Rain

"Humankind, despite its artistic pretensions, its sophistication and its many accomplishments, owes its existence to a six-inch layer of topsoil and the fact that it rains."

– Anonymous

What is Green Infrastructure?

From Wikipedia:

“Green Infrastructure is a network providing the “ingredients” for solving urban and climatic challenges by building with nature.

The main components of this approach include stormwater management, climate adaptation, less heat stress, more biodiversity, food production, better air quality, sustainable energy production, clean water and healthy soils, as well as the more anthropocentric functions such as increased quality of life through recreation and providing shade and shelter in and around towns and cities.

Green infrastructure also serves to provide an ecological framework for social, economic and environmental health of the surroundings”

Green Infrastructure & Rain Water:

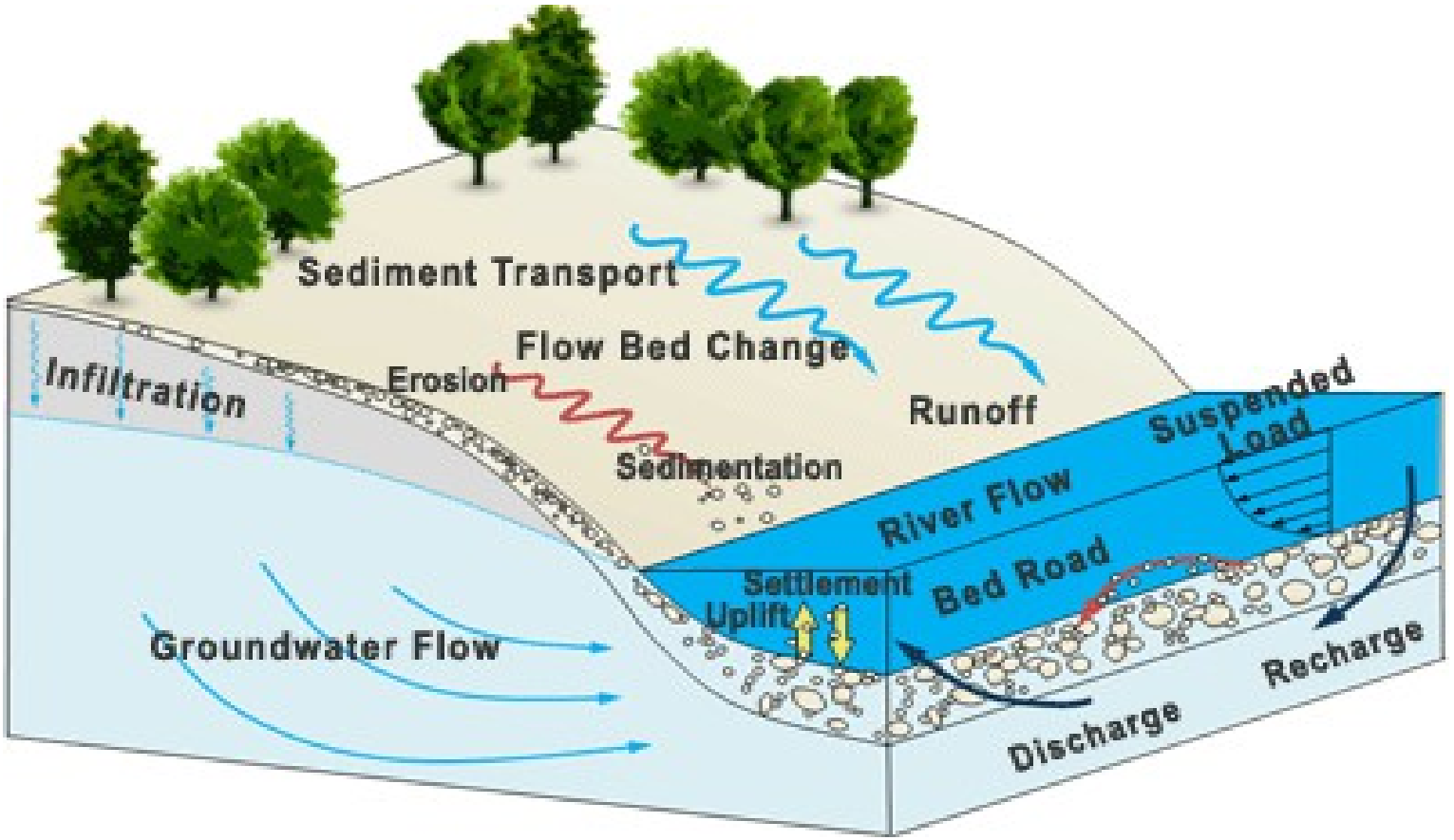
Green infrastructure, as it relates to rain water, is a cost-efficient alternative to the use of gray infrastructure as the default solution to urban rain water management.

Grey infrastructure is still an important part of urban environments, but as a backup for a small portion of the heavier rain fall events, rather than the first and last tool in the toolbox.

