Wetland Studies and Solutions, Inc.®

WSSI's Steps Toward Sustainability

Wetland Studies and Solutions, Inc.

Leading by Example

Sustainability at WSSI

When it comes to sustainability, Wetland Studies and Solutions, Inc. (WSSI) both talks the talk and walks the walk. WSSI's Gainesville, Virginia, office is one of the Commonwealth's "greenest" buildings, as described herein. The office includes 42,190 square feet of space on a 28,400 square-foot footprint. The site is 5.18 acres, including 1.75 acres of forested open space. Although the office was designed and built in 2005, WSSI adds new features annually to help keep the building on the cutting edge of sustainable design.

Calculations show that the building uses 70% less potable water and 42% less energy than a typical office building of the same size and capacity. Approximately 20% of the building's energy is supplied by Virginia's largest rooftop solar photovoltaic system, and the majority of the building's non-potable water needs are supplied by two rainwater harvesting cisterns.

WSSI also provides opportunities for the public to learn about sustainability. WSSI's self-guided tour allows visitors to see the building's green features at their own pace. Information can be obtained at the WSSI front reception desk during standard business hours; the exterior tour signs are available for viewing at any time.

LID and LEED

Low-Impact Development (LID) is an holistic stormwater management method that mimics predevelopment (forested) hydrology through the use of small-scale stormwater management techniques (sometimes called Integrated Management Practices, or IMPs). IMPs are often integrated into the landscape and tied together through a system of underdrains. Underdrains are perforated pipes that collect water from the gravel base beneath most IMPs and convey that water to a stream or other outfall. Because WSSI's site sits on mostly clay soils, water can not readily infiltrate, and the underdrain system ensures the IMPs drain after rainfall events.

The Leadership in Energy and Environmental Design (LEED) green building rating system was developed by the U.S. Green Building Council as a national standard for sustainable building design and construction. The program certifies facilities in one of four levels: Certified, Silver, Gold, and Platinum.

WSSI's office, which earned LEED for Commercial Interiors (LEED-CI) certification in early 2006, was the first facility in Virginia to be certified at the Gold level.

WSSI boasts the first LEED Gold-certified building in the Commonwealth of Virginia.

Sustainability Throughout the Building

Materials used Throughout the Building

- Ceiling tiles contain 78% recycled content
- Steel doors and frames contain 50% recycled content
- Carpet contains 11% recycled content and is recyclable
- Translucent walls are made with natural materials
- Translucent walls contain 40% recycled content
- Metal-shaving countertops contain 35% recycled content
- Wheat board surfaces and cabinets are rapidly-renewable
- Wheat board surfaces and cabinets contain 95% recycled content

Energy Considerations - Light Levels

WSSI maintains a light level around 0.9 Watts per square foot throughout the building. (Typical buildings maintain a light level closer to 1.6 Watts per square foot, expending nearly double the energy that WSSI's building does.) WSSI's light level is low because of the building's parabolic reflective fixtures, which reflect the light upward and then diffuse it throughout the space. The fixtures produce a more even light distribution than typical fixtures, even though the light level is lower. Energy is also saved by allowing abundant natural light to enter the space through large windows. Daylight sensors turn the interior perimeter lights off when sufficient natural light is available.

Energy Savings Throughout the Building

- Fluorescent lights and parabolic reflective fixtures save energy
- Motion sensors turn the lights off when rooms are empty
- Daylight sensors turn the lights off when natural light abounds
- Large windows provide additional light
- Operable windows provide natural ventilation
- Low U-value glass reduces heat transfer through windows
- Extra insulation increases the building's energy efficiency
- Energy Star® appliances and computers save energy
- Translucent walls allow light into conference rooms
- Carbon dioxide sensors provide additional ventillation if needed

Green Roof, Recycling, and Rest Rooms

Working Beneath a Green Roof

WSSI's green roof sits on a one-story building extension on the north and east sides of the building. Extra steel joists help to accommodate the weight of the saturated soil, plants, and stone on the roof. Exposing the ceiling below the green roof helps us find any leaks that may occur. (The roof, however, has not leaked since its 2005 installation.)

Four-inch (4") roof drains convey runoff from the roof to the exterior cistern for irrigation, and the green roof provides additional insulation for the one-story building extension.

