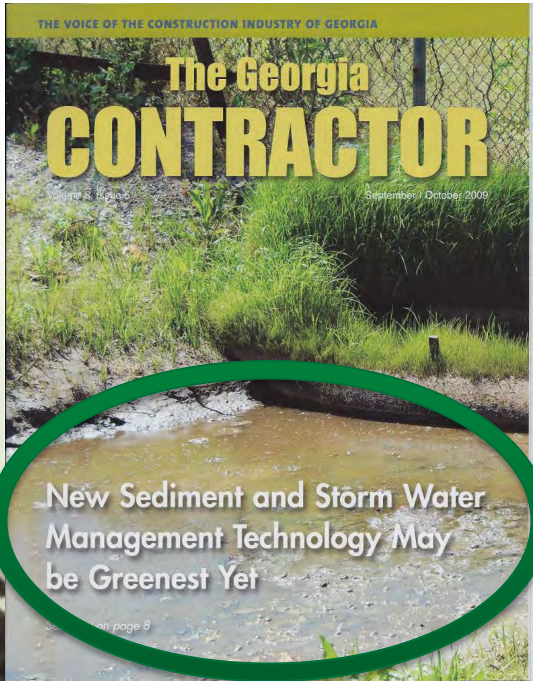
Working *with* Nature:

Compost-Based BMPs in Green Infrastructure & LID Applications

Dr. Britt Faucette,
PhD, CPESC, LEED AP
Filtrexx International

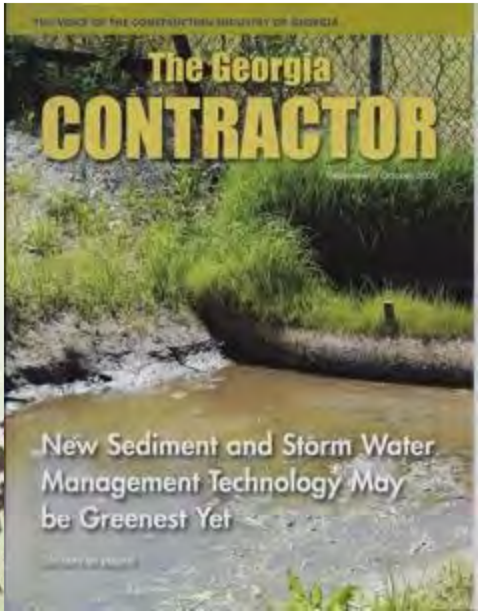
When you manage organic matter, you also manage the water cycle, carbon cycle, nutrient cycles, and climate.



Outline

- Stormwater/Water = Green Infrastructure (LID)
- Compost & Stormwater *Volume* and *Biofiltration*
- Compost Applications (BMPs)
- Research, Performance, & Design
- Case Studies
- Q/A

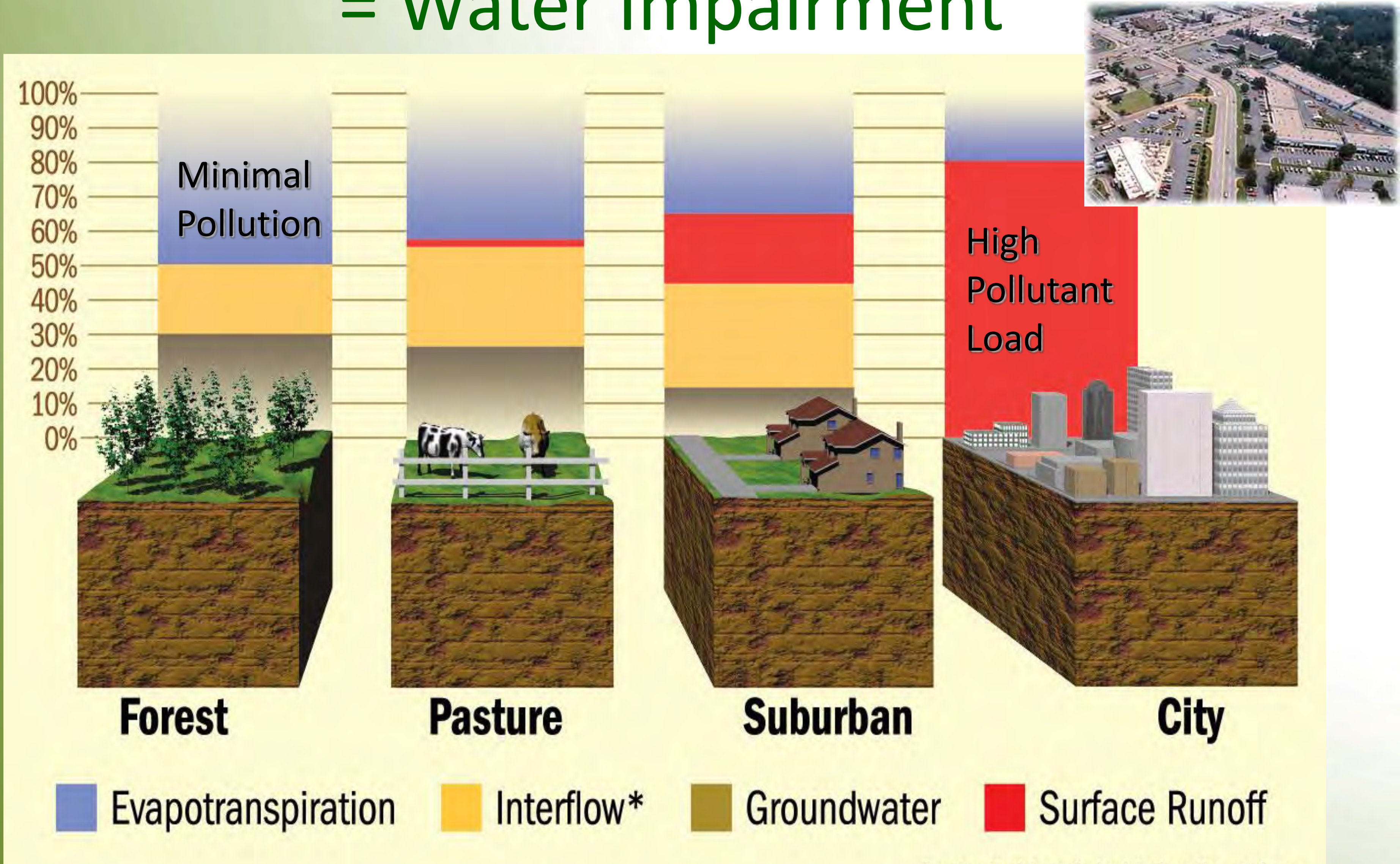
✓ *Ecosystem Services*



Stormwater Impact

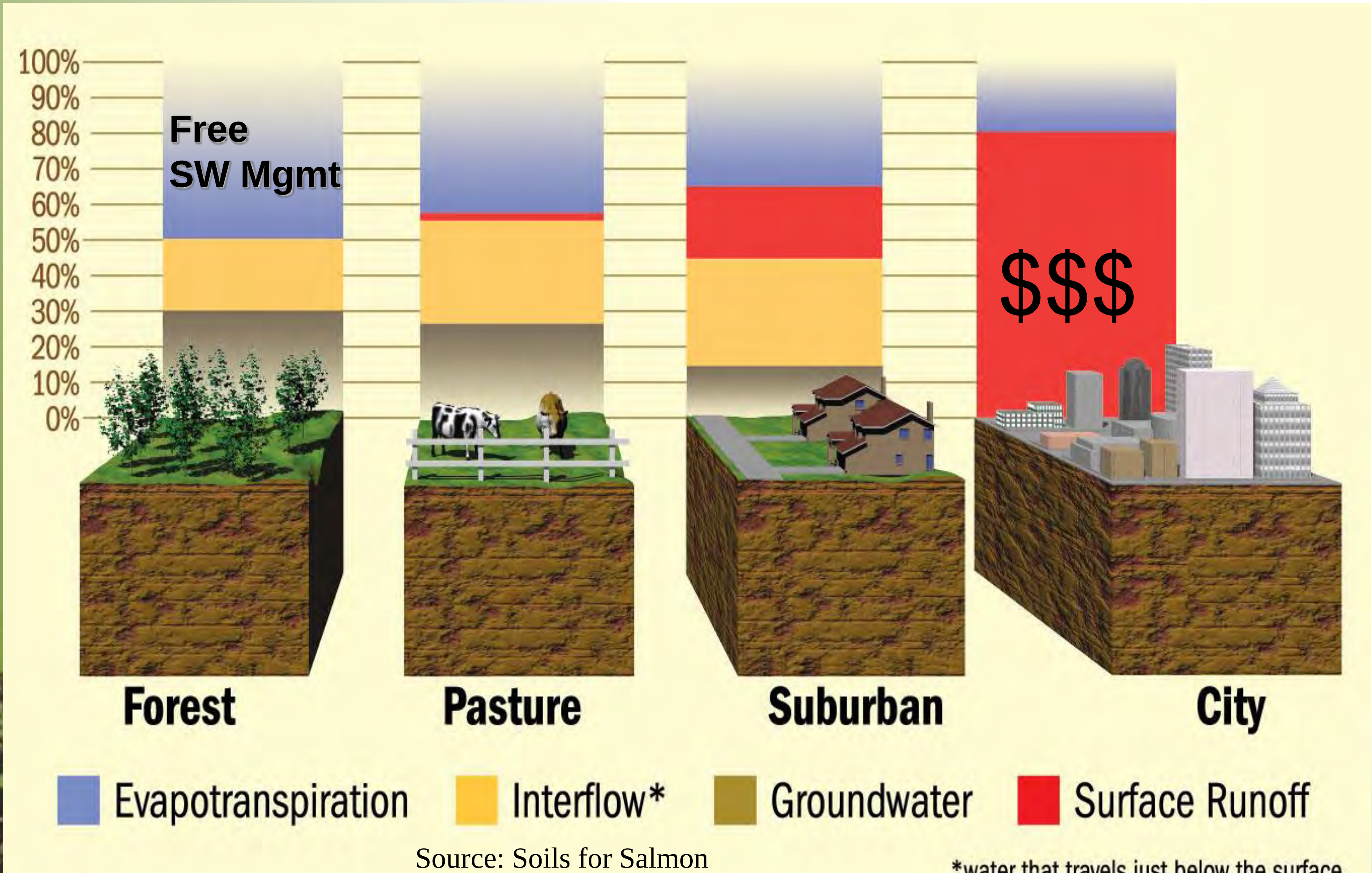
- 850 – US cities w/ outdated & under-designed SWM infrastructure
- 75% of Americans live near polluted waters
- 50,000 Impaired water bodies (TMDLs)
- $44,000,000,000 – annual total cost to society