The Basic Principle:

- Keep the rain water as close to where is falls as possible, for as long as possible, without it becoming stagnant.
- Ideally long enough for it to flow down into the soil rather than across surfaces or into gray infrastructure.
- A great deal of the rainwater services we rely on are provided by parks, forests, wetlands, floodplains and agricultural lands. Improving their ability to hold rain water would have significant benefits for low lying urban areas.

Water falling straight down isn't the cause of flooding, water flowing across surfaces is.



https://www.getc.co.jp/english/e_services/example/sedimen/

Urban Green Infrastructure:

Urban Green Infrastructure:

Images from https://cvc.ca/wp-content/uploads/2016/11/DISCUSSION-PAPER-Roads-and-Runoff-Implementing-Green-Streets-in-the-Greater-Golden-Horseshoe.pdf

Urban Green Infrastructure:

How much water are we working with?

- Average annual rainfall in Ottawa 920mm
  - High in 25 years 1,348mm (2015)
  - Lowest in 25 years 748mm (2013)
- The most rain falls during the 31 days centered around June 25, with an average total accumulation of 7.6 cm in that period each year

https://www.currentresults.com/Weather/Canada/Cities/precipitation-annual-average.php

https://ottawa.weatherstats.ca/charts/precipitation-yearly.html

https://weatherspark.com/y/23201/Average-Weather-in-Ottawa-Canada-Year-Round

This link includes lots of interesting weather statistics, including wind, sun, snowfall, temperatures etc.

Provincial Infiltration Goals

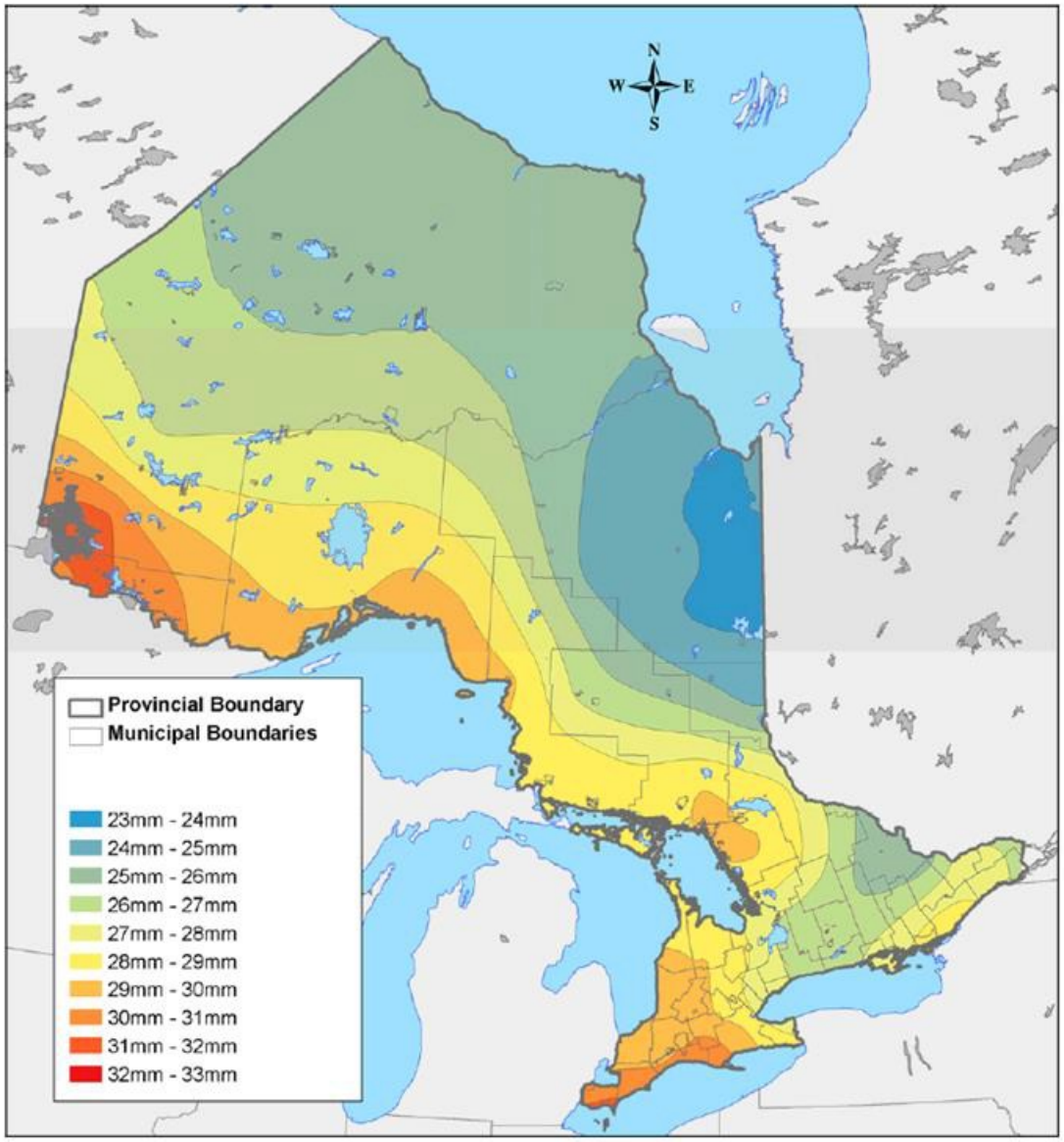


Figure 3.67 – Recommended Regional 90% Percentile Volume Targets for Ontario
(represented by the 95th percentile daily rainfall contours April - October, where daily volume exceeds 2mm).