Recycling at WSSI

- Plastic
- Glass
- Metal
- Cardboard
- Paper
- Batteries
- Ink cartridges

Regional Materials

Using locally-produced or manufactured building materials decreases the energy required during transportation. Overall, 35% of the materials in the building came from less than 500 miles away. The concrete blocks used at the back of the building were manufactured across the street.

Rest Room Water Use

WSSI uses 70% less potable water than a typical office of the same size, and much of that water is saved in the rest rooms. Sensor-activated faucets turn the water off when not in use. Low-flow toilets, faucets, and showerheads use approximately 30% less water. Waterless urinals save one gallon of water per use. Toilets flushed with harvested rainwater use no potable water.

Rest Room Materials

The rest room stall partitions, ceramic tile, and countertops contain between 30% and 90% recycled content.

If everyone installed fixtures to reduce potable water consumption by 50%, our population could double without building another sewage treatment plant.

Kitchen and Workspaces

Kitchen

1. Energy-efficient lighting
2. Wheat board cabinets are rapidly-renewable
3. Low-VOC paint
4. Glass doors allow interior views
5. Water-efficient dishwasher uses 60% less water
6. Recycled metal-shaving countertop
7. Natural linoleum flooring
8. 11% recycled content in carpet and low-VOC carpet adhesive

The kitchen's linoleum flooring contains 35% recycled content and natural materials (cork flour, wood dust, and linseed oil). Unlike vinyl flooring, linoleum contains no petroleum products, conserving resources and improving air quality.

The kitchen's metal-shaving countertops are made from recycled metal shavings (that would otherwise be discarded because they are are too small to re-melt) and a recycled binder. The resulting surface has a similar aesthetic to granite.

Workspaces

9. Daylight- and motion-controlled lights
10. 78% recycled content in ceiling tile
11. Low-VOC paint
12. 50% recycled steel in doors and frames
13. 62 thermal zones
14. Abundant natural light
15. Task-level lighting
16. Corn-based polylactic acid (PLA) fabric
17. EnergyStar®-compliant monitors and computers
18. Wheatboard worksurfaces
19. 30% recycled steel in workstation panels
20. 45% recycled content in task chair
21. 11% recycled content in carpet and low-VOC carpet adhesive

The building's 62 thermal zones translate into one thermostat for every two employee workstations. Each thermostat is capable of modifying the temperature (set by a computer-controlled master thermostat) by two degrees in either direction to increase employee comfort.

Green Roof

Improves Habitat, Air Quality, and Runoff

Quick Facts About the Green Roof

- The roof is 3,626 square feet
- The roof occupies a one-story building extension
- The roof is designed for a live load of 62 pounds per square foot
- Extensive and intensive areas provide variety
- Two wetland pods add character and habitat variety
- The growing medium is a lightweight, expanded shale 3" to 9" deep
- The growing medium detains and filters stormwater
- Plants uptake water and release it through evapotranspiration
- Plants help reduce the heat island effect
- Plants provide habitat and food for insects and birds

Green Roof Variety

Extensive green roofs have shallow soil and little organic matter. They can host only a small variety of plants, mostly hardy plants like sedums. Sedums thrive in the hot, dry, windy conditions commonly found on roofs.

Intensive green roofs have deeper soil with more organic matter; they can sustain a much wider variety of species, even trees.

WSSI's two *wetland pods* are each comprised of flexible pipe, an impermeable pond liner, highly organic soil, and wetland plants. Moisture sensors and drip irrigation lines ensure that the pods stay wet.

Design Considerations

Five roof drains situated along the outer edge of the roof convey water to the underground cistern. In times of drought, the roof can be irrigated from the building's interior cistern.

The growing medium is comprised of shale particles that have been heated until the organic matter burns away and the shale expands, increasing the soil's capacity to retain water while also making it lighter. The growing medium weighs approximately 50 pounds per cubic foot when fully saturated with water. (Soil usually weighs closer to 120 pounds per cubic foot when fully saturated.)

Maintenance Considerations

Especially during the establishment period, green roofs must be maintained to ensure that weeds do not choke out the other plants. Periodically, WSSI trims the sedums and allows the clippings to grow into new plants to fill in any bare areas on the roof. WSSI also performs other routine landscaping maintenance as needed.

