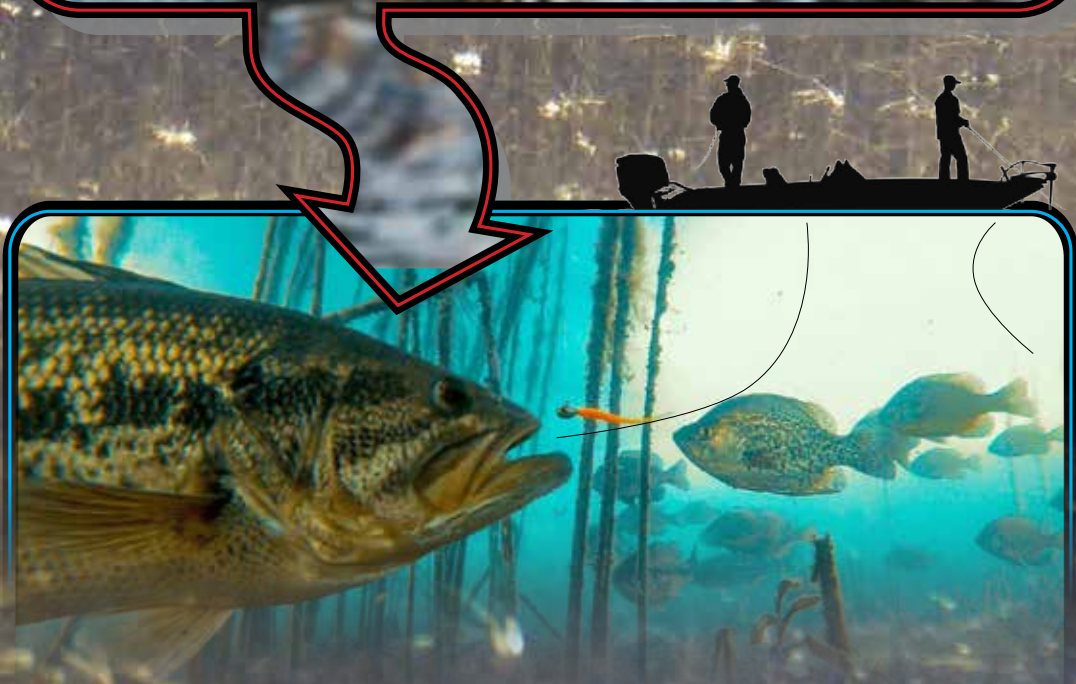


PREVIEW SAMPLE

STORM WATER **science**



***For the Next-Generation
Water Warriors***



Contaminants 1.0

Stormwater

EUTROPHICATION

Over-enrichment of a water body with excess nutrients that triggers rapid plant and algae growth.



Source

Silt	Fine dirt, dust and clay particles from roads and construction sites.
Phosphorus / Nitrates	Organic nutrients from farms, urban leaves, animal waste, sewage plants.
Pesticides / Herbicides	Farms, lawns, landscaping.
Chloride	Road salt
E. Coli	Animal waste, sewage plants.
Hydrocarbons/Gas & Oil	Roads and industrial sites.
Heavy Metals	Roads and industrial sites.

Contaminants

1.2

Emerging

PFAS is everywhere. It was patented in 1941 and grew into a branch of the plastics industry that prevents things from sticking. Ideal for cookware and waterproofing.



Source: Creative Commons

Threat

Phosphorus

Ancient - present

Farm runoff, urban leaves and lawn fertilizers continue to feed algae blooms in waterways.

Chloride

Road Salt, 1940 - present

Increasing infiltration into groundwater threatens aquifers and ecosystems. Stormwater from roads as well as through sewage treatment.

Glyphosate

Herbicide "RoundUp"
1974 - present

Widely-used herbicide and a multi-billion dollar industry, which impacts policy decisions. In 1970 Monsanto chemist John E. Franz discovered that the chemical was a potent, non-selective herbicide that killed unwanted plants by blocking a specific plant enzyme, which eventually launched as RoundUp.