https://wiki.sustainabletechnologies.ca/wiki/Runoff_volume_control_targets

Infiltrate all of the water from 90% of rain events

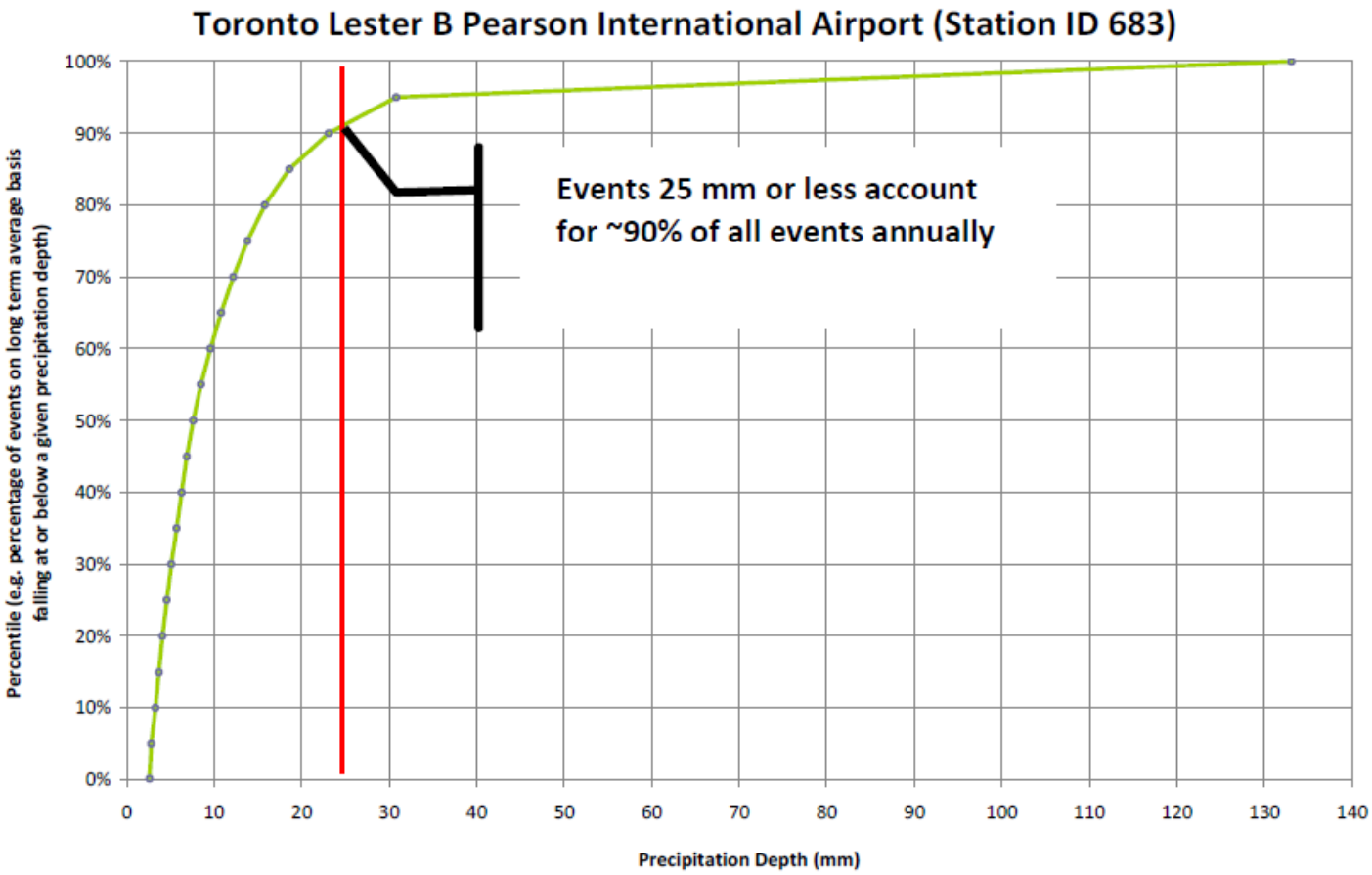


Figure 1.1 - Percentile of Precipitation Events (Toronto Lester B Pearson International Airport

Your soil as a living sponge

Soil is living and that life has huge implications on how soil and water interact.

