



Vegetating Green Infrastructure

putting the green in green

May 9, 2014

Outline [green infrastructure vegetation needs to...]

1. absorb stormwater



2. look good



3. be maintainable



4. examples



stormwater [vs. rainwater]

language matters...

STORMWATER: 'hazardous rain' (sediment, pollution, velocity, temperature, etc.)



If can capture prior to its transformation, then it's **RAINWATER.**



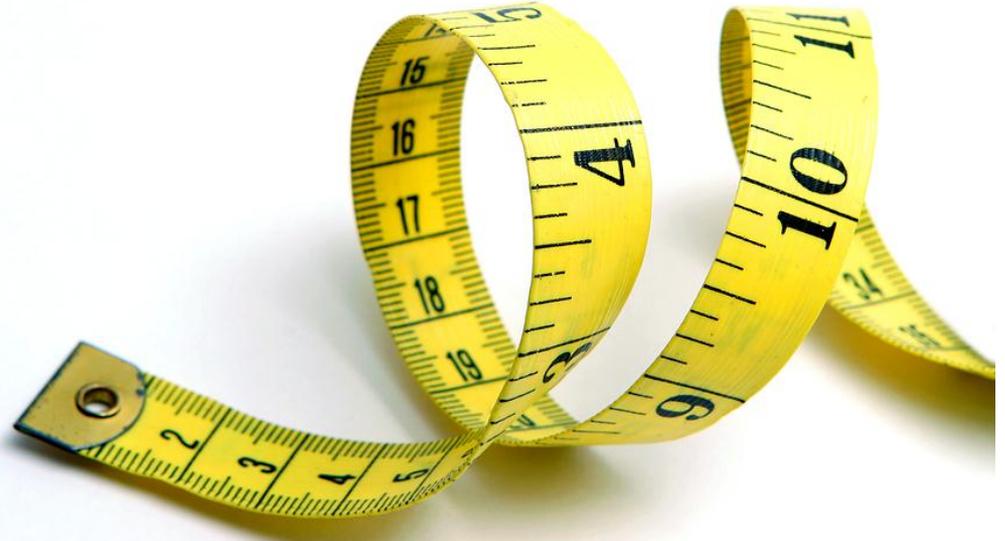
If you are treating its altered state, then you are dealing with the reality of stormwater and must plan for its impacts—especially on plants.

1

absorb [stormwater]

most stormwater standards based in the easily testable/measurable

- area
- slope
- length of treatment train
- void space
- infiltration capacity of soils



performance of plants (other than coverage) don't fit neatly into inexpensive and measurable standards (shade/sun, soils, wisdom of design, maintenance, etc.)

absorb stormwater [the power of plants]

why people use lawn

- predictable
- culturally acceptable
- dense surface germination
- maintenance regime clear (however...)



- A lawn mower pollutes as much in one hour as 40 automobiles driving
- 30-60 percent of urban fresh water is used for watering lawns
- 67 million pounds of pesticides are used on U.S. lawns each year
- 580 million gallons of gasoline are used in lawnmowers each year

absorb stormwater [the power of plants]

why lawn doesn't measure up

- 6 inch roots max.
- doesn't like prolonged standing water



- not hardy without inputs of watering/fertilizing



absorb stormwater [the power of plants]

why lawn doesn't measure up

- doesn't penetrate deeper soil layers which can affect soil development and therefore, infiltration

University of Wisconsin study, 2010

prairie vs. lawn rain gardens

After 5 years, prairie rain gardens:

- greater median infiltration rates
- prairie roots 4.7 feet deep vs. lawn .46' feet
- greater biological activity
- greater earthworm activity
- greater pedoturbation and soil development

