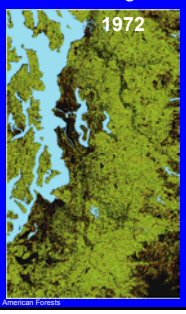
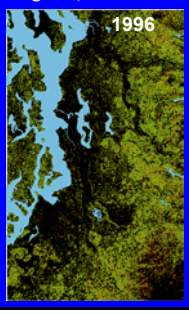
Stormwater Challenges in Urban Landscapes, and the Toolbox of Solutions

David McDonald
Seattle Public Utilities
david.mcdonald@seattle.gov
introduction to the seminar
Stormwater:
Turning a Potential Problem into an Asset
at UW Center for Urban Horticulture, 1/25/06
(first presented 2/24/04, 2nd 1/27/05)

The Stormwater Problem:
Impacts of turning spongy forests into cities

1972-1996: Amount of land with 50% tree cover decreased by 37% in Puget Sound region (from 42% of land down to 27%).





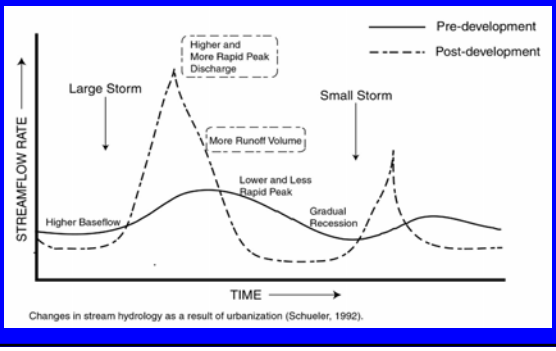
American Forests

Impervious surface (roads, buildings) increased proportionately.

WA population doubled 1962-98.

2.7 million more people by 2020!

Changes in hydrology (runoff vs. infiltration) after development



Changes in stream hydrology as a result of urbanization (Schueler, 1992).

What happens to soils and soil functions as we turn forests into cities?

↑compaction
↑erosion
↑loss of topsoil
↓soil organisms
↓soil structure
↓natural fertility & disease prevention
↑impervious surface

cause:

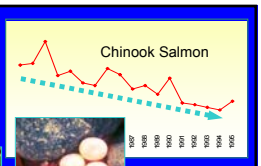
↑winter runoff
↑need for irrigation & chemicals
↓biofiltration of pollutants

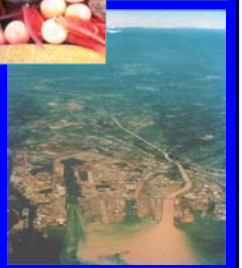
What happens to streams as we turn forests into cities?

↑runoff = ↑peak storm flows
↑erosion of stream bank and bed
↑fine sediment choking spawning gravels
↑pollutants (automotive, landscape fertilizer and pesticides)
↓groundwater recharge
↓summer low flows
↑summer stream temperature
↓oxygen in spawning gravels
↓LWD - logs and rootwads that young salmon need
↓food supply for young salmon

What are the impacts?

- Salmon decline
- Pollution
- Erosion
- Flooding & property damage
- Failing landscapes





What does current science tell us?

- Biological integrity of streams decreases rapidly when total impervious area in watersheds exceeds 5-10%.
- Traditional stormwater detention structures in developed areas are insufficient to prevent storm damage to streams.
- Salmon are in trouble unless we change our development practices.
- We need to:
  - decrease construction footprint
  - decrease impervious area (roads, houses)
  - maintain natural "buffer zones" along streams
  - preserve native soils and forests
  - restore ability of disturbed landscapes to detain & infiltrate rainwater

The solutions:
Turning Stormwater into an Asset

- **Goal:**
  - Onsite management of stormwater quantity and quality that mimics predevelopment site function
- **Strategy:**
  - Protect existing soils & vegetation, where possible
  - Restore/replace soil & veg. functions on disturbed sites
- **Objectives:**
  - Decreased runoff and pollution
  - Reduced landscape needs for water and chemicals
  - Creative, elegant, and appealing site design
  - Healthier, more sustainable landscapes

Today's presentations:
A Toolbox of Solutions, for a Variety of Sites

- Site protection and soil amendment
- Swales for infiltration and bio-filtration
- "Rain gardens" (bio-retention cells)
- Plant selection and architecture for stormwater retention areas
- Permeable paving
- Cisterns
- Green roofs

Start with the Soil - Restoring soil function with organic amendments

Stormwater management with soil best practices

- Incorporate 15-30% compost (by volume) into soil before planting
- Compost amendment builds soil structure, moisture-holding capacity
- Increases surface porosity

UW trials, turf on glacial till soil

Compost-amended till soil – up to 50% reduction in storm water runoff

Erosion and sediment management

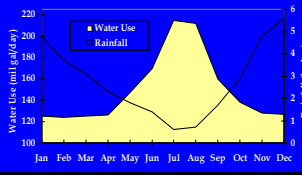
- Compost berms or blankets – slow water, bind surface soil, and reduce erosion immediately
- Enhance survival/growth of plantings, helping to stabilize slopes over long term.

Berms instead of silt fence

Compost blankets on steep slopes

Added benefits of soil amendment

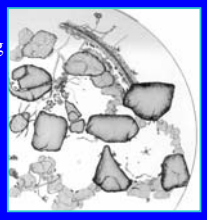
- Improved fertility & plant vigor:
  - Better survival = fewer callbacks
  - Less need for fertilizers and pesticides
  - Reduced maintenance costs
- Bio-filtration of urban pollutants
- Reusing "wastes" (yard waste, manure, biosolids, construction, landclearing waste)
- Reduced summer irrigation needs

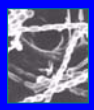


Restoring soil life, to restore soil functions

Soil organisms create:

- soil structure
- fertility = nutrient cycling
- plant disease protection
- biofiltration
- stormwater detention





Compost kickstarts the soil ecosystem!
(Provides food and home for organisms)

How to select compost

Know your supplier!

