

**Biomimicry Oregon Genius of Place Project**  
**Appendix K**  
**Stormwater Workshop Breakout Group Design Concepts**

Team	Concept Name	Inspiring Organism	Description	Where it would apply / scale / who would implement
<b>Three Trees</b>	Living Street Signs	Moss	Gutters holding plants on the back of street signs.	street signage
	Moss inspired "cupwalls"	Moss	Long, skinny cups attached to walls.	building and other urban facades exposed to rain.
	Seasonal building evaporative feather coolers	Root structure (hydraulic redistribution), Mycorrhizal fungal networks	Collect winter stormwater into a cistern. In summer, wicks absorb water up into a feather type material that evapotranspires to cool ambient air.	buildings, areas prone to the heat island effect.
	Wood chip mulch on roof	Downed Wood	Sandwiched mat of roof chip mulch on rooftops. 4 - 6 inches thick.	rooftops
<b>Lichen</b>	Living awnings	Moss	Living, vegetated awnings over sidewalks for people to avoid the rain in the winter and intense sun in the summer.	awnings, public plaza spaces (would allow for more absorptive material on the ground), ball fields, gazebos
	Dead wood strategic plan	Downed Wood	An underutilized resource in the city, downed wood would be better integrated into the urban forest management program. In Portland, there is no strategic program for the placement of these sponges to absorb water. There are lots of neighborhoods with trees at the end of their useful life. We prune, take care of trees and there is a lot of debris.	parks, nature areas, street medians, art work
	Beaver dam stormwater "checks"	Beaver Dam	Beaver dam like complexes and berms to slow water on concrete and cement surfaces.	streets, parking lots
	Vegetated sidewalks	Moss	Pervious, vegetated sidewalks, mulched paths provide a soft walking surface. Could be limited to a portion of a sidewalk to maintain ADA compliance.	sidewalks, parking strips

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<b>Real World</b>	Sidewalk moss	Moss	Moss or synthetic moss along paved areas.	impervious surfaces
	Interconnected curb and gutter system	Mistletoe	Integrated stormwater system mimics an "our property" approach to water management instead of an individual "property rights" focus. More collaborative, decentralized, cross-boundary approach.	Anywhere
	Capillary Tap	Root structure (hydraulic redistribution)	Distribution and capillary mechanism that could help get to deeper water during summer periods.	Rain gardens, water scarce areas
<b>Mycorrhizal</b>	Paving complex	Downed wood, Mycorrhizal fungal networks	Layered pervious pavement system that uses capillary action between the layers to release water into the ground. A bark-like paving layer is on the top, followed by a capillary layer, infiltration layer and bedrock layer on the bottom. Analogous to layers within a tree (bark, cambium, heartwood).	Roadway systems, parking lots
	Stormwater nets	Canopy structure	Nets over the city to capture water (similar to the Japanese "fractal shade" cover inspired by tree canopies).	Building that are close to each other, stadium covers
	Water solid machine	Tardigrade - water bear	Stores water and "reactivates" it during the summer for use.	Any collection/storage location?
	Moss pavers	Moss	Moss paver that absorbs, stores water for later release. Not to be used in a frozen context.	Sidewalks, plazas, public spaces

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	Stormwater tree	Downed wood, mistletoe, canopy structure	Analogous to the layers of a tree trunk to absorb, distribute & evapo-transpire water. Imagine a bark layer on the outside of a building that absorbs water and transpires it to the atmosphere. Imagine a mistletoe like system that "lives" on rooftop building equipment absorbing toxic emissions and fluid leaks, cleaning air or converting "waste" into energy.	Building cladding systems, rooftop equipment
	Living walls	Moss	Living wall ideas - cups, textured walls.	Wall facades
<b>Absorption</b>	Green roof promenades	Old Growth Canopy Structure	Create a series of multi-layered, linked "awnings" that "walk away" from buildings to redirect & slow water flow away from buildings & provide cover. Could be green roofs, or other material, depending on functions desired. elevations may vary depending on shading requirements and other water direction desired outcomes.	Sidewalks, alleys, adjacent to buildings. Could work well for retrofits. Could be useful where you don't have a right of way on the street level to work with... where on-street treatment is limited.
	Engineered eco-soils	Mycorrhizal Fungi	Add mixtures to soils to increase absorption capacity.	Eco-roofs, rain gardens.
	Sponge Pave	Moss	Put spongy material in voids beneath pavement.	
	Absorption Concrete	Downed Wood	Manufacture a pervious concrete material that has voids filled with absorbant material.	sidewalk pavement, building walls