Demo concept from Didi Pershouse https://lali.teachable.com/

Every 1% increase in soil carbon (organic matter) allows the soil to hold 1” of additional rainfall.

Carbon is only part of the recipe, biological activity is required to create soil structure.

Some of the life in soil:

Bacteria

- Cyanobacteria
- Actinomycetes
- Fungi
- Protozoa
- Nematodes (plant feeding and predatory)
- Anthropods (Micro and other)
- Worms*
- Topsoil that is not covered by a layer of coarse, decomposing organic matter is in decline.

Creating healthy soil environments

- Provide habitat, provide sustenance - If you build it, they will come; If you introduce them, they will establish much more quickly.
- If you can introduce biology (compost) into the sub soil it will remain through more extreme temperature and moisture swings and will encourage deeper root growth, improving water penetration and drought survival.

Compost

- Mixed sources create greatest biological diversity in resulting compost
- Nitrogen bound up in the composting process of carbohydrates becomes available again as the decomposition process progresses. Balancing the nitrogen and carbon ratios in compost allows for all of the carbohydrates to decompose at the same time, rather than sequentially as the nitrogen becomes available.
- Most biological suppressants (allelopathic chemicals) from plant materials break down in composting process, some in as little as 2-3 weeks, most or all within 1 year.

Plants are critical to soil health

- Dense plant cover critical to ecosystem health
- Layers of the ecosystem (don’t omit the bottom layer!)
- Seasonal variation and nutrient retention
- Established landscapes with effective base planting layers do not require regular addition of mulch
- Bare soil is dead or dying soil

Soil Carbon Sequestration

- A percentage of the plant material and fungi in the soil convert to stable carbon (humus). A significant amount of liquid carbon (sugar) is exuded from the roots of healthy plants into the soil microbiome and a portion of this becomes stable soil carbon
- How fast can it work? A hotly debated topic. Some claim they build soil carbon by as much as 10-15% per year, others claim 1-2%
- 0.004 annual increase in soil carbon worldwide would offset all fossil fuel us. https://www.4p1000.org/

Does your soil work?

- Surface infiltration rates of forest and meadow soils that have not been disturbed:
  - Meadow: 300 to 500 cm per hour
  - Forest: 500 to 1000 cm per hour
- Compaction caused by typical construction activities reduces this by 70 to 99 percent*
- Healthy garden soil infiltration rates are anywhere between 20cm and 50cm or more per hour.

*Source:
https://abe.ufl.edu/faculty/mdukes/pdf/stormwater/Gregor-et-%20al-JSWC-compaction-article.pdf

What if it isn't working?

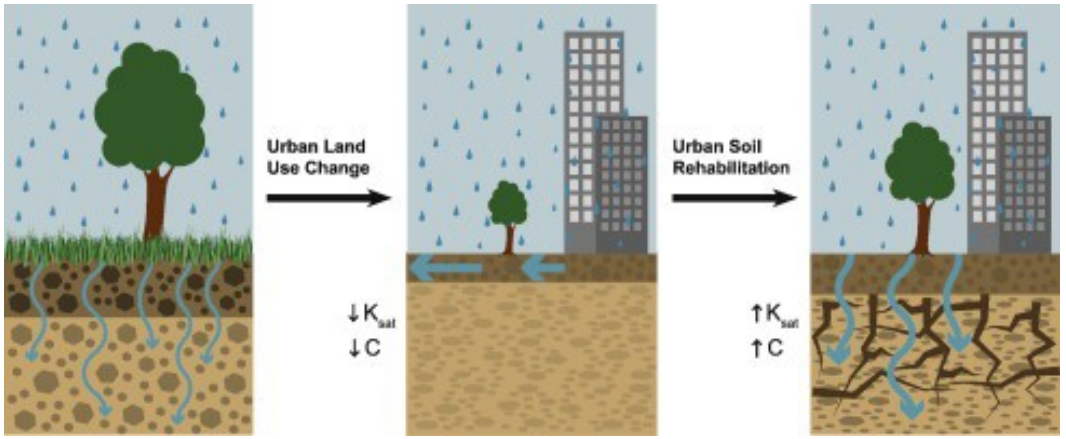
How can you help improve the hydrological function of your soil?

Urban soils are almost invariably missing their natural layering and are heavily compacted.

This results in the loss of much or most of the biological diversity and soil life populations.

While we can't restore the ped structure, we can restore the hydrological function and restart the carbon sequestration cycle. The biology can take it from there.