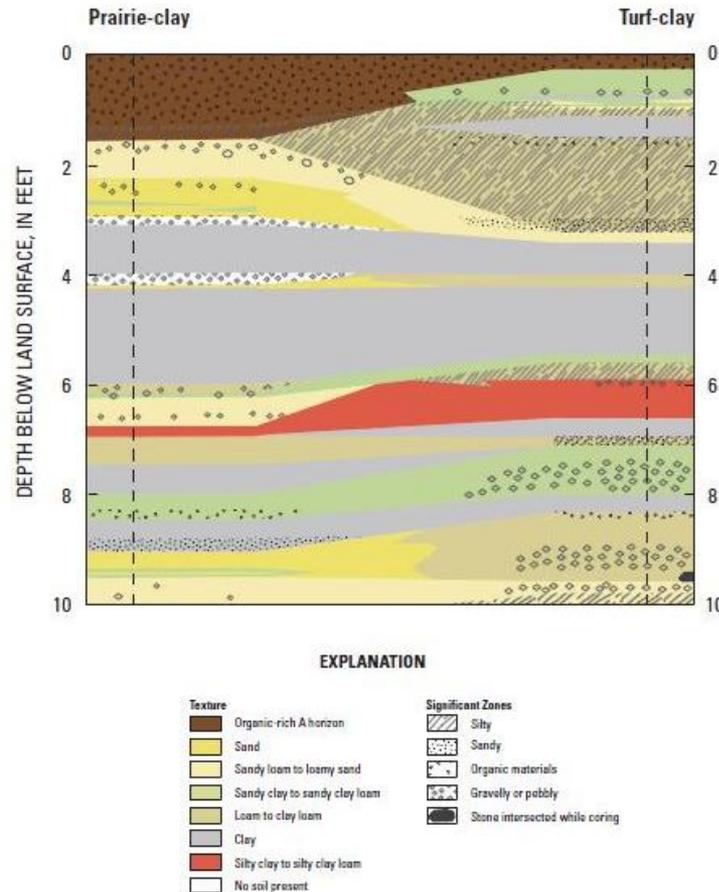
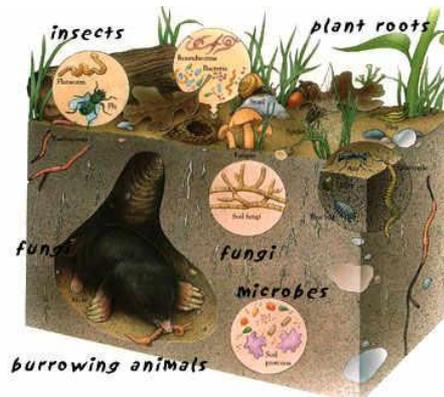


Figure 9. Cross section of soils and subsurface deposits between the turf and prairie rain gardens in clay.

absorb stormwater [the power of plants]

why some native plants perform (with informed design)

- evolved in this region to tolerate conditions of wet/dry cycles
- deep roots
- builds soil health (mixing of surface organics, macrofauna, water, and air deeper into soil profile)
“living creatures in the upper soil horizons can have a bigger impact on infiltration than the inherent permeability of the inorganic component of the soil (Dierks, 2011)”
- Australian study 2012 on root types and hydraulic conductivity



USGS
science for a changing world

Prepared in cooperation with the City of Madison and Wisconsin Department of Natural Resources

Evaluation of Turf-Grass and Prairie-Vegetated Rain Gardens in a Clay and Sand Soil, Madison, Wisconsin, Water Years 2004–08



Scientific Investigations Report 2010–5077

U.S. Department of the Interior
U.S. Geological Survey

absorb stormwater [the power of plants]

why some native plants work--bonus advantages

- create habitat
- complex associations and relationships



absorb stormwater [the power of plants]

- doesn't necessarily have to be native to do the job of stormwater absorption (though roots not as extensive)