Microplastics

1970s - present

Expansion of plastics industries has given society enormous value but also threats from thousands of new materials, such as synthetic polyester fabrics (PET) that lose particles in the wash. Molecules, nanoparticles and microparticles are very persistent throughout the world, in our bodies, even threatening the blood/brain barrier.⁵ The marine food web is contaminated.

PFAS

1940s - present

Thousands of poly-fluoro compounds infiltrate the global environment and human bodies, with major risks to human health and economies. The US military alone has a PFAS exposure in the tens of billions of dollars, the cost to remove or destroy PFAS.

6PPD-q

1965 - present

6PPD is the anti-oxidant used in tires, so tires last longer. 6PPD-q is formed in the environment. Prevalent in stormwater near busy highways. Tire particles and microscopic dust are washed into waterways every time it rains.

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Engineering 2.1

3 Categories of Runoff

1

Urban

CONTAMINANTS

Silt

Phosphorus / Nitrates

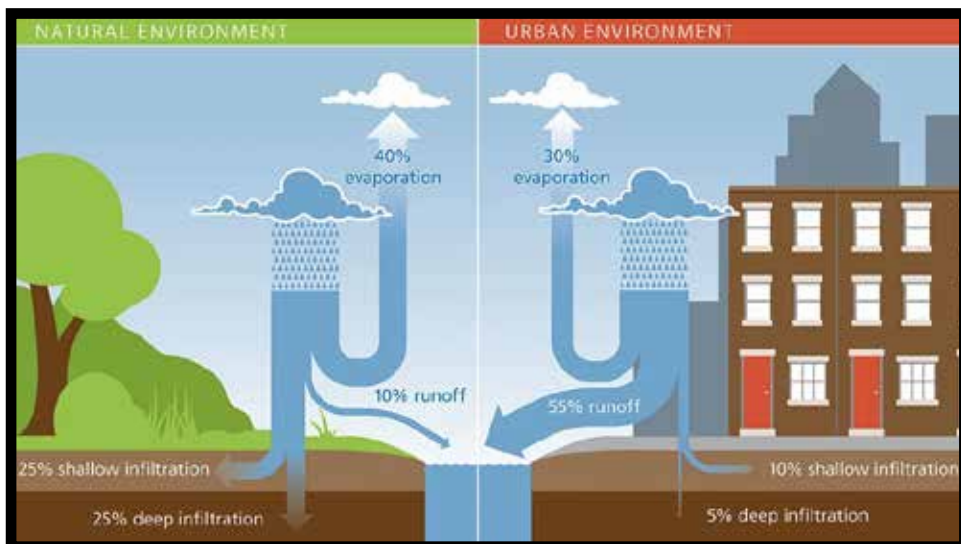
Heavy Metals

Herbicides / Pesticides

E. Coli

Urban environments have a lot of hard surfaces that are impermeable. Water runs off and takes with it all the dirt, trash and contaminants with it into the environment. Eventually the chemicals can end up in your food, your body. We can use smart engineering, working with natural filtration systems.

Source: Creative Commons



Engineering 2.3

How to Sample Stormwater



Bottle Types

Learning to sample stormwater is step one in taking control of the water in your neighborhood and making a difference in the world. It will give you the feel for a career working with water.



Culvert



Basin



Sheet Flow 1



Sheet Flow 2



Sheet Flow 3



Sheet Flow 4

Char21™ is a patented mixture of:

Chopped Switchgrass: Used for initial natural pollutant adsorption and structural loft.

Hardwood Biochar: Large-chunk biochar provides long-term filtration and adsorption.

Re-activated Carbon: Retains high levels of organic pollutants, oils, and greases.

Calcium Silicate Aggregate:

A processed slag material that helps increase pH and precipitate out heavy metals.