Urban Subsoiling

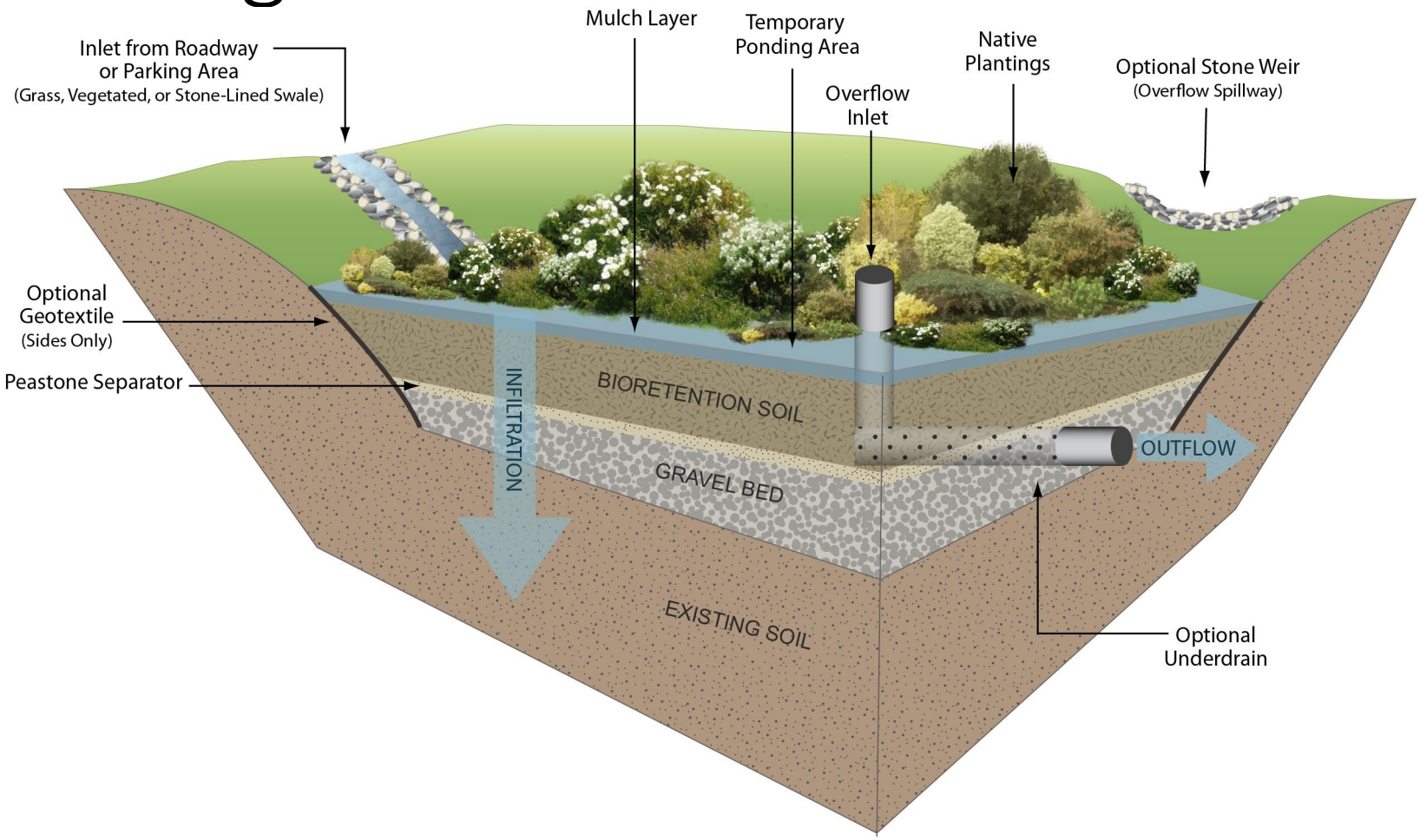


- Restores hydrologic and biological functions
- Does not fully restore soil structure or granule formation
- Rainwater infiltration rates comparable to soil that has not been compacted in cases of equivalent surface plantings (20cm+ per hour)
- Restores carbon sequestration cycle (stable with turf cover, active sequestration with more intensive plantings)
- Fosters success and dense, drought resistant turf in high-use zero-input turf area

Urban Subsoiling

- Repairing the damage:
- Breaking up compaction to a depth of 50cm prior to application of topsoil and plant material installation
- Till compost (not topsoil) in as deep as possible (study I read only managed a depth of 20cm given conditions and available equipment)
- Apply blended topsoil and compost as finish layer

Bio-retention or infiltration Rain gardens



http://prj.geosyntec.com/npsmanual/bioretentionareasandraingardens.aspx

Infiltration swales vary in design

https://cellcode.us/quotes/government-state-delaw

- By USEPA Environmental-Protection-Agency - Rain Garden, Public Domain, https://commons.wikimedia.org/w/index.php?curid=51969907

Infiltration isn't always good

- Near buildings or other foundation areas excess water can be damaging
- If water contains contaminants it can be harmful to groundwater
  - Sodium Chloride may be exempt from environmental protection laws when applied to roads but that doesn't change its environmental impact.