Land Use = Hydrology = Pollutant Load = Water Impairment



Source: Soils for Salmon

Ecosystem Services *for Free*



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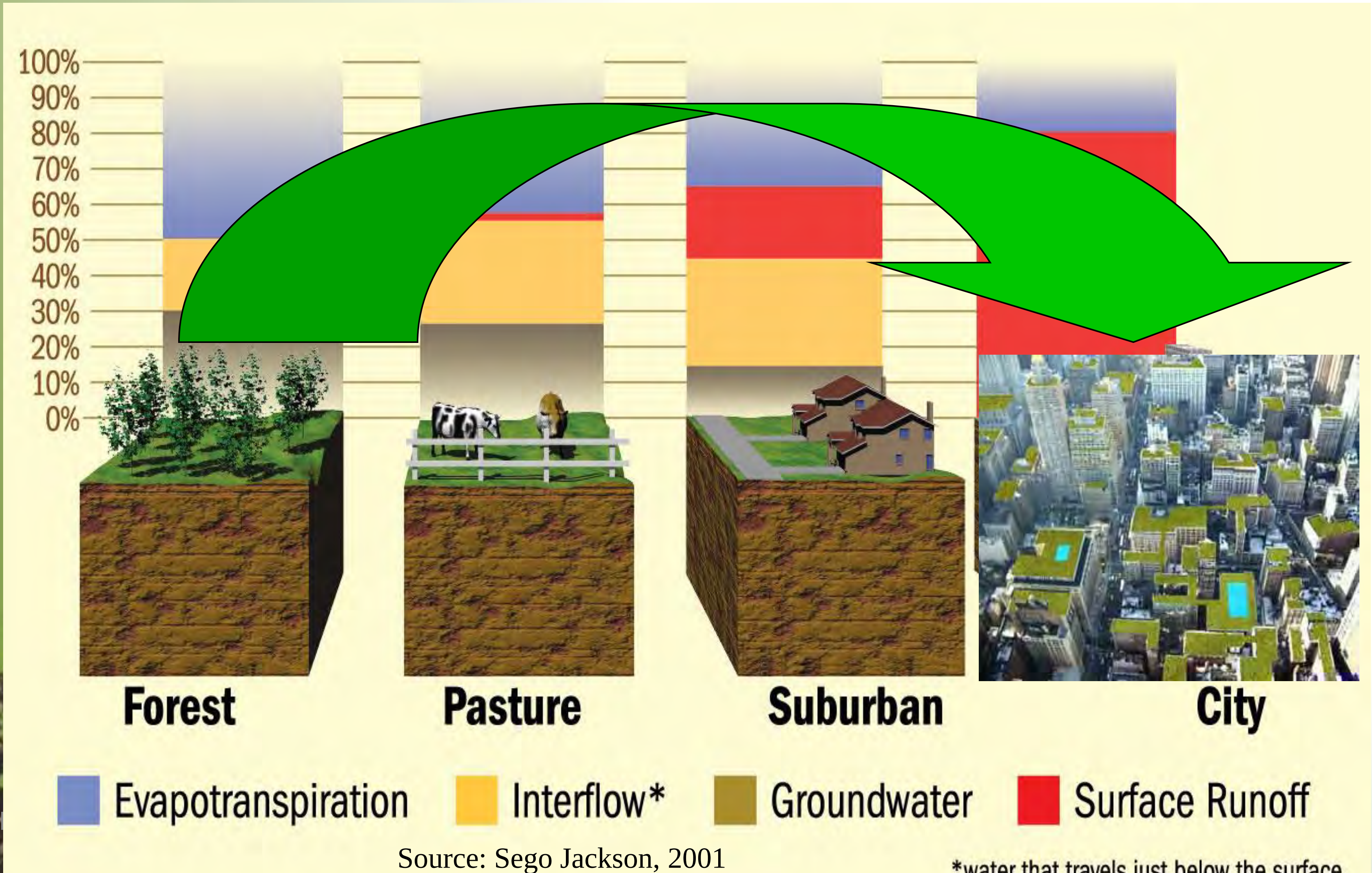
What is Green Infrastructure?

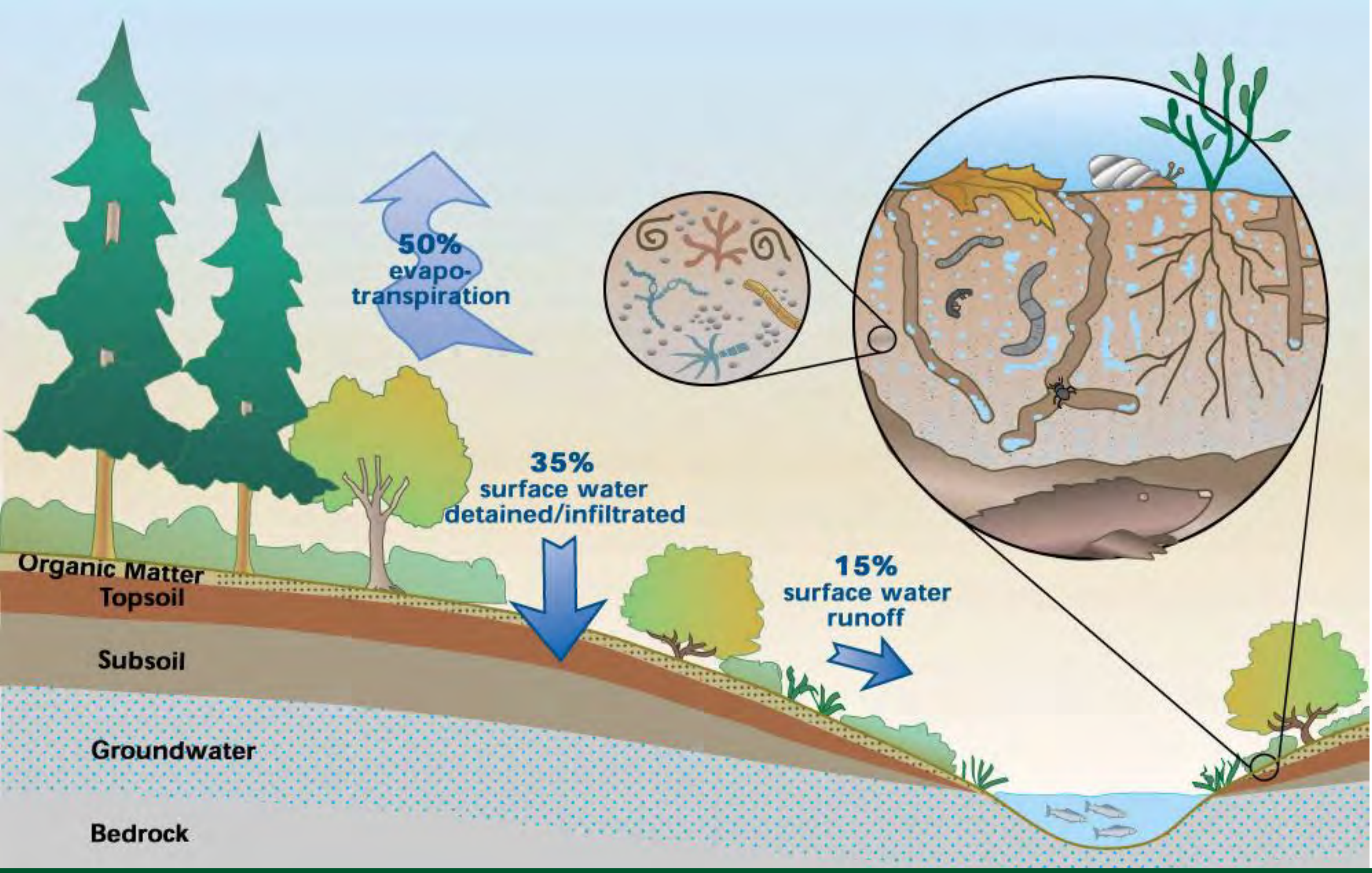


Source: Sego Jackson, 2001

Real Estate Value of Green Infrastructure Sites

- $4000 cost save/residential unit
- 6% - green infrastructure
- 15% - water quality
- 5% - reduce flooding in flood plain
- 30-50% energy savings