Solar Energy at WSSI

Provides Electricity and Hot Water

Solar Photovoltaics

- The system was Installed in December 2010
- The system began producing power on January 19, 2011
- 572 monocrystalline panels produce electricity
- The panels have a capacity of 185 Watts each
- The overall system provides 105.82 kW
- The system is the largest solar photovoltaic system in Virginia
- The system will produce 22,740 kWh annually
- The system will provide 20% of the building's 640,000 kWh annual demand
- Ballast mounting holds the panels on the roof
- The photovoltaic panels are covered by a 25-year warranty
- The panels, ballast, and accessories weigh 8.5 pounds per square foot
- The system is tied to the electrical grid

Solar Hot Water

WSSI's solar water heater heats water for the building's showers and sinks. The water heater consists of sixty (60) evacuated-tube solar collectors, a collection manifold, plumbing, and a heat exchanger. The tubes are under vacuum, which allows the system to create vapor (and therefore begin heating water) at approximately 30° Celsius (86° Fahrenheit), as compared to the standard boiling point of water, 100° Celsius (212° Fahrenheit). The vacuum also provides excellent insulation, allowing even weak sunlight to heat the tubes. Therefore, the system provides a substantial amount of heat for the building's water supply, even on cold or overcast days. If necessary, the hot water tank can also act as a conventional water heater to provide supplemental heat.

Other Benefits of Solar Energy and Green Roofs

The "urban heat island" effect refers to the elevated temperatures experienced in urbanized areas which is due, in large part, to the increase in asphalt and other dark surfaces covering the ground; when these surfaces are hit by sunlight, they convert the solar energy to heat.

WSSI's second-story roof is covered in a high-albedo (highly-reflective) membrane beneath the solar panels to minimize the amount of sunlight absorbed by the building. WSSI's green roof (opposite page) and solar panels convert solar energy to photosynthesis and electricity, respectively, rather than heat. These surfaces both turn sunlight into an asset and help to minimize the "heat island" effect.

Low-Impact Development

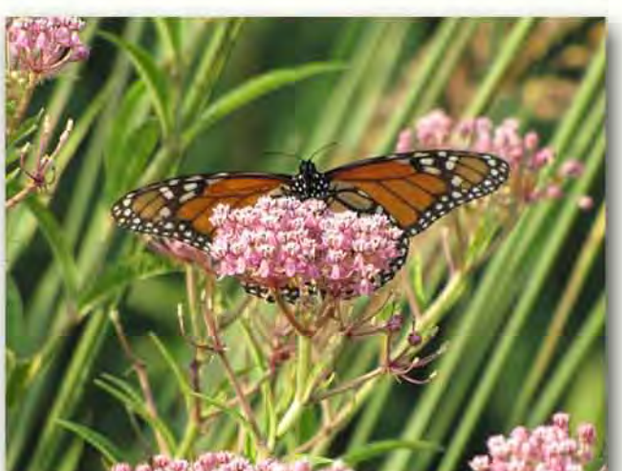
Preserving Natural Function at WSSI

1. GravelPave2 pervious pavement
2. Naturalistic landscape
3. Permeable concrete pavers
4. Green roof
5. Living wall
6. Bioswale
7. Underground cistern
8. Rain garden
9. Pervious concrete
10. Porous asphalt
11. Underground gravel bed detention
12. Dog kennel and dog waste composter
13. Community garden
14. Native forest and nature trail

A Quick Look at LID

LID uses a suite of small-scale stormwater management techniques to mimic the hydrologic function of a forest. Ideally, the management techniques are integrated to achieve a treatment-train effect; integrated management practices (IMPs) can achieve greater treatment than stand alone techniques.

LID's benefits over traditional stormwater management can include: an increased time of concentration (the time water takes to reach the stream); reduced nutrient load; reduced runoff volume; improved habitat; and increased infiltration and groundwater recharge.



The National Wildlife Federation and the Virginia Department of Game and Inland Fisheries recognize WSSI's site as a Certified Wildlife Habitat

The Rain Garden

A Hydrologically-Functional Landscape

Rain Garden Concept

A rain garden (or bioretention basin) is a landscaped feature that provides stormwater management benefits. Rain gardens are shallow, gently-depressed features that collect water and detain it briefly. Rain gardens provide detention, filtering, and volume reduction through evapotranspiration.