- can be cultivars of native plants

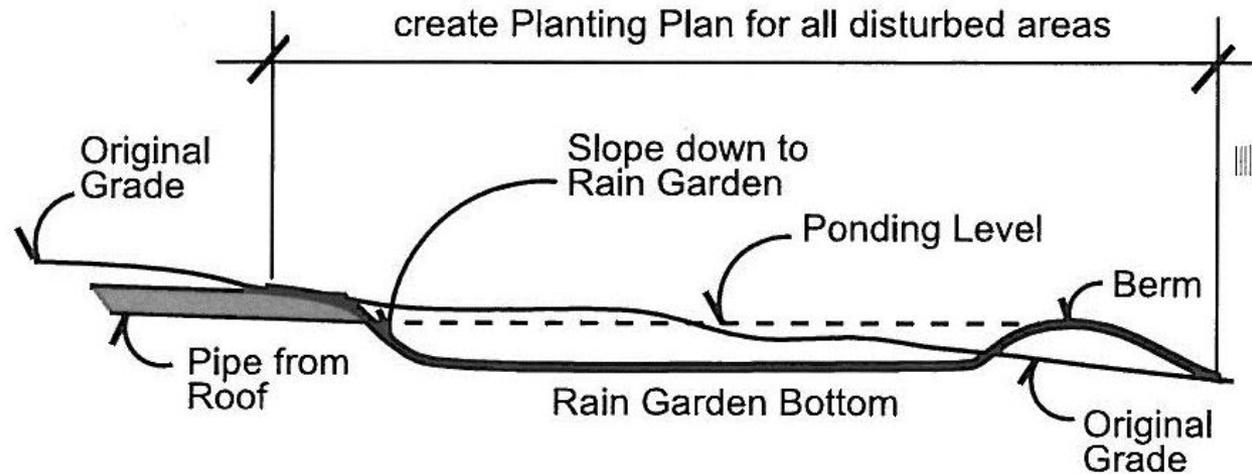


- more expensive (native plugs vs. gallon perennials)

absorb stormwater [the power of plants]

good stormwater design for plant success

- 6 inch depth
- slopes vs. bottom
- soil type and affect on sizing



- catchment area—don't expect miracles

2

look good [type of GI]

location—proximity to people and views

‘cues to care’ important:
intentional edges

- design itself
- lawn
- fence
- sign



look good [bioswales]

parking lot or road side—likely visible



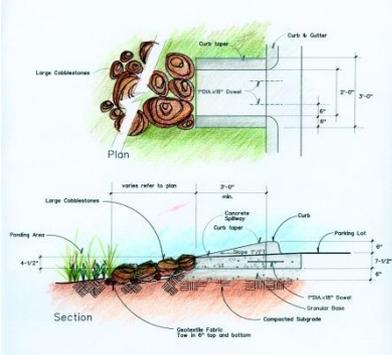
salt damage and snow piles
(direct the snow plowing pattern if possible)

look good [bioswales]