(Source: NCSU)



Low Impact Development (LID) =
restore natural site hydrology

Federal Agencies w/ Compost BMP Specifications

USDA
Natural Resources Conservation Service

US Army Corps of Engineers

filtrexx®
SUSTAINABLE TECHNOLOGIES

Compost Tools

Filter Media

- Designed for Optimum Filtration & Hydraulic-flow

Growing Media

- Designed for Optimum Water Absorption & Plant Growth

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Stormwater BMPs

Erosion & Sediment Control

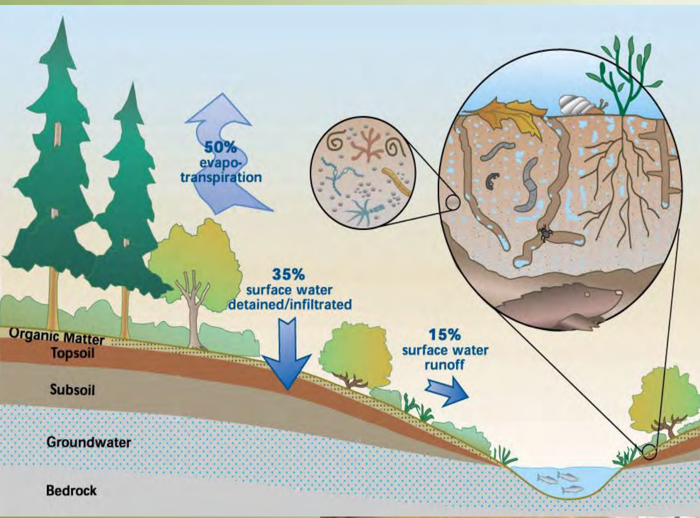
1. Perimeter Control
2. Inlet Protection
3. Ditch Check
4. Filter Ring/Concrete washout
5. Slope Interruption
6. Runoff Diversion
7. Vegetated Cover
8. Erosion Control Blanket
9. Vegetated Sediment Trap
10. Pond Riser Pipe Filter

Low Impact Development

11. Runoff Control Blanket
12. Vegetated Filter Strip
13. Engineered Soil
14. Channel Liner
15. Streambank Stabilization
16. Biofiltration System
17. Bioretention System
18. Green Roof System
19. Living Wall
20. Green Retaining Wall
21. Vegetated Rip Rap
22. Level Spreader
23. Green Gabion
24. Bioswale

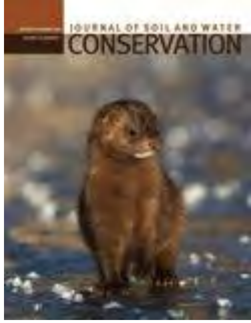

10. 30. 2001

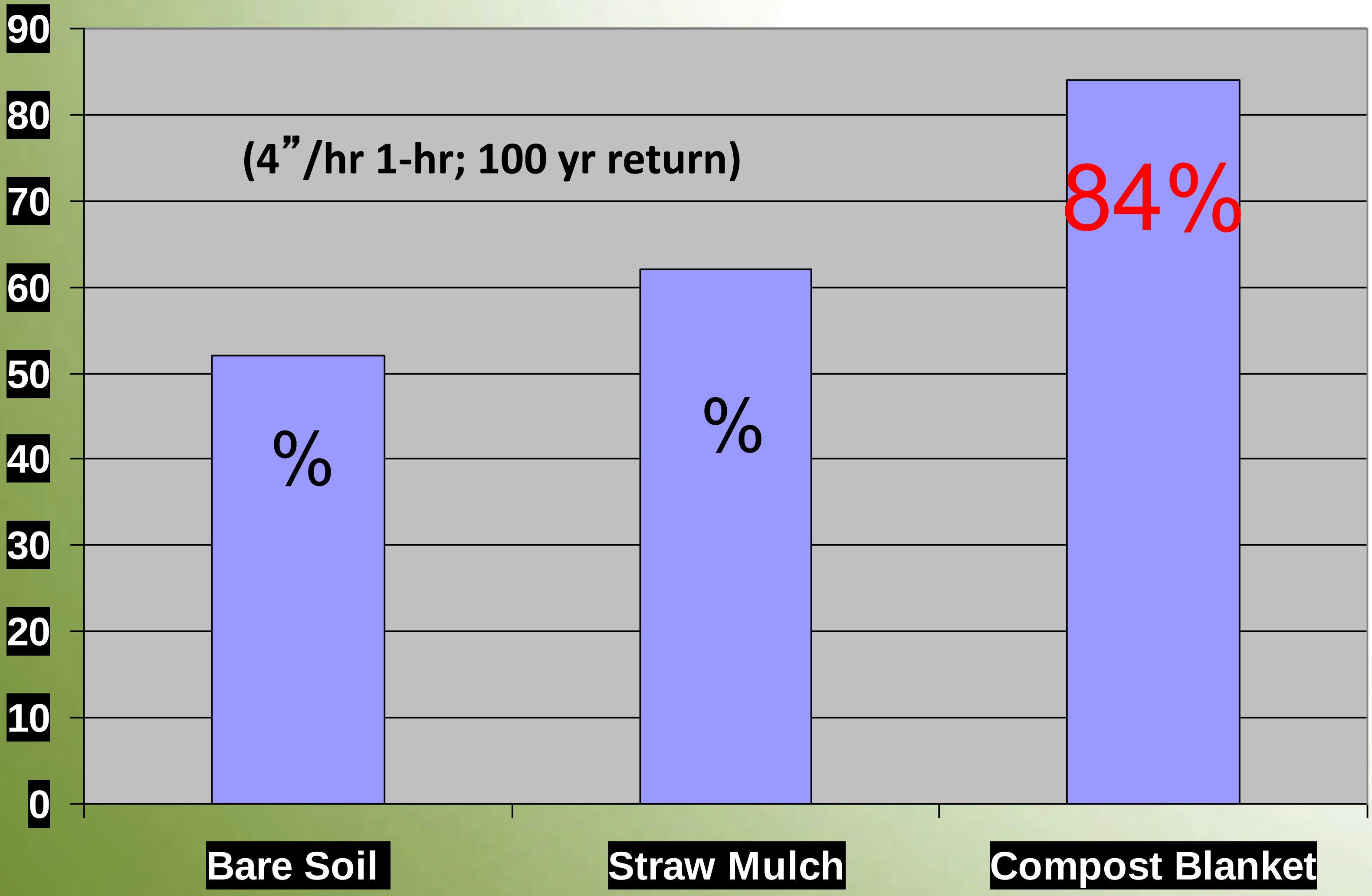
Runoff + Erosion Control



Designed to: 1) dissipate energy of rain impact; 2) hold, infiltrate & evaporate water; 3) slow down/disperse energy of sheet flow; 4) provide for optimum vegetation growth

Rainfall Absorption





Runoff Volume Reduction

Reduction	Influencing Factors	Reference
49%	Sandy clay loam, 10% slope, 1.5" blanket, 3.2 in/hr – 1 hr rain	Faucette et al, 2005
60%	Sandy clay loam, 10% slope, 1.5" blanket, 4.0 in/hr – 1 hr rain	Faucette et al, 2007
76%	Silty sand, 2:1 slope, 3" blanket, 1.8 in/hr - 2.4 hr rain	Demars et al, 2000
90%	Loamy sand, 3:1 slope, 2" blanket, 4.0 in/hr – 2 hr rain	Persyn et al, 2004

Pollutant Load Reduction:

Compost Blanket vs Conventional Seeding

	Total N	Nitrate N	Total P	Soluble P	Total Sediment
Mukhtar et al, 2004 (seed+fertilizer)	88%	45%	87%	87%	99%
Faucette et al, 2007 (seed+fertilizer)	92%	ND	ND	97%	94%
Faucette et al, 2005 (hydromulch)	58%	98%	83%	83%	80%
Persyn et al 2004 (seed+topsoil)	99%	ND	99%	99%	96%

Runoff Curve Numbers

Watershed Surface	Curve Number*
Parking lot, driveway, roof	98
Commercial district	92
Dirt road	82
Residential lot: ¼ ac, ½ ac, 1 ac	75, 70, 68
Cropland	71-81
Pasture	61-79
Public green space	61-69
Woodland and forests	55-66
Brush >75% cover	48
Vegetated Compost Blanket	55

*Based Hydrologic Soil Group B

Reference: USDA SCS, 1986

Ecosystem Services:
Economics of Green Infrastructure

- Compost Blanket vs Impervious Surface
- Area = 10 acres
- Design Storm = 3 in/24 hr

✓ Stormwater Volume = 54,300 vs 752,100 gallons (1400% increase!)