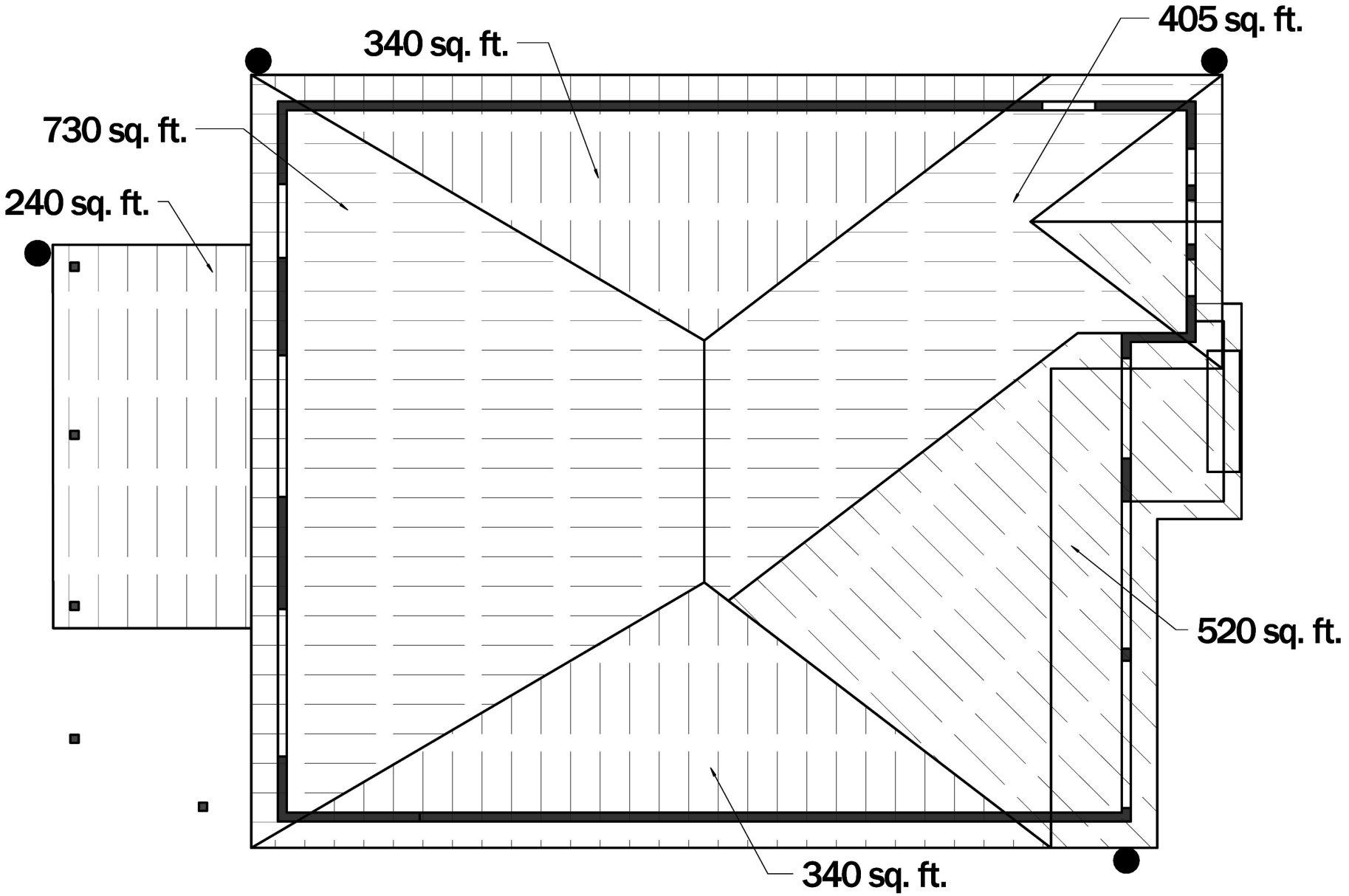
Salt use best practices here if you are interested:

https://conservationontario.ca/fileadmin/pdf/conservation_authorities_section/SWP_Good_Practices_Salt_Vulnerable_Areas_2018.pdf

Source Water Protection maps for Ontario:

https://conservationontario.ca/conservation-authorities/source-water-protection/source-protection-plans-and-resources/

How much water are you working with?