Rain Garden Quick Facts

- 1,635 s.f. ponding area and 11,600 s.f. buffer
- Collects water from impervious parking
- Collects water from exterior cistern overflow
- Weeding and maintenance are done as needed
- Re-mulched annually

Soil Media Considerations

WSSI's rain garden soil media is composed of 83% sand, 8.5% organic leaf mulch, and 8.5% onsite topsoil. The media is extremely porous, which allows water to drain from the rain garden within a short period of time. If the soil media has too much fine material, water will pond for too long and create potential mosquito habitat.

Plants and Vegetation in the Rain Garden

WSSI's rain garden is planted with a variety of native perennials, shrubs, and trees chosen specifically for their ability to withstand both dry conditions and periods of inundation. The sandy soil media does not retain water within its structure for long periods of time, which makes plant selection key to creating an attractive feature. The plants provide shade, wildlife habitat, and visual appeal, and their roots create macro-pores in the soil media which increase the rain garden's permeability over time. WSSI's rain garden plants include:

Common Name	***Scientific Name***
Black Gum	*Nyssa sylvatica*
Musclewood	*Carpinus caroliniana*
River Birch	*Betula nigra*
Winterberry	*Ilex verticillata*
Buttonbush	*Cephalanthus occidentalis*
Chokeberry	*Aronia arbutifolia*
Northern Bayberry	*Myrica pensylvanica*
Witch Hazel	*Hamamelis virginiana*
Joe Pye Weed	*Eupatoriadelphus fistulosum*
Mistflower	*Conoclinium coelestinum*
NY Ironweed	*Vernonia noveboracensis*
Sea Oats	*Chasmanthium latifolium*
Slender-Leaved Mt. Mint	*Pycnanthemum tenuifolium*
Brown-eyed Susan	*Rudbeckia triloba*

Rainwater Harvesting

For Irrigation and Non-Potable Interior Uses

Interior Cistern

WSSI's interior cistern collects and stores the equivalent of one quarter inch of water from the roof of the building to flush the building's ten toilets. The cistern is connected to two of the roof's five downspouts. The water is untreated; particulates settle to the bottom of the tank, below the outlet pipe, and the tank is cleaned manually as needed (typically annually). The outlet pipe and pump are screened to filter floating particulates.

Since the water is not potable, it runs through a pipe network separate from the building's potable water. Each network is clearly labeled to ensure that the lines are not inadvertently crossed in the future.

Interior Cistern Quick Facts

- Installed in April 2009
- 4,000 gallon polyethylene tank
- Overflows to the exterior cistern (below)
- Automatically switches to city water if needed
- Modeled to go dry approximately three days per year
- Completely separate, labeled plumbing lines
- Saves 48,000 gallons of potable water annually

Exterior Cistern

WSSI's 8,000-gallon, exterior (underground) cistern collects and stores one-half inch of water from the building's roof to water the landscape. The exterior cistern also collects overflow from the interior cistern. Overflow from the exterior cistern enters the rain garden through the site's underdrain network, and large storms overflow through the underdrain network directly into the gravel bed detention area.

The harvested water is pumped through WSSI's drip irrigation system, which is comprised of a grid of flexible, perforated tubing. The drip irrigation system applies water directly at the base of the plants, where it is absorbed by the roots. Drip irrigation is more efficient than spray irrigation because the evaporation loss is lower. WSSI also used spray irrigation because traditional pop-up heads are too short to be effective in the naturalistic meadow landscape.

The native vegetation doesn't require much water when mature. WSSI irrigates regularly, however, to ensure that the cistern has adequate capacity to accept the next storm.

Permeable Parking Surfaces

Pavers, Gravel, Concrete, and Asphalt

Permeable Pavers

WSSI's permeable concrete pavers have spaces at the corners to allow runoff to enter a gravel substrate, where it infiltrates (if the in-situ soil allows) or is released through an underdrain. WSSI's pavers have spaces at the corners for approximately 10% surface void space. The pavers sit on an 8" gravel base to retain runoff, but since the site's soils have a high clay content, 4" perforated underdrains convey the runoff to the vegetated floodplain on either side of the site. A concrete header curb separates the paver parking spaces from the asphalt drive lane.

Little maintenance is performed on the permeable pavers. Debris is removed as necessary, but sediment collecting in the void space has not been a large issue because most cars that park on the pavers are clean. Weeds are also not a problem due to the surface's deep gravel base.