- **<u>Option 1: Containment/Pond:</u>**
- Real Estate Value = $50,000/acre
- SW Pond Design/Construction = $1/gal

✓ Stormwater Pond (4 ft deep) = 0.5 acre
- - $25,000 (lost usable real estate)

✓ Stormwater Pond Cost = $697,800 (design/construction)
- TOTAL = $722,800

Ecosystem Services:
Economics of Green Infrastructure

- Compost Blanket vs Impervious Surface
- Area = 10 acres
- Design Storm = 3 in/24 hr

✓ Stormwater Volume = 54,300 vs 752,100 gallons (1400% increase!)

- **<u>Option 2: Off-Site Discharge (Grid):</u>**
- Water Conveyance Cost = $0.26/gal
- Water Treatment Energy Cost = 2 kWh/1000 gal
- Energy Cost = $0.13/kWh
- Carbon Emission = 2 lbs CO_2/kWh

✓ Water Conveyance = $181,428/yr
✓ Energy Cost = $91/year
✓ Carbon Emission = 1,396 lbs/CO_2/yr

Ecosystem Services:

Carbon Footprint Reduction

- 2700 yds^3 compost
- 5400 tons of organics diverted from landfill
- 380 tons of methane (20 x CO_2)
- 7600 tons CO_2e
- 1520 cars off the road

1 ton organic waste = 140 lbs methane (Sakai, 2007)

1 car = 5 tons CO_2/Yr (US EPA, 2014)

Compost Tools

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Growing Media

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Stormwater BMPs

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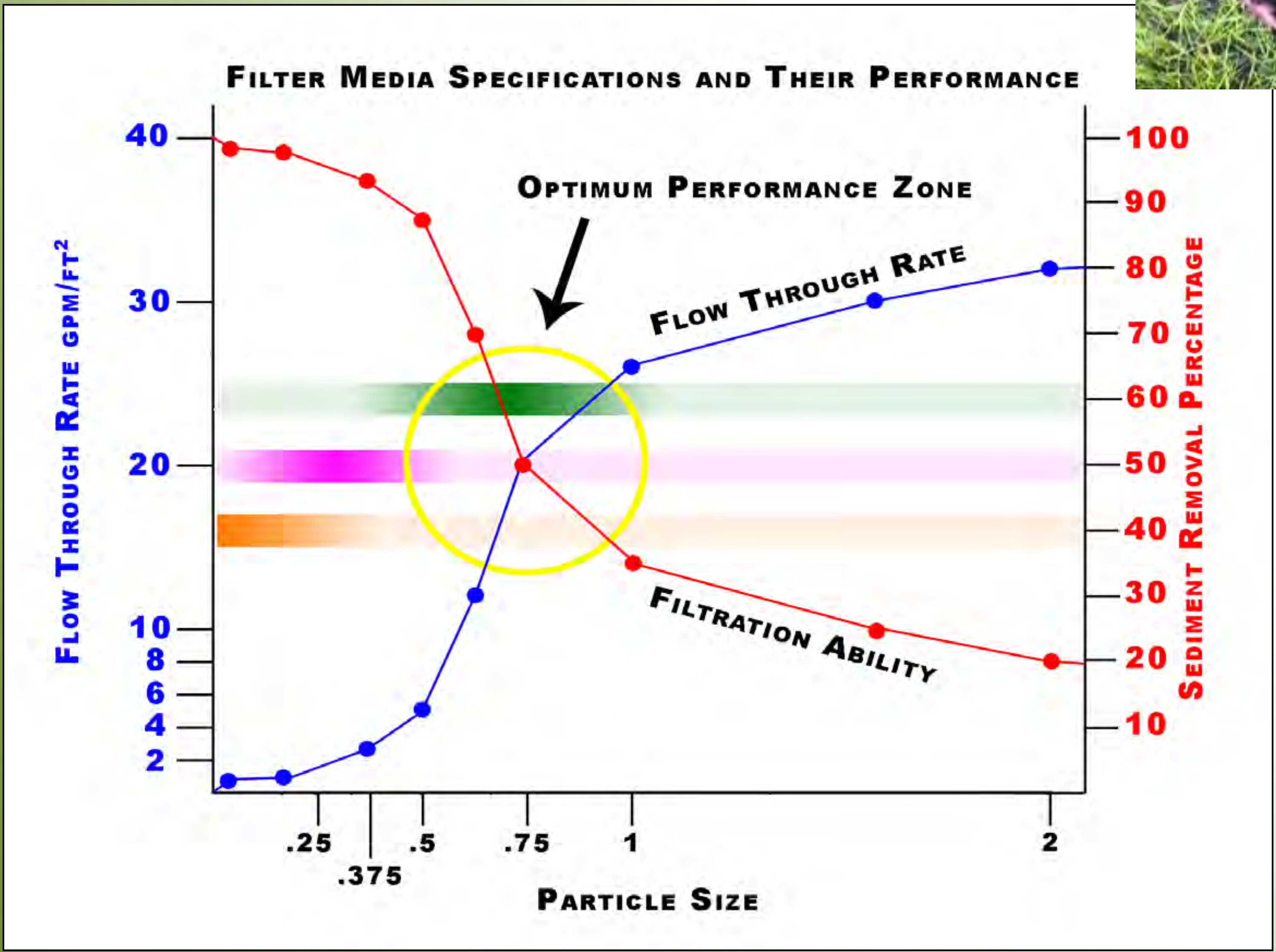
SUSTAINABLE TECHNOLOGIES

Compost Biofilter/Sock 3-Way Biofiltration

- Physical
  - Traps sediment in matrix of varying pore spaces and sizes
- Chemical
  - Binds and adsorbs pollutants in storm runoff
- Biological
  - Degrades various compounds with bacteria and fungi

Particle Size Specifications



(Bio)Filtration Devices use Filter Media

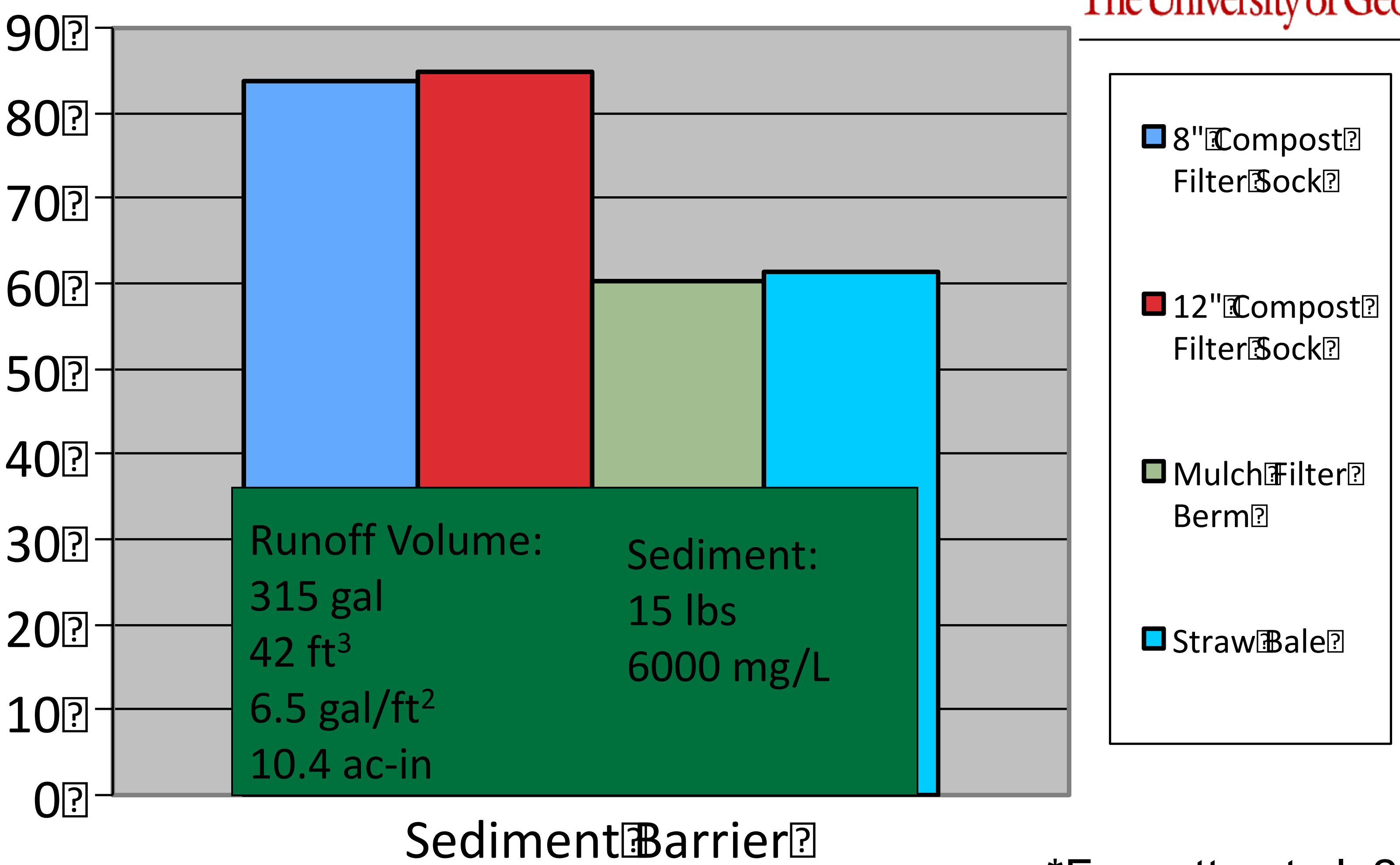
TS Reduction of Sediment Barriers

San Diego State University	Runoff Exposure	Sediment Exposure	Sediment Removal
Filter Sock	•260 gal •1.7 g/ft^2 •2.75 ac-in	•850 lbs •150 lbs/ft^2 •125 t/a	77%
Silt Fence	•260 gal •1.7 g/ft^2 •2.75 ac-in	•850 lbs •150 lbs/ft^2 •125 t/a	72%
Straw Wattle	•260 gal •1.7 g/ft^2 •2.75 ac-in	•850 lbs •150 lbs/ft^2 •125 t/a	59%