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<b>We Like Moss/Riparian</b>	Sidewalk H2O Management System	Moss	Use sidewalk system to replace or augment current stormwater underground pipes. Intentionally widen spaces between sidewalks and add moss there to increase absorptive capacity. Create new sidewalk materials that mimics the hydrophilic/hydrophobic attributes of moss. Sidewalks become part of h2O management system: some water is absorbed, some infiltrates into ground below, and the remaining water is conveyed to current stormwater collection points via directed runoff.	Sidewalks
	Perforated Pipe Stormwater Collection	Mistletoe	Mistletoe-inspired perforated stormwater collection pipes allows for gradual water loss along the system, for more soil absorption, and less at end of pipe. Currently in Portland there are streambeds that are no longer active - goal of this design: to reactivate / rewater these via groundwater recharge.	Stormwater infrastructure
	Mossy Roof	Moss	moss-inspired: "embrace the moss on a roof!" ...explore other ways of holding water on a roof via a water-absorbent tile.	Buildings
	Plant Your Gutter Salmon Gutters		Add plant life to gutters to slow down run off. Salmon farming in the gutters.	Gutters
	Plant Below Sidewalks		Grated sidewalks with low light plants below to increase absorption capacity below sidewalk.	Sidewalks

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<b>Slow Flows</b>	Stormwater Generator		Put microturbines in vertical pipes / gutters to generate energy from stormwater flows. Take advantage of all the vertical things in cities. Vivek has a group of students working on this idea right now; they submitted their idea to EPA's Rainworks Challenge.	Buildings
	Street Wood	Downed Wood Beaver Dam	Sections in the street can be cut out to intercept through a "street wood complex" spanning the street. The upper (upstream) portion mimics the "group of straws" idea from the deadwood concept, and channels stormwater to the downstream part of the matrix which consists of a permeable rock matrix. Some of the water is infiltrated, depending on soils, and the rest is channeled to a ditch alongside the street to infiltrate. Could place the street wood structures 20-30 feet above crosswalks to signal drivers that they are approaching a crosswalk and to watch for pedestrians.	Street infrastructure, City transportation / stormwater folks.
	Hydro Cradles	Moss Canopy Structure Mistletoe	Catch water in cups on side of buildings. Cups are larger at the base of the building and smaller as they go up to capture all of the water. Maybe have solar panels as well, and heat could help with evaporation. Water drains down the side of the building and feeds ground floor uses - perfect for mixed use building scenarios with ground floor commercial.	Buildings, architects.

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	Geo-Engineering Tulip	The British	Place a big funnel above Portland to capture water - inspired by a tulip and many other flower shapes. Brits are looking at placing a big shield above the city to block sunshine.	
<b>Spongewoods</b>	Tributary Stormwater Collection	Stream systems	Systems approach to stormwater collection, as tributary streams to main channels: collect in smaller arterioles, then move water to larger system.	Stormwater infrastructure
	Moss Strips	Moss	Increase absorptive capacity between sidewalk and street.	Sidewalks
	SpongeWood	Downed wood	Use wood everywhere - in raingardens, parks, on ecoroofs, etc. - leave where it is vs. transporting - Joke about SPONGEWOOD: "now that Tom's in the private sector, he's going to call it 'spongewood' and try to market it!"	Parks
	Absorb with Trash		Reusing / repurposing materials for absorptive capabilities (plastic caps, bottles, etc.)	
	Comcrete		"Comcrete" - put compost in concrete.	
<b>Wishful Thinkers</b>	Moss Awnings	Moss	Hydrophobic layer on surface... make it more evaporative through miracle material to emanate the water more easily. Hydrophillic 'sponge' on bottom keeps surface cool & wet - then more evaporation on the surface. Result: reduced runoff.	Awnings, but perhaps could scale larger.
	Under-aggregate Absorption	Downed Wood	Add absorptive media under aggregate media under permeable pavements to holds more water and evaporate it later.	Roads, sidewalks
	Super Absorbent Carpet Pad		Super absorbent carpet pad that doesn't mildew to capture water, retain it, and wick it out.	Basements

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<b>Mossy Absorbers</b>	Building Wrap / Living Wall on Steroids	Moss	<p>Challenge: How to use what comes out of buildings... Create a moss wrap around a building that would absorb the excess heat generated inside the building and increase the biological activity... the evapotranspiration. It would expand and contract to store water. It would be a "living wall on steroids." Use the 3 dimensionality of the building to increase surface area substantially by covering all four sides of the building. Roof layer would also absorb water and expand and contract. Collection area on roof would channel water to walls for storage.</p>	Commercial buildings
	Street Storage	Mycorrhizal Fungi	<p>Streets as storage and conveyance to users. There is a ton of water to store and manage in winter and not as much biological activity. "Who can use that water?" Industrial users, non-potable uses in homes like toilet flushing.</p> <p>Design concept: Permeable streets with water storage layer underneath. Use capillary action to pull stored water up to those who need it (industry, homes). Street absorbs sound as well as water.</p>	Streets

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**Breakout Group Design Concepts Filtering Meeting**  
**April 21, 2013**

A small group met at Glumac on April 21, 2013 to review concepts generated from the breakout groups in the January 2013 Genius of Place Stormwater workshop. The intent of the meeting was to identify the most practical and brainstorm next steps to move them toward implementation. The group reviewed the video presentations & drawings from the workshop, and a summary list of the concepts. Following are the concepts deemed most practical.