GravelPave2

GravelPave2 is a product that combines filter fabric with a grid of plastic rings that hold gap-graded gravel in place. The filter fabric separates the smaller surface gravel from the larger base stone. Periodically, WSSI rakes the gravel and adds additional gravel as necessary to ensure a uniform surface.

Pervious Concrete

Pervious concrete contains little or no fine material. The subsequent stone-to-stone contact provides strength, and the void space left by the lack of fine material provides a high infiltration rate. WSSI's pervious concrete surfaces are 6" deep with a 12" gravel base. (Part of the permeable concrete surface also sits directly above the underground gravel detention bed, which is 40" deep.) The gravel base must be deep enough that runoff does not sit in the concrete itself; this could create a slick condition if the surface freezes. Pervious concrete can be vacuumed or plowed as necessary to remove debris or snow.

Porous Asphalt

Placing porous asphalt is similar to placing conventional asphalt. Porous asphalt has less fine material than conventional asphalt; to make up for this, porous asphalt uses fibers to add strength and reduce cracking. (The fibers act as a "bridge" between the aggregate.) WSSI's porous asphalt is 4" thick with a 12" gravel base; part of the surface also sits directly above the underground gravel detention bed. Porous asphalt can be swept or plowed as necessary, and it can also be salted in the winter.

Additional Permeable Surface Considerations

- Permeable surfaces are most applicable to low-traffic, low-speed applications such as parking
- Mud from cars can infiltrate permeable parking surfaces and degrade permeability over time
- To promote infiltration, gravel must be gap-graded and must include no fine material
- Sand should not be applied to permeable pavements in the winter because it will clog the surface

Additional LID Techniques

Detention, Bioswale, Walls, and Landscape

Underground Gravel Detention

The gravel detention bed occupies much of the space beneath the rear parking lot. The gravel bed, which is 40" deep, collects water from the building roof, and the surfaces behind the building. It detains the water for 24 to 36 hours, releasing it slowly through a 1.625" orifice to the existing stream. The slow release of water helps to reduce streambank erosion downstream of WSSI's site.

Bioswale

WSSI's bioswale is a 275' vegetated swale with three stone checkdams along its length. It conveys water from 12,650 s.f. of impervious parking surface to the existing stream channel. The checkdams help slow the water to reduce suspended nutrients and sediment before the water enters the stream channel. The bioswale is planted according to the principles of naturalistic landscaping (see below), so it is difficult to distinguish the from the surrounding landscape now that the plants have grown in. The plants help to slow and filter the water, and they uptake a portion of the runoff volume through evapotranspiration.

Living Walls

WSSI uses living walls on portions of the south- and east-facing walls to shade and cool the building in the summer and to provide habitat for songbirds and insects. In the winter, the vines lose their leaves and allow the sun to warm the building. The 3-dimensional wire lattice bolts to the wall and hosts a variety of native climbing vines, including:

Common Name	***Scientific Name***
Trumpet Honeysuckle	*Lonicera sempervirens*
Purple Passionflower	*Passiflora incarnata*
Dutchman's Pipe	*Aristolochia macrophylla*
Snowdrift Clematis	*Clematis armandii 'Snowdrift'*

Naturalistic Landscaping

WSSI uses locally-native plants and the land's natural contours to create a landscape that closely resembles surrounding natural areas. Locally-native plants usually require less irrigation and maintenance; are aesthetically pleasing; provide abundant wildlife habitat; and can mimic natural hydrologic function.

Naturalistic landscapes benefit both human and animal habitats.

Employee Health, Wellness, and Community

Employee Gym and Wellness Program

The WSSI gym began with a small group of employees in early 2005. Workouts took place during the lunch hour wherever there was room- often in the parking lot of WSSI's old facility during good weather and in conference rooms during inclement weather. WSSI's gym now boasts:

- State-of-the-art cardio machines and weight-lifting equipment
- Daily trainer-led workouts for employees
- Employee volleyball and basketball games

Employee Dog Kennel

WSSI provides a six-room kennel for those employees who want to bring their dogs to work. Kennel rooms and cleaning duties are shared on a rotating basis; some dogs get along well enough to share a room. The kennel also includes an exterior fenced dog run for dogs who need more activity.