ASTM 6459 for RECPs

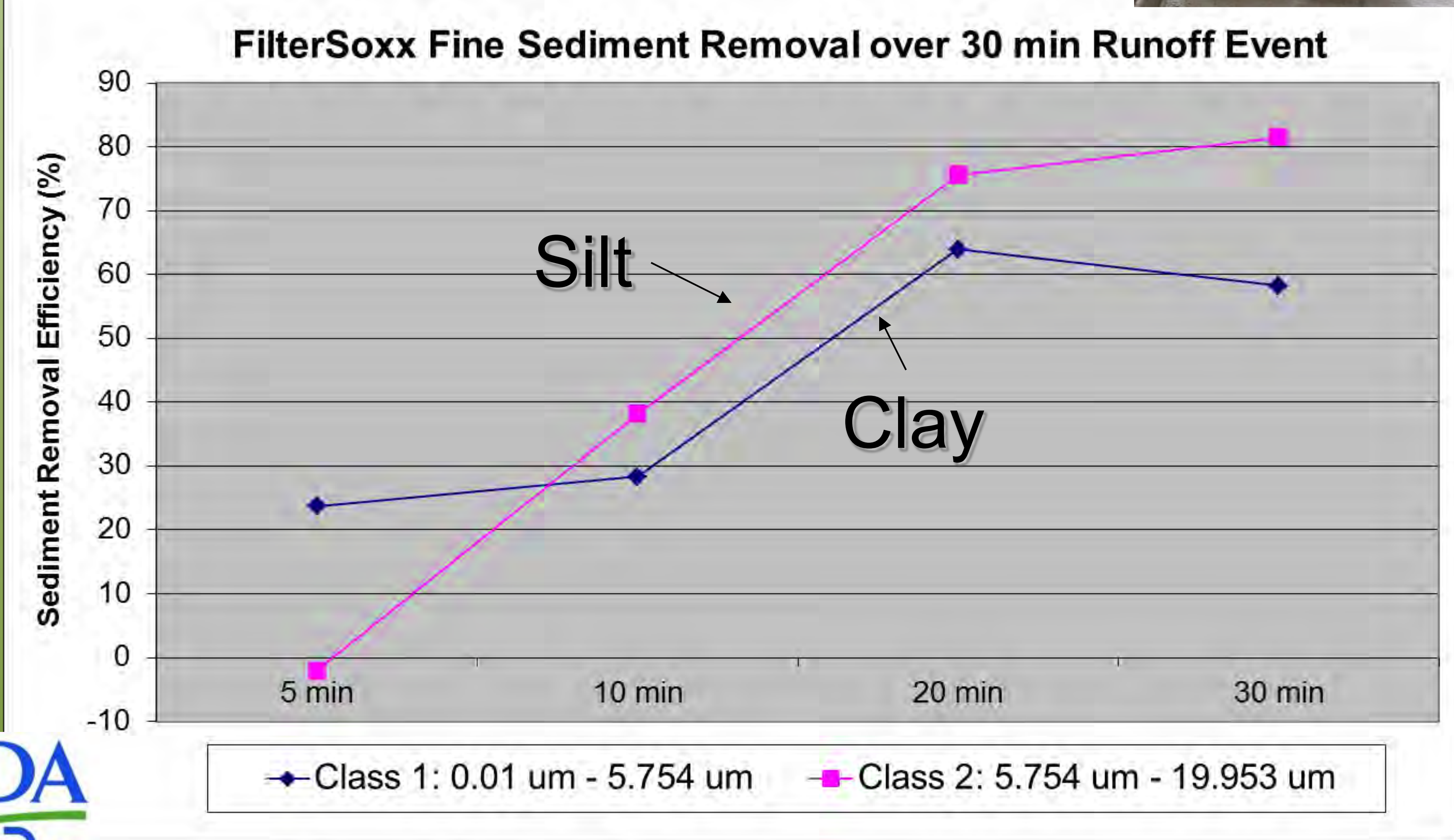
% TSS Reduction of Sediment Barriers

The University of Georgia



*Faucette et al, 2009

Fine Sediment Removal



*Faucette et al, 2009

Stormwater Pollutant Removal (%)

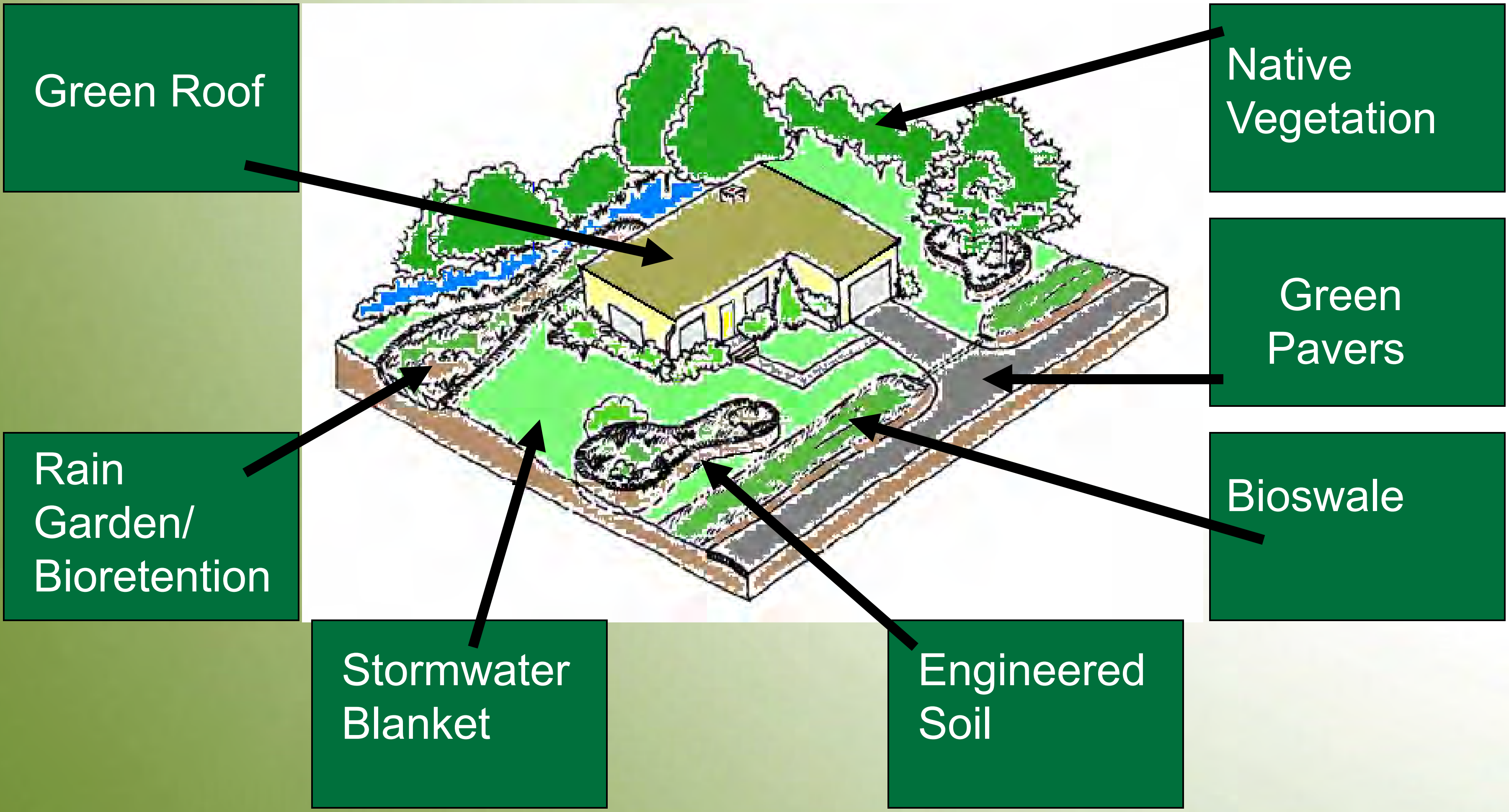
	TSS	Turbidity	Total N	NH_4-N	NO_3-N	Total P	Sol. P	Total coli.	E. coli.	Metals	Oil	Diesel
Filter Sock	80	63	35	35	25	60	92	98	98	37-78	99	99