Filtering participants were: Craig Briscoe, Geoff Winslow & Nicole Isle (facilitator), Glumac; Johanna Brickman, Oregon BEST; Casey Cunningham, City of Portland Bureau of Environmental Services; Josh Lighthipe, KPFF Consulting Engineers; Mary Hansel, freelance.

**Team Spongeworks:** –Tributary Stormwater Collection - Murray's Law

The team investigated how the branching systems found in nature that distribute fluids could inspire a systems approach to stormwater collection. Conventional stormwater collection systems begin as “tributary streams” that feed into main channels. The team wondered if the efficiency of the system could be improved by mimicking the geometry described by Murray’s Law: the cube of the diameter of a parent vessel equals the sum of the cubes of the diameters of the daughter vessels. This is an optimum arrangement to move fluids using pressure differentials instead of energy inputs. We see it in tree branches, leaf veins, our lungs, and in fungal networks.

The review team liked the idea because it poses a potential method for moving water through pipes using minimal or no energy for pumping. However, the team questioned how adaptive such a system would be could new pipe branches be added over time?

**Teams: Real World:** Hydraulic Tap

The team investigated how root structures could inspire a design for tapping into deeper water during summer periods. The concept is based on hydraulic redistribution, where passive redistribution of water occurs whenever a water potential gradient exists across soil layers.

**Multiple Teams:** Absorptive Overhang and Roof Products

Several teams investigated the idea of integrating a series of overlapping canopies, awnings, and roof structures over existing impervious surfaces to delay runoff and maximize surface area potential for evaporation or channeling water to a storage location. These structures can play host to elements that help absorb water, further reducing the amount of water that reaches the ground during storm events. Inspired by moss and the multi-tiered design of tree canopies, five teams used bio-utilization (incorporating nature) and biomimicry (emulating nature) approaches in their designs. Materials included vegetation and moss, water-absorbent tile, synthetics, and a "miracle material" with hydrophobic and hydrophobic layers to absorb water and promote evaporation. The review team found this general idea to be highly practical although the added weight may require more structural support. Canopies that are not attached to buildings would pose a low risk to buildings or design investment, should early pilot test models fail. The review team believes the idea may be innovative enough to capture the interest of building roof and envelope manufacturers.

A related policy idea is to require a certain amount of canopy cover per area for new developments.

**Teams Mycorrizhal & Mossy Absorbers: Stormwater Tree / Building Wrap**

From canopy structure to the bark and inner layers of wood, two teams re-imagined a breathable building wrap inspired by trees, moss and downed wood. The material would have an outer layer that functioned like bark by absorbing water and transpiring it to the atmosphere. Some teams looked at the idea of adding "mossy cups" to the exterior of buildings and the review team thought it would add an extra absorptive quality to the nature-inspired building wrap. Team Mossy Absorbers addressed the challenge of how to use what comes from inside a building, and imagined a building wrap material that draws excess heat from the building interior and uses it to increase evaporation of stormwater collected on the outside of the material. The review team thought both concepts deserved further investigation and recommended creating a material mimicking wood and/or moss forms at the micro or nano scale.

**Multiple Teams: Under-Aggregate Absorption**

Inspired by downed wood and moss, six teams developed a concept that includes an absorptive media beneath the aggregate layer underlying permeable pavement. The material would capture water and either distribute it to where it's needed and accelerate infiltration and/or evaporation through capillary action. Team We Like Moss/Riparian imagined a "sidewalk H2O management system" using this concept and other ideas. Magic Carpet Pad: Also inspired by downed wood, this newly imagined super absorbent carpet pad would capture, retain and wick out water without forming mildew. The review team thought that the pad would indeed be a "miracle" material if designed to avoid potential health issues.

**Teams Lichen & Spongeworks: Dead Wood Strategic Plan**

An underutilized resource in the city, downed wood would be better integrated into the urban forest management program. In Portland, there is no strategic program for the placement of these sponges to absorb water; they could be placed in rain gardens, parks, medians, etc. There are many neighborhoods with trees at the end of their useful life, and a lot of debris is generated through pruning.

**Team Absorption: Engineered Eco-Soils**

Inspired by the absorptive capacity of mycorrizhal fungi, Team Absorption imagined developing add mixtures to the absorption capacity of soils. Absorptive capacity in mycorrizhal fungal networks is increased due to the comparatively large surface area of the mycelium to root ratio, and to cell membrane chemistry. Soils engineered for increased absorption could be used near sidewalks, alleys, adjacent to buildings, or on eco-roofs.