the myth of sheet flow



protecting plants at point flow entry

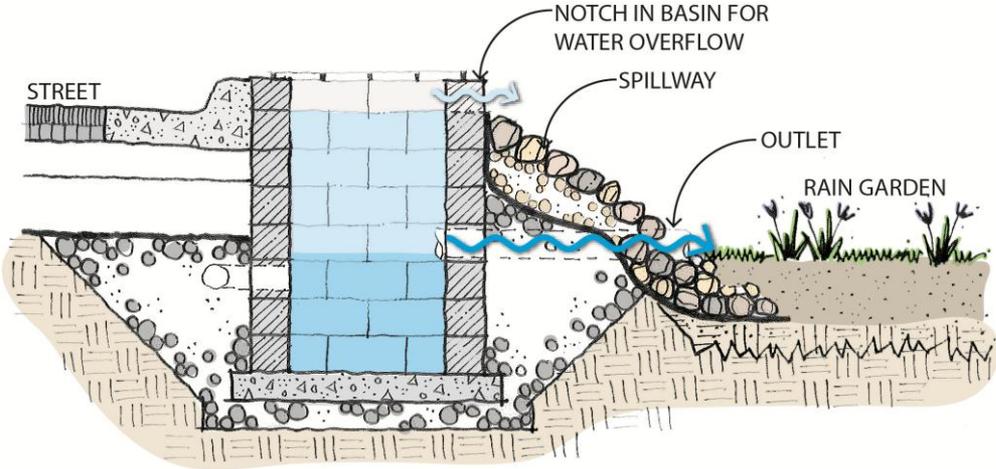
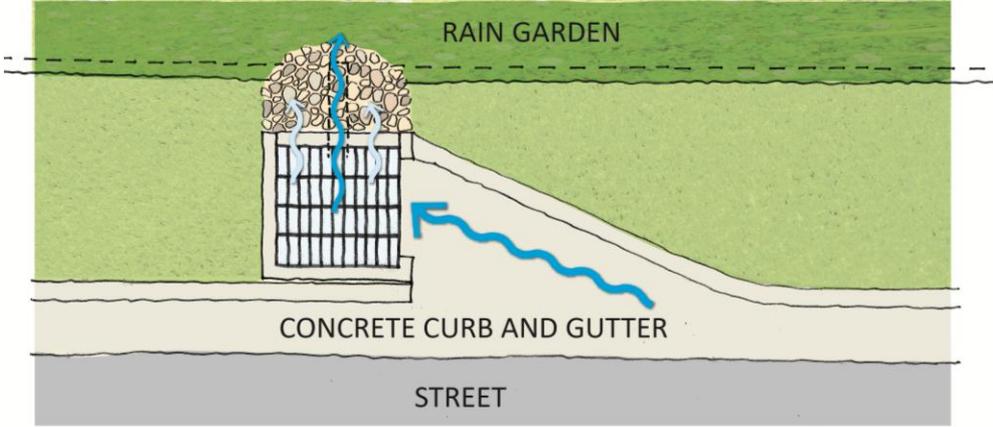


issues of sediment and velocity



look good [bioswales]

Issues: sediment and maintenance

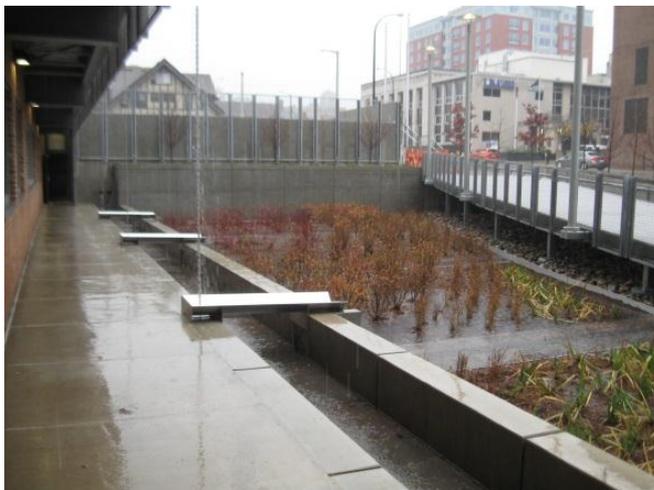


look good [planters]

high visibility with close views

often right next to structure—foreground to building

- neat
- massing
- layers
- dormant seasons



look good [rain garden + detention basin]

location, location, location!

if far off from people, don't need as much control over looking good (seeding option)

- visible edge condition important



if close, needs more care and organization for human visual preferences



look good [general principles]

structure



massing

don't just think about color of blooms—texture, line, patterns, height



many people tend to balk at much height—if close up, 4' and under except for punctuation of trees and shrubs

3

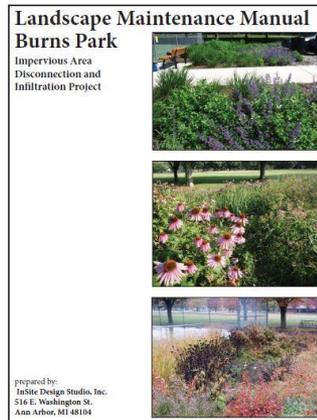
maintenance [how to promote success]

no such thing as no maintenance!

•site assessment:
know thy enemy...