*Faucette et al, 2008; Faucette et al, 2009; Faucette et al, 2013

City of Chattanooga

Analysis	2-1-2007 (Pre-retrofit)	6-8-2007	8-30-2007	12-13-2007	3-19-2008	1-28-2009	7-28-2009	% Reduction
COD	1600 mg/L	259 mg/L	255 mg/L	125 mg/L	125 mg/L	405 mg/L	214 mg/L	**75-93**
TSS	1370 mg/L	208 mg/L	38 mg/L	18 mg/L	24 mg/L	249 mg/L	177 mg/L	**82-99**
Oil/Grease	107 mg/L	27 mg/L	N/A	N/A	5 mg/L	18 mg/L	37 mg/L	**65-95**

Sustainable Site Development = Max Pollutant Load Reduction



Southface Responsible Solutions for Environmental Living

Eco Office
Grand Opening

- ✓100% rain/stormwater capture
- ✓Zero discharge
- ✓84% Water Savings
- ✓130,000 gal/yr

Southface

Responsible Solutions for Environmental Living


The Sustainable Site

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24 Compost-Based BMPs Inside

*"….*an essential tool for engineers, designers, architects, regulators, planners, contractors, consultants, policymakers, builders, and water resource managers."
– Forester Press

Thanks!

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Ecosystem Scientist

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Working *with* Nature:

Green Infrastructure & LID with Compost-Based BMPs

Dr. Britt Faucette, PhD, CPESC, LEED AP
Ecosystem Scientist

Peak Flow Rate Reduction

Reduction	Influencing Factors	Reference
36%	Sandy clay loam, 10% slope, 1.5” blanket, 3.2 in/hr – 1 hr rain	Faucette et al, 2005
42% **(30% relative to straw)**	Sandy clay loam, 10% slope, 1.5” blanket, 4.0 in/hr – 1 hr rain	Faucette et al, 2007
79%	Loamy sand, 3:1 slope, 2” blanket, 4.0 in/hr – 2 hr rain	Persyn et al, 2004

Compost + Additives

- To target specific runoff pollutant
  - Fine Sediment
  - Nutrients (N & P)
  - Bacteria
  - Metals
  - Petroleum Hydrocarbons

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SUSTAINABLE TECHNOLOGIES

Low Impact Development (LID) =

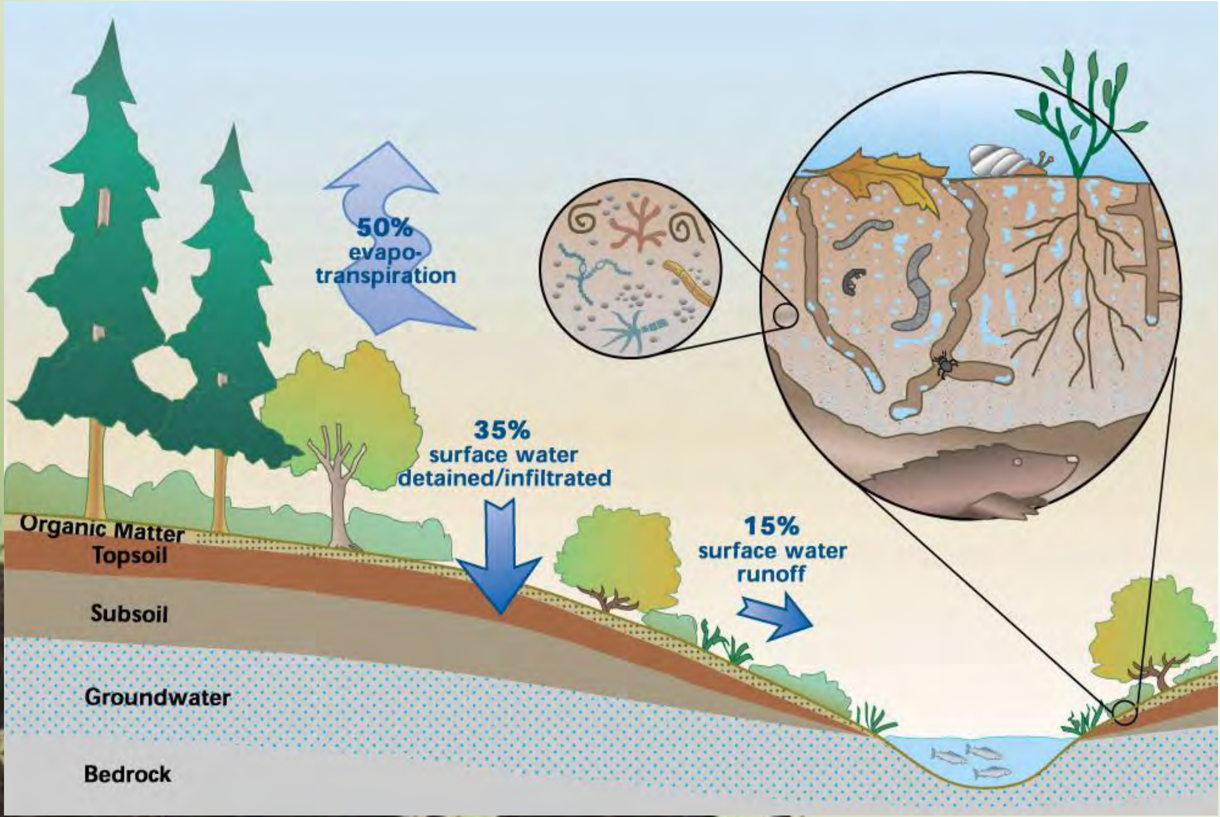
hydrology mimics natural site, distributed, decentralized

- Runoff Volume ⇩
- Runoff Rate ⇩
- Pollutant Loading ⇩
- Flooding ⇩
- CSOs ⇩
- ✓ *Water Quality* ⇧
- ✓ *Wildlife Habitat/Biodiversity* ⇧
- ✓ *Aesthetics/Land Value* ⇧

Green Infrastructure = green stormwater management; site preservation/restoration; integrated design & practices; reuse

Green Infrastructure *Design* with Compost (& Soil)

1. Interception
2. Transpiration
3. Infiltration
4. Evaporation
5. Surface Roughness
6. Flow Path Disruption
7. Biofiltration



Research Literature

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•Faucette, B., J. Governo, R. Tyler, G. Gigley, C.F. Jordan, and B.G. Lockaby. 2009. Performance of compost filter socks conventional sediment control barriers used for perimeter control on construction sites. Journal of Soil and Water Conservation. 64:1:81-88.

•Faucette, L. B., K. A. Sefton, A. M. Sadeghi, R. A. Rowland. 2008. Sediment and phosphorus removal from simulated storm runoff with compost filter socks and silt fence. Journal of Soil and Water Conservation. 63:4:257-264.

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•Faucette, L. Britt, J. Governo, C.F. Jordan, B. G Lockaby, H. F. Carino, and R. Governo. 2007. Erosion control and storm water quality from straw with pam, mulch, and compost blankets of varying particle sizes. Journal of Soil and Water Conservation. 62:6: 404-413.

•Faucette B, C. Jordan, M. Risse, M. Cabrera, D. Coleman, L. West. 2005. Evaluation of Storm Water from Compost and Conventional Erosion Control Practices in Construction Activities. Journal of Soil and Water Conservation. 60:6: 288-297.

USEPA Compost Filter Sock Spec

Parameters	Units of Measure	Compost Filter Sock
pH	pH units	5.5 – 8.0
Soluble salt concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5
Moisture content	%, wet weight basis	30 – 60
Organic matter content	%, dry weight basis	25 – 65
Particle Size Distribution	% passing a selected mesh size, dry weight basis	2 in. (50 mm), 100% passing; 1/2 in. (12.5 mm), 60% passing
Stability Carbon dioxide evolution rate	mg CO_2–C per g organic matter per day	<8
Physical contaminants (manmade inerts)	%, dry weight basis	<1

USEPA Compost Blanket Spec

Parameters	Units of Measure	Surface to be Vegetated	Surface to be left Unvegetated
pH	pH units	5.5 – 8.0	N/A
Soluble salt concentration (electrical conductivity)	dS/m (mmhos/cm)	Maximum 5	Maximum 5
Moisture content	%, wet weight basis	30 – 60	30 – 60
Organic matter content	%, dry weight basis	25 – 65	25 – 100
Particle Size Distribution	% passing a selected mesh size, dry weight basis	- 3 in. (75 mm), 100% passing - 1 in. (25 mm), 90 – 100% passing - ¾ in. (19 mm), 65 – 100% passing - ¼ in. (6.4 mm), 0 – 75% passing Maximum particle length of 6 in (152 mm)	- 3 in. (75 mm), 100% passing - 1 in. (25 mm), 90 – 100% passing - ¾ in. (19 mm), 65 –100% passing - ¼ in. (6.4 mm), 0 – 75% passing Maximum particle length of 6 in (152 mm)
Stability Carbon dioxide evolution rate	mg CO_2–C per g organic matter per day	<8	N/A
Physical contaminants (manmade inerts)	%, dry weight basis	<1	<1


Asheville
Daily Planet
CITY OF ASHEVILLE

What would nature do?