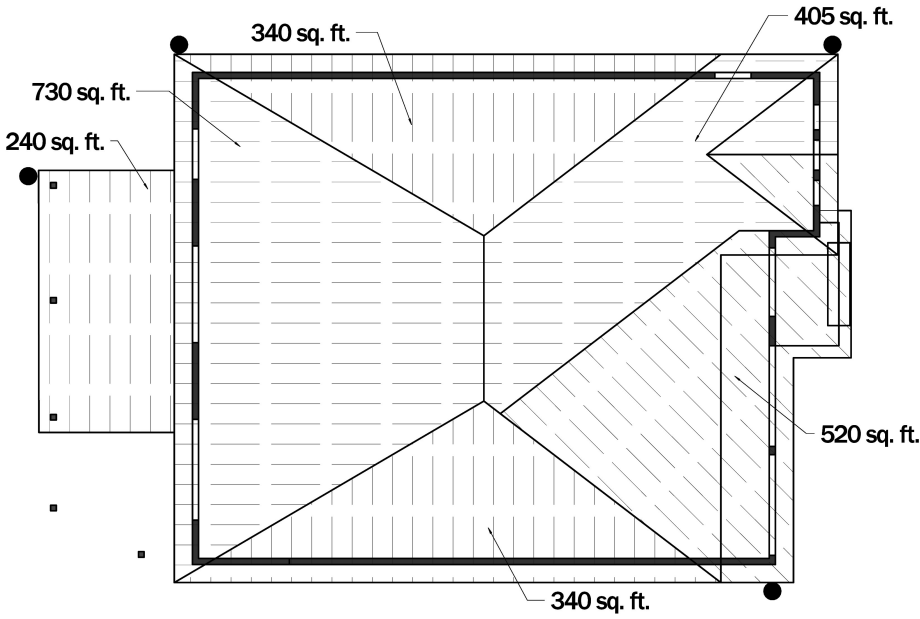


Quick calculations

- Measure the outside of your house and sketch it on graph paper (1 square to either 1' or 2' usually works)
- Use Google or http://maps.ottawa.ca/geoottawa/ to take a look at the top of your house and roughly work out how much of it drains to each down spout.
- In a 1” rainfall every 12 sq. ft of roof will collect 1 cubic foot of of water

Quick calculations

- Cubic feet x 7.48 = gallons
- Cubic feet x 28.32 = liters
- A large rain barrel holds 55 gallons / 220 liters
- The downspout with the most flow would fill 11 rain barrels in a 1” rain event
- The total house would fill 27 rain barrels in a 1” rain event



Design and build your rain garden

- Select an area away from structures and large trees.
- Decide whether you are trying to catch all of the rainwater within the rain garden or if will primarily function as a dispersal point for water to flow into other garden or turf areas.
- Excavate the area that you select and line it with filter fabric if there will be any rain before the gravel and planting media are installed.

Design and build your rain garden

- Fill the bottom with clean, coarse stone, topped with a 4” layer of fine chipped stone (Premium Bedding Stone from Greely Sand and Gravel is a good option)
- Top with 12 to 24” of planting media - Planting media should be a blend of coarse sand and organic mater, very low in silt and clay.
- Top with 3” of mulch, either wood or gravel.
- Place gravel or river stone where water will flow.

Design and build your rain garden

- Remove filter fabric from bottom of garden
- Fill the bottom with clean, coarse stone, topped with a 4” layer of fine chipped stone (Premium Bedding Stone from Greely Sand and Gravel is a good option)
- Top with 12 to 24” of planting media - Planting media should be a blend of coarse sand and organic mater, very low in silt and clay.
- Install your plants.
- Top with 3” of mulch, either wood or gravel.
- Place gravel or river stone where water will flow.

Design and build your rain garden

- Make sure to plan for a place for excess water to flow away to.
- Try to avoid having surface water flow into the garden, it will introduce silt and eventually clog the drainage.
- Don't install fabric between the layers in your garden, it will clog over time and stop the water from flowing through.
- Expect 30% to 40% voids in the rain garden media and base, so if you have a garden that is 5'x8'x2' deep it can hold roughly 32 cubic feet or 900 liters of water

Things to remember when designing your rain garden

The water soaks down and out – Rain gardens are better away from your house and other structures

They are not meant to have standing water for long so, if they are properly designed, they don't attract mosquitoes.

Because they are designed to drain quickly they are dry more often then wet – select plants accordingly.

They need an overflow area for extreme rainfalls.

The area where the water flows needs to be covered by something that won't wash away

Resources:

- Infiltration Calculator:

https://wiki.sustainabletechnologies.ca/wiki/Drainage_time

- Sustainable Technologies Wiki

https://wiki.sustainabletechnologies.ca/wiki/Main_Page

- Sustainable Technologies Evaluation Program (STEP)