•maintenance
plans



Field Guide: Maintaining Rain Gardens, Swales and Stormwater Planters (2013)
This document is available on the Oregon State University Stormwater Solutions website: <http://www.extension.oregonstate.edu/stormwater/sites/default/files/fieldguide.pdf>
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•budget

<http://extension.oregonstate.edu/stormwater/sites/default/files/fieldguide.pdf>

•defined
responsibilities



3

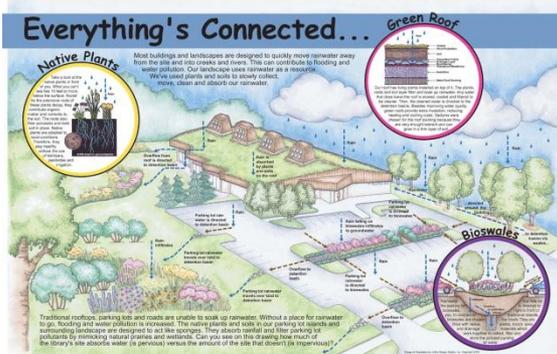
maintainable [weeding]

for highly visible GI—weed and mulch like a perennial bed



let them be the dressing up for your project—front and center

interpret them and educate your users—'green points'



maintainable [weeding: how design helps]

think about massing areas (even if irregular in shape) planted on a basic grid or lines—maintenance crews can see the intent



4

the plants [structure: shrubs, trees, grasses]



red twig dogwood



elderberry



potentilla



arrowwood viburnum



redbud



ninebark & cvs.



gray dogwood & cvs.



switch grass & cvs.

the plants [height]

The 3 foot (and under) club for **SUN** (from wet to drier):



wild iris



fox sedge



switch grass 'Shenandoah'



Canada anemone



obedient plant



riddell's goldenrod



purple coneflower



prairie dropseed



nodding wild onion

the plants [height]

The 3 foot (& under) club for **SHADE** (from wet to drier):



wild iris



sensitive fern



fox sedge



Canada anemone



great blue lobelia



astilbe (not native)



'hot lips' turtlehead



wild columbine



wild geranium

the plants [low spreaders/creepers at edge]



wild strawberry



common cinquefoil



Canada anemone

the plants [not-so-polite, but good performer plants]



boltonia



'obedient' plant



wild strawberry



Canada anemone



switch grass



boneset



big bluestem



yellow coneflower



golden alexander



false sunflowers

the plants [other taller good performers]