(#WWND)

Natural Capital is the stock material within the environment which provide free ecosystem services that maintain our economic, environmental, and human health (ex. forests, biodiversity, *organic matter*)

Ecosystem Services include soil erosion control, storm water prevention/filtration, maintenance of natural cycles (water, carbon, nutrients), clean water, waste reduction, climate regulation (regional and global).

Ex: 1 tree can evapotranspire 2.5 million gal water, regulating the water cycle and regional climate

Ecosystem services valued at $33 trillion/yr globally (Global GDP = $30 trillion/yr) – R. Costanza, Economist

The closer we manage landscapes to their natural design the more we save on energy, inputs, hard infrastructure, and financial expenditure…..*working with nature takes advantage of services that are both free and efficient.*

- Carl Jordan, Ecologist

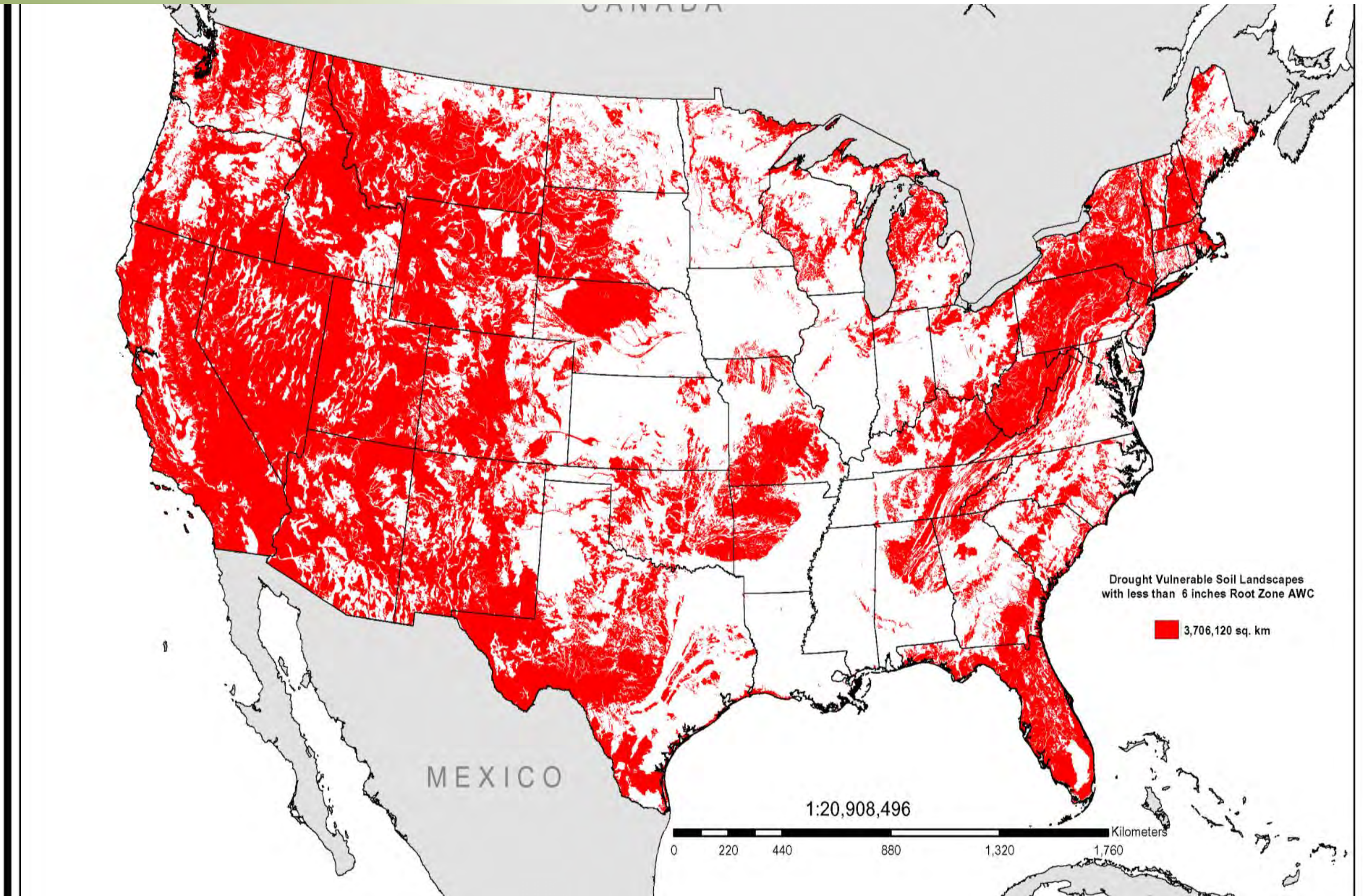
Ex: 50% of all fertilizer use in US is to compensate lost nutrients due to soil erosion.

Lets Talk Storm Water...

Lets Talk Storm Water…

…..and Compost.

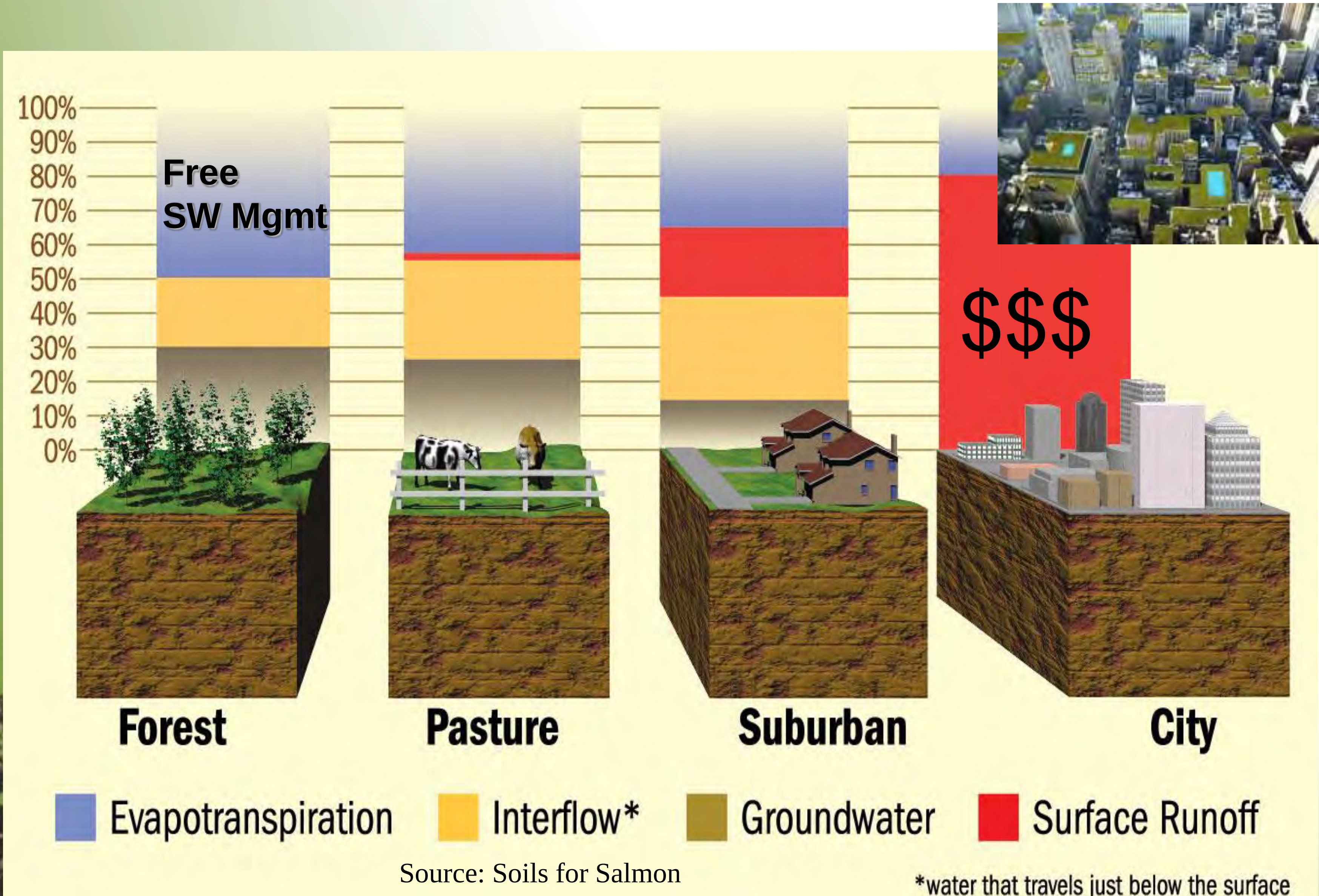
Drought Vulnerable Soils



Federal & State Agency Approval

- US Environmental Protection Agency (EPA) National Menu of BMPs
- USDA Natural Resources Conservation Service (NRCS)
- US Army Corp of Engineers
- American Association of State Highway Transportation Officials (AASHTO)
- Nearly all State DEP/EPA/DNR & State DOT Agencies

Ecosystem Services for Free



Source: Soils for Salmon

What about *climate change*?