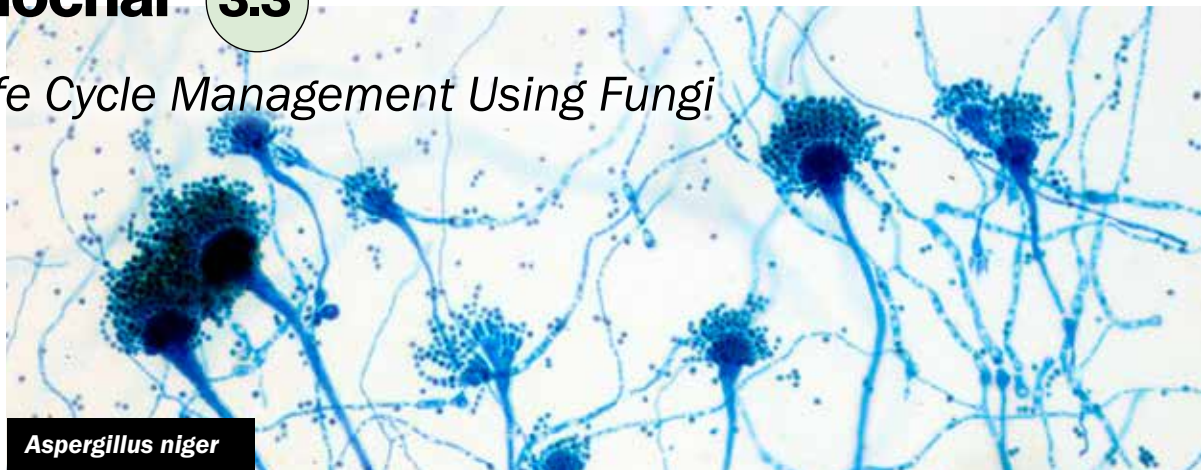


Source: www.frugalfun4boys.com

RAIN 10 Input mg/L	RAIN 10 Output mg/L	RAIN 10 Change %	RAIN 20 Input mg/L	RAIN 20 Output mg/L	RAIN 20 Change %
0.034	0.006	82%	0.042	0.002	95%
0.682	0.15	78%	1.12	0.1	91%
3.94	1.33	66%	0.926	0.139	85%
0.68	0.283	58%	0.83	0.178	79%
0.688	0.254	63%	0.926	0.139	85%
7.04	3.38	52%	10.3	2.48	76%
1.36	0.967	29%	3.65	2.71	26%
10 ml	<1 mL	>97%	10 ml	<0.5 mL	>97%
10 ml	<1 mL	>97%	10 ml	<0.5 mL	>97%
10 ml	<0.5 mL	>97%	10 ml	<0.5 mL	>97%
7.05	7.49	0.44	7.05	7.97	0.94

Biochar 3.3

Life Cycle Management Using Fungi



Aspergillus niger

Source: Creative Commons

As biochar filters get saturated with contaminants, fungi are a clear alternative to the landfill. This provides a complete life cycle treatment process for stormwater chemicals.

Proven or promising results for....*

- **PFAS**
- **PAH**
- **PCB**
- **Hydrocarbons /Petroleum**
- **Plastics / Microplastics**
- **Pesticides, Herbicides**
- **Synthetic dye**
- **Detergents**
- **Heavy Metals** (Adsorption)
- **Pharmaceuticals/Antibiotics**
- **E. Coli**
- **Radioactive Waste**



Oyster
(*Pleurotus ostreatus*)

Degrades complex aromatic rings and stubborn waste components.²¹



Turkey Tail
(*Trametes versicolor*)

Secretes powerful extracellular enzymes (like lignin peroxidase and laccase) that smash tough chemical bonds in pollutants.²²



White-rot Fungus
(*Phanerochaete velutina*)

Produces enzymes to attack a variety of organic contaminants such as pesticides.²³

* Levels of mycoremediation vary. Validation for some chemicals, such as PFAS is ongoing.

Technology 4.0

Stormwater Testing

Low-cost tools and technologies are available for any American citizen to learn what's in their water.

D.I.Y.

E. Coli

3M Petrifilm is used with an incubator to get results in a day or two.



pH Phosphorus Nitrates Ammonia

For fish environments.

Chloride (Salt)

Keep track of the impact of road salt on ecosystems.



Heavy metals are everywhere.
Here's how to track them down.

Heavy Metals



Dissolved Oxygen

Critical for fish ecosystems.

Silt Microbes

Cool microscope connects to iPhone.



Total Suspended Solids (TSS)

Runoff from roads, construction sites that cause turbidity.

Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by individual particles that are generally invisible to the naked eye.