swamp milkweed—use with fox sedge



snakeroot



new england aster—needs facer or trim



prairie dock



joe pye weed



false sunflowers

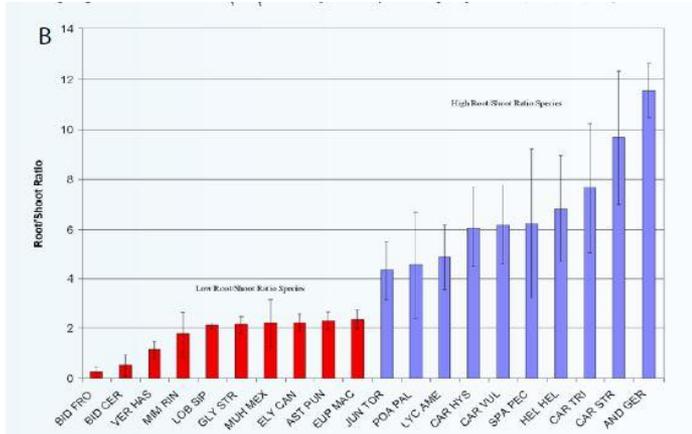


blue vervain

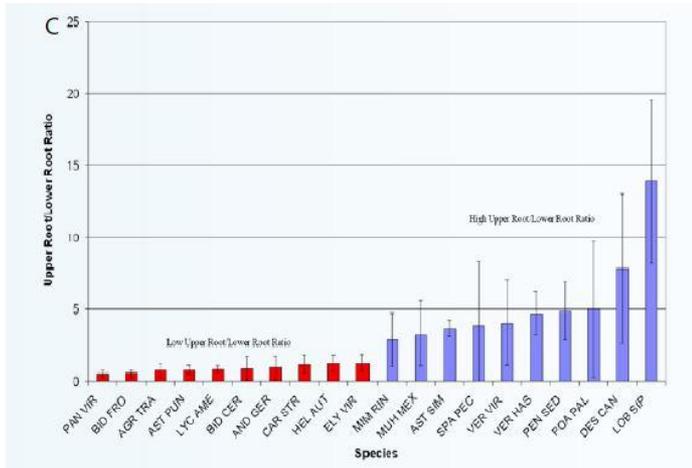


ironweed

the plants [herbaceous root study]



root/shoot ratio



upper root/lower root ratio

Standouts:



switch grass



fox sedge



big bluestem



tussock sedge



sneezeweed



fox sedge roots



THE AMAZING DIVERSITY OF ROOT FORMS AMONG NATIVE WETLAND PLANTS

Linking root architecture to soil processes is a research frontier (Reubens et al. 2007). Early writings about root architecture (Lynch 1995) describe various forms of roots, ranging from fibrous to taproot, and a recent paper (De Baets et al. 2007) used the simple model of branched roots vs. carrots to compare effects of root architecture on water erosion rates. But looking beneath the surface of the soil, that is, students in Adaptive Restoration Lab (Botany 670 Class 2007) found many variations in root attributes among the 40 species they studied. All were grown by Arboetum Project Assistant Josh Brown during summer in microcosms (6" diameter, 17" height pots) at the Arboetum's outdoor Mesocosm Facility.

WHY THE "GROWING INTEREST" IN ROOTS?

According to Reubens et al. (2007), "it is clear that control of soil movement by roots is highly dependent on the root system architecture...very little attention however has been paid to morphological root characteristics." Thus, these Belgian authors call for research to develop ways to characterize roots that will lead to "sound management decisions concerning species selection for land rehabilitation."

Our interest began with the Arboetum plan to create new stormwater facilities with channels and pond edges that need to be vegetated. Rejecting the common target of a cattail-lined pond, the Arboetum Stormwater Committee endorsed the use of diverse native plantings. But which species would function best in erosion reduction and stormwater infiltration?

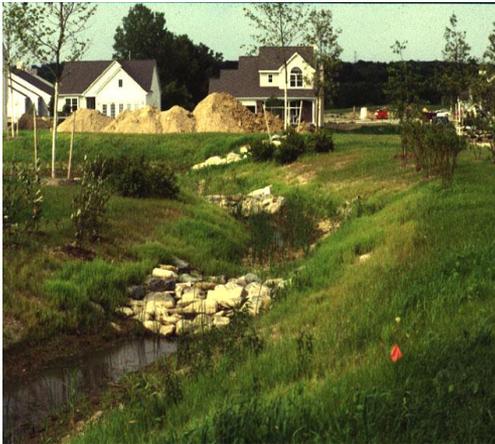
TESTING THE BENEFITS OF ADDING TOPSOIL

In proposing green ideas for the Arboetum's planned stormwater facilities, we learned that project permittees require the addition of 6" of topsoil as a "best management practice" for establishing vegetation in stormwater basins and channels. This requirement is counter to two scientific findings: (1) *topsoil addition favors growth of shoots over roots*, leading to heavy shoots and weak roots, i.e., plants that would be easily uprooted and washed downstream during a heavy rain event; and (2) *topsoil can leach nutrients to downstream waters*. As an example, the new stormwater basin north of the new power plant on the UW campus has the required 6" of topsoil, and indeed, native plants are growing well above ground. In summer, a thick algal scum also thrives, suggesting that the nutrient-rich topsoil added nutrients on site and to water that flows to Lake Mendota. Thus, we included a second experimental

the plants [seed vs. plug]

When to use, and *not* to use seed

- no point flow for seed!
- timing must be right
- erosion control blanket
- cover crop



conclusions [why we are here]