WSSI's kennel also houses a composting bin to render dog waste into soil rather than sending it to a landfill where anaerobic conditions would slow its natural degradation. Installed in May 2010, the composter has a capacity of 90 c.f. (755 gallons) and will produce continuous compost after its fifth year of installation. (It will take approximately five years for the first waste to be rendered into compost; after that, the process simply cycles as more waste is added.) Odors are continuously vented through a roof vent. WSSI plans to distribute the compost throughout the landscape to enrich the soil.

Employee Vegetable and Fruit Garden

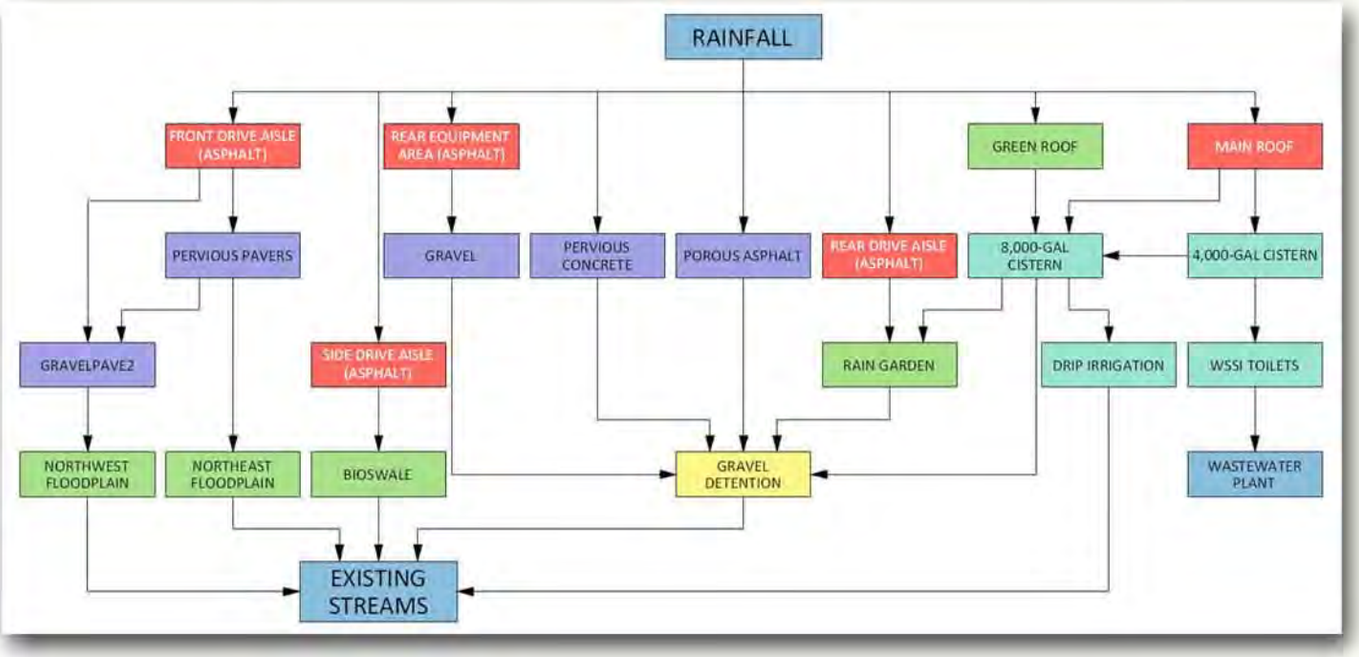
WSSI's community garden is planned, planted, maintained, and harvested by employees. The garden is a series of raised beds with an irrigation system and fencing to protect the plants from local wildlife. The harvest changes each summer but often includes tomatoes, legumes, squash, corn, melons, strawberries, and a host of other vegetables and fruit. The harvest is shared among employees on a first-come, first-serve basis. The garden encourages employee camaradarie and healthy living.

Employee Bicycle Access and Walking Trail

WSSI provides five cruiser-style bicycles and helmets for employee use. To facilitate bike riding and walking, WSSI's site also includes a 1,850 linear foot woodchip trail that winds through the forested Resource Protection Area (RPA) between the site and the nearby shopping center. The trail gives employees an easy way to walk or ride to the shopping center for lunch or errands. The trail includes three low-impact, wooden boardwalks to cross the stream and other ecologically-sensitive areas