Climate Change…and *Compost*

1. Reduce Carbon Footprint (prevention)
2. Mitigate Effects of Climate Change (treatment)

✓ Compost……..does *BOTH*.

Carbon Footprint

- Carbon emissions reduction
- Carbon sequestration

Project Carbon Sequestration

- 10 acres of permanent vegetation (grass)
- Western US = 0.4 tons/ac/yr/CO_2 (CCX, 2008)
- Total = 4 tons/CO_2
- 0.5 cars off the road

Climate Change…and *Storm Water*

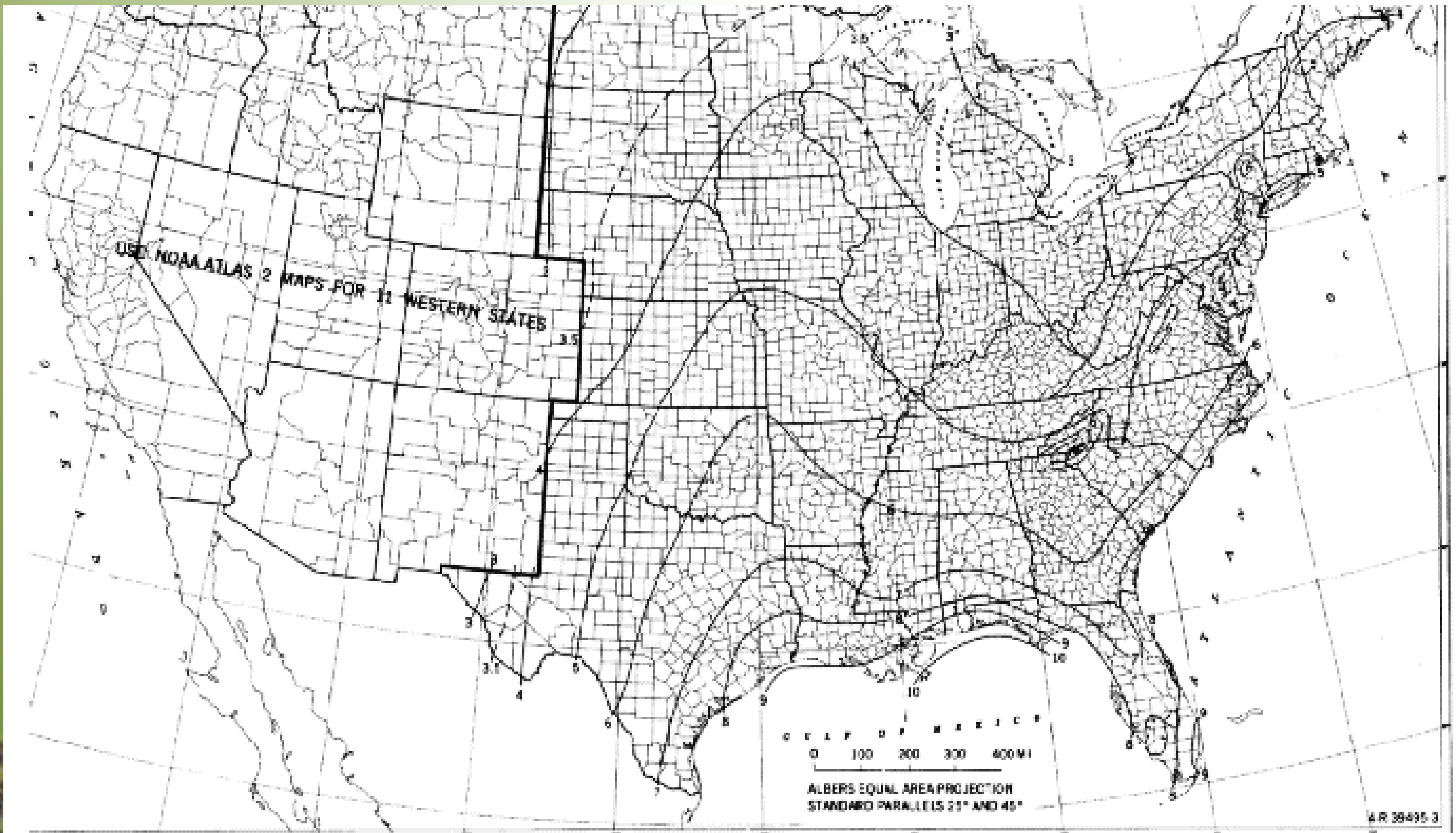
✓ Increasing storm intensity and frequency =

- More Storm Water, Pollutants, Floods

✓ Increasing drought =

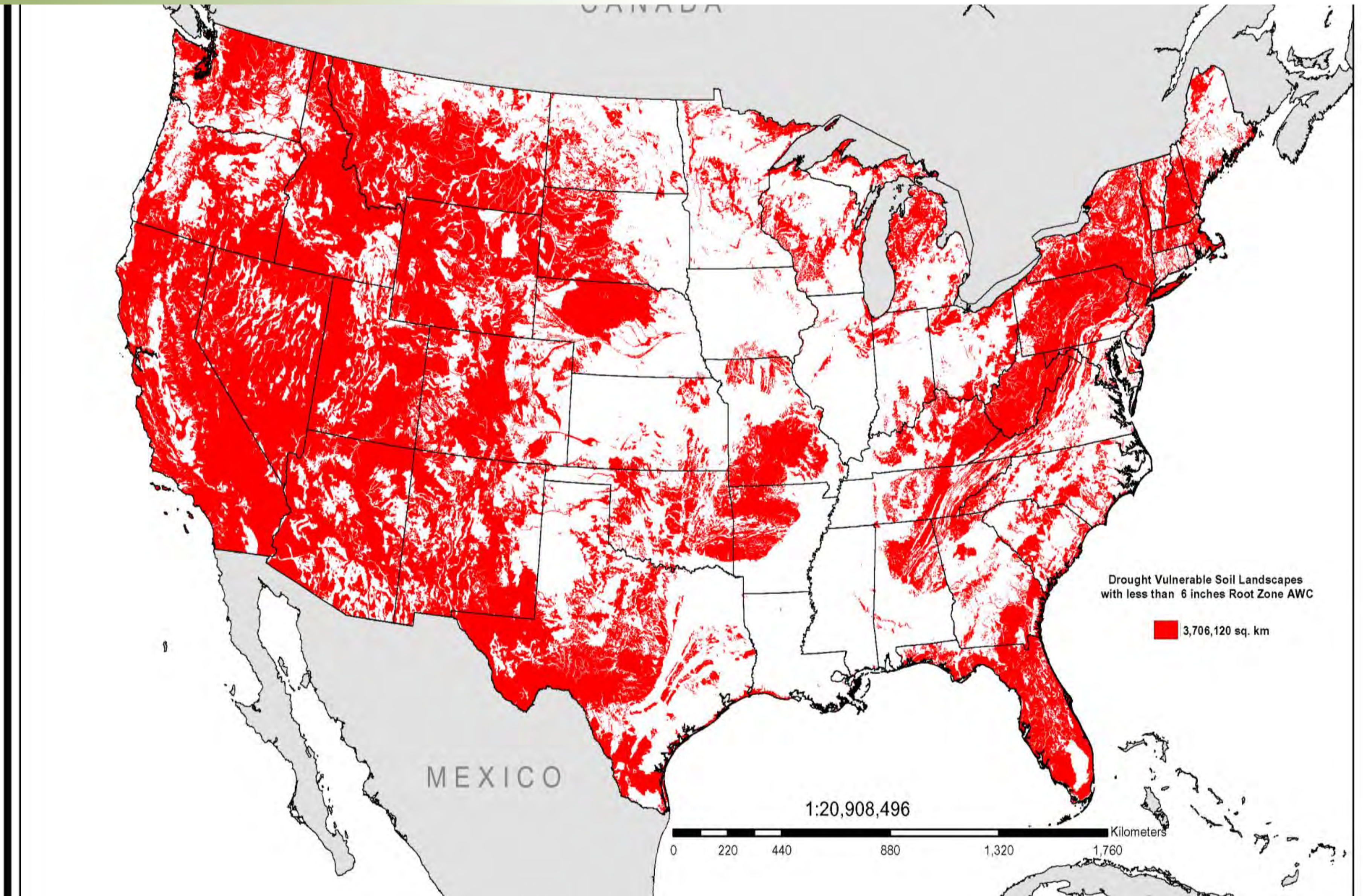
- Water Restriction, Plant Cover Loss, Soil Erosion, Fires

USDA/NOAA 2,5,10, 25, 50, 100 yr Design Storm Events



US Weather Bureau TP 40, 1961

Drought Vulnerable Soils



Climate Change Mitigation & Compost

- Increased Storm Water?

✓ Organic Matter = Volume reduction & Filtration

- Increased Drought?

✓ Organic Matter = Water holding capacity increase

✓ Reduced irrigation by 30% (Gaskin et al, 2003)

Compost –
The *Naturally* Sustainable BMP

- 100% Recycled
- Bio-based, organic materials
- Locally manufactured
- Reduces Carbon Footprint
- Builds/Protects Nat Capital
- Enhances Ecosystem Services
- Benign to *Restorative*