https://sustainabletechnologies.ca/

Plants - Cover all of the ground

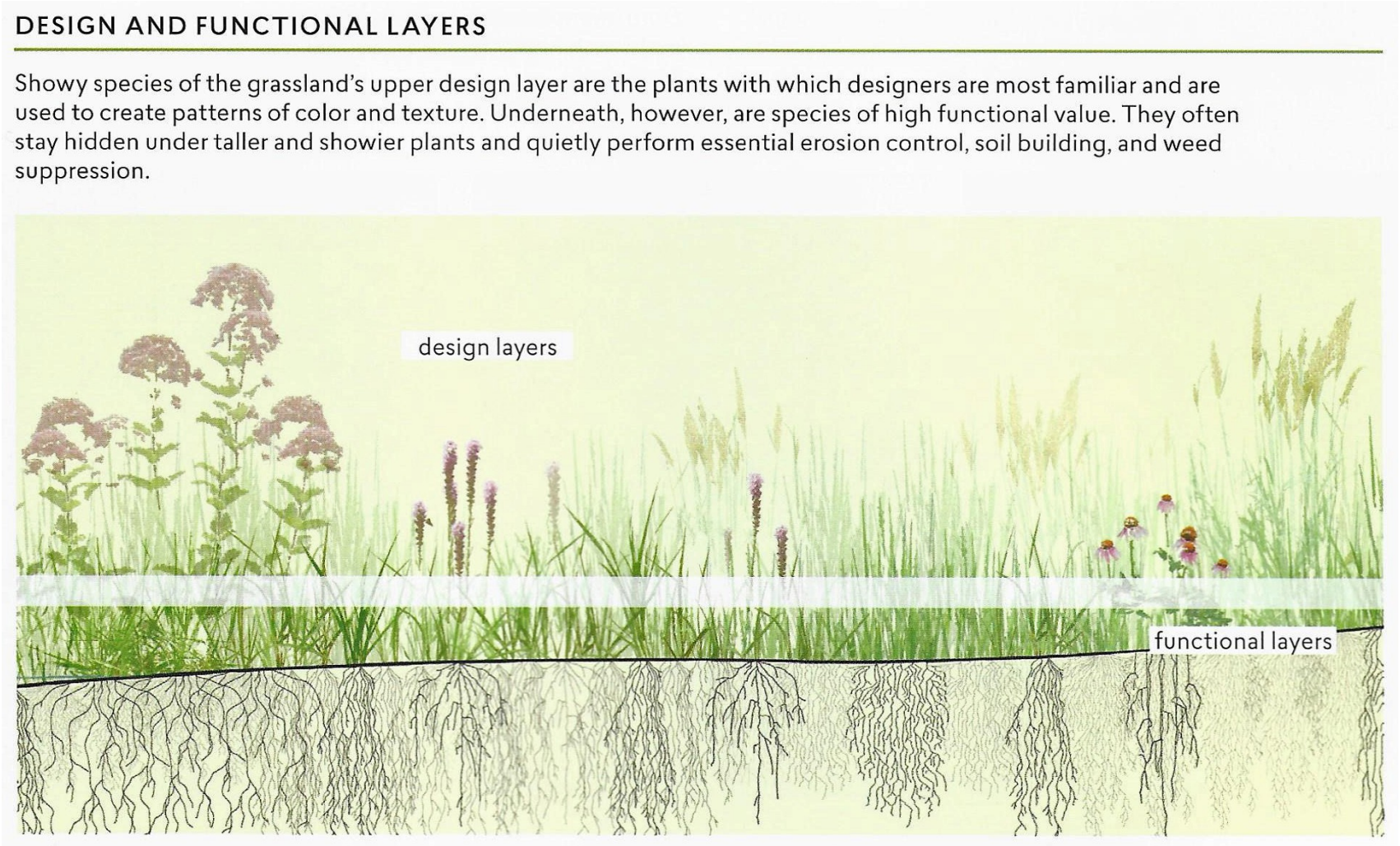


Image from Planting in a Post-Wild World by Thomas Rainer

Plants: Respect the conditions

Rain gardens dry out quickly. Plants need to be tolerant of both wet and dry conditions.

Many plants adapted to natural conditions (as opposed to garden conditions) work well in rain gardens.

Some of the tougher garden plants also work well for very difficult or salt exposed conditions

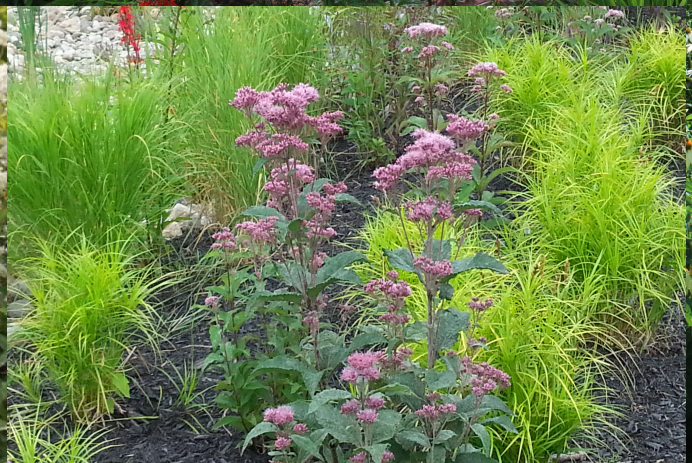
Plants: Native

- Start by looking for plants that are adapted to moist meadows (or woodlands, if your area is shaded).
- Plants close to their wild genetics will be more adapted to the variable conditions in rain gardens.
- Locally native plant species will also provide habitat for locally adapted insects and birds, layering an additional important function into a single space.
- You can find a good list here:
- http://guelph.ca/wp-content/uploads/HealthyLandscapes_RainGardens.pdf







Any Questions?

A copy of this slide show, with click-able links, can be downloaded from the SOUL website at:

Organiclandcare.ca on the resources page.

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