-establish and maintain vegetation and urban tree canopy. Application of improved soil management practices during construction can reduce stormwater runoff and outdoor water use, produce more lush yards and landscaped areas that are easier and cheaper to main-

Topsoil being reapplied during construction (foreground) and a tree protection zone (background).

tain, and provide the growing environment needed by urban trees to reach maturity.

A New Approach

With the release of a new best practices guide on preserving and restoring healthy soil, the Toronto and Region Conservation Authority (TRCA) hopes to foster change in construction industry practices and municipal standards. The guide recommends that soil in all landscaped areas should meet minimum standards for quality and uncompacted depth, especially those that receive runoff from adjacent roofs or pavements. In terms of quality, the topsoil should contain at least 5 to 10 percent organic matter, a critical component to the water holding capacity and biological health of soil. If topsoil is low in organic matter, it should be amended with compost to meet the standard. In terms of uncompacted soil depth, topsoil should be at least 20 centimeters deep, representing double the amount that is typically applied to yards and parks during construction, and the total uncompacted soil depth should be at least 30 centimeters.

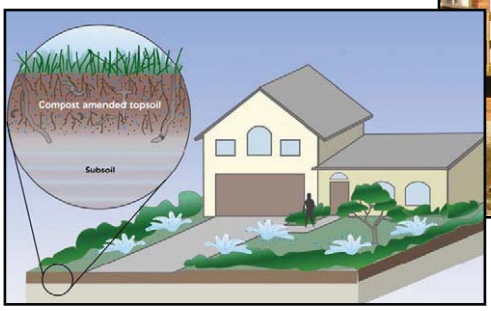
Higher standards are recommended in areas where shrubs and trees will be planted as they need richer and deeper soil to thrive. To make adoption of these practices easier, guidance is also provided on how to develop a soil management plan for your site, including templated forms for planning and field inspection and tools for calculating the quantities of topsoil and compost needed.

Best practices and optional methods to meet the standards are described in stepwise detail. Examples of the best practices include:

- Leaving existing trees, vegetation and soil undisturbed to the greatest extent possible
- Stripping, stockpiling and preserving existing topsoil on-site for reapplication in areas to be landscaped
- Restoring post-construction soils in areas to be landscaped to meet minimum soil quality and depth standards

Recommended approaches to restoring healthy soil functions involve reversing compaction through the use of subsoiling or tilling equipment and incorporating compost and mulch to increase organic matter content. Incorporating compost helps reverse the effects of compaction and adds organic matter. Every one percent of organic matter in a 30 centimeter deep topsoil can hold

up to 16 litres of plant available water per square meter, which adds up to substantial water storage capacity if all landscaped areas in a development meet the recommended standards. Compost also has soil binding properties, acting like glue which aggregates and holds soil particles together, making it more resistant to erosion. When subsoiling and tilling is combined with compost amendment, studies have shown that the volume of runoff produced by a landscaped area constructed on compacted soil can be reduced on the order of 75 to 90%.



Minimum standards for topsoil depth and quality can produce healthier, easier to maintain and more absorbent lawns and gardens. Image source: Soils for Salmon.

How stripping and stockpiling is done on construction sites also affects the quality of topsoil available for reapplication on landscaped areas. To produce healthier topsoil stockpiles, the guide recommends a two-phase topsoil stripping process in which the higher quality topsoil obtained from a shallow first pass of stripping equipment is stockpiled separately from the mixture of topsoil and subsoil obtained from subsequent passes. Keeping the height of topsoil stockpile mounds below two meters and turning them over prior to reapplication is also recommended to minimize the portion of the mounds that become anoxic during storage and to help distribute soil micro-organisms surviving in the top 30 centimeters throughout the mound.

Healthier Landscapes

The lawns, gardens, sports fields, parks and open space components of our communities all contribute to how absor-

bent our urban landscapes are to rain and snowfall. They also contribute to making our cities, towns and villages, beautiful and healthy places to live. Everyone's yard should be a functioning part of the "treatment train" of stormwater management best practices helping to manage urban runoff. By improving on conventional construction practices and municipal standards to ensure all landscaped areas contain healthy functioning soils, the impacts of urbanization on the local water cycle and the health of our urban rivers, lakes and wetlands could be reduced.

A copy of the TRCA guidance document, Preserving and Restoring Healthy Soil: Best Practices for Urban Construction, can be downloaded from the Sustainable Technologies Evaluation Program (STEP) website (www.sustainabletechnologies.ca).

STEP is a multi-agency program, led by the Toronto and Region Conservation Authority. The program helps to provide the data and analytical tools necessary to support broad implementation of sustainable technologies and practices within a Canadian context. The main program objectives are to:

- monitor and evaluate clean water, air and energy technologies;
- assess barriers and opportunities for implementing technologies;
- develop supporting tools, guidelines and policies; and
- promote broader use of effective technologies through research, education and advocacy.

Technologies evaluated under STEP are not limited to physical products or devices; they may also include preventative measures, alternative urban site designs, and other innovative practices that help create more sustainable and liveable communities. **L&W**

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