Field tests:

- earthy smell - not sour, stinky, or ammonia
- brown to black color
- uniform particle range
- stable temperature (does not get very hot if re-wetted)
- moisture content

Specs

- DOE guidelines for Grade A Compost

Mfr.-supplied info:

- Meets Grade A guidelines
- Weed-seed trials
- Nutrients, salinity, contaminants

Soil/compost lab test info:

- Nutrients
- Salinity
- pH
- % organic content

Summary of Soils BMP's

- New Construction
  - Retain and protect native topsoil & vegetation (esp. trees!)
    - Minimize construction footprint
    - Store and reuse topsoil from site
    - Retain "buffer" vegetation along waterways
  - Restore disturbed soils by tilling 2-4" of compost into upper 8-12" of soil.
  - Rip to loosen compacted layers at topsoil/subsoil horizon.
- Existing Landscapes
  - Retrofit soils with tilled-in compost when re-landscaping
  - Mulch beds with organic mulches (leaves, wood chips, compost), and topdress turf with compost
  - Avoid overuse of chemicals, which may damage soil life

Clearing up the confusion about "% organic"

"% Soil Organic Matter Content" (S.O.M.) in lab soil tests is by loss-on-combustion method

- Most composts are 40-60% organic content by this method

<u>Recommended soil amendment rates</u>
(for low-organic soils):

- <u>5% Soil Organic Matter Content for Turf</u>
  - produced by 15-20% compost amendment by volume
- <u>10% Soil Organic Matter Content for Landscape Beds</u>
  - produced by 25-30% compost amendment by volume

WA State Guidance on soil & other BMPs: DOE's 2001 Stormwater Mgmt. Manual

- Equivalency will be required for Phase 1 NPDES permittees (big cities and counties)
- Volume V, Chapter 5 - "On-Site Stormwater Mgmt."
  - Downspout, sheet, & concentrated flow dispersion
  - BMP T5.13 Post-Construction Soil Quality and Depth
  - Other Site Design BMP's including preserving vegetation, cisterns, roofs, rain gardens, porous paving, soil compaction protection, & T5.35 "Engineered Soil/Landscape Systems"
- Volume III, Chapter 3 - "Flow Control Design"
  - Downspout infiltration and dispersion

www.ecy.wa.gov/programs/wq/stormwater/manual.html

DOE BMP T5.13
Post-Construction Soil Quality and Depth

- Retain native soil and duff wherever possible
- All areas cleared and graded require 8 inch soil depth:
  - Soil organic matter content ≥ 10% dry weight (by loss on combustion method)
    - 10% O.M. results from roughly 25-30% compost by volume added to low-organic subsoil).
    - May use native topsoil, incorporate organic amendments into existing soil, or bring in topsoil blend to meet spec
  - pH 6-8, or original pH
  - Subsoil scarified 4 inches below 8-inch topsoil layer
  - Protected from compaction after amendment
  - Mulched after planting, & maintained by leaving organic debris

Guidelines Manual for Implementing BMP T5.13

- Manual developed regionally in consultation with experts
- Proposes 10% O.M. for landscape beds, but 5% for turf
- Develop a "Soil Management Plan" for each site
- Four options for soil management in different areas of site:
  1) Leave native soil & vegetation undisturbed, protect from compaction
  2) Amend existing soil in place (with compost or other organic)
  3) Stockpile site topsoils prior to grading for reapplication
  4) Import topsoil meeting organic matter content standards
- Choose pre-approved or custom calculated amendment rates
- Simple field inspection and verification procedures
- Includes model specs written in CSI and APWA formats
- Available at: **www.soilsforsalmon.org**

Putting organics to work - restoring soil functions

Redmond Ridge, Quadrant Corp.

- Large, master-planned development
- Forest left undisturbed where possible - no compaction
- Cleared vegetation & duff stockpiled for use as amendment
- Removed topsoils stockpiled
- All soils amended to 12" depth with organics
- **Early Problems:** Too much organic esp. for turf areas, organic materials not composted (landclearing & duff) - soft soil, excessive water retention, low N, plant/turf problems as result

Redmond Ridge: current method

- Grade site 12 in. below finish
- Install foundation, along with driveway & walkway rock pads
- Spread 14 in. amended soil mix, (will settle to 12 inches) rip in first lift to mix with subsoil
- Soils blended offsite from native duff plus compost
- Soil organic matter controlled to ~10%, pH and C:N ratio for optimal plant growth

Putting organic soil amendments to work - SEA Streets

Street Edge Alternative onsite detention demo, Seattle Public Utilities and SDOT.

- Compost in wet and dry zones
- **98% reduction in runoff.**

www.seattle.gov/util/NaturalSystems/

Broadview Green Grid, Seattle

compost-amended soil in bio-retention swales

Broadview -
erosion control with compost blankets, berms, and socks

WsDOT projects around Washington

Erosion control with compost Blankets

Chelan

Extensive soil bio-engineering info at:
www.wsdot.wa.gov/eesc/cae/design/roadside/SBwebsite/mainpage/Index.html

Soil Amendment

Photos courtesy of Sandy Salisbury, WSDOT

SR14, Vancouver

A natural solution -
for healthier streams, and healthier landscapes

- Conserve existing soils and vegetation where possible.
- Restore natural functions in disturbed soils by reducing compaction and using organic amendments.

download the Soil BMP manual at
Washington Organic Recycling Council
www.SoilsforSalmon.org

download the new Low Impact Development Technical Manual at
Puget Sound Action Team
www.psat.wa.gov/Programs/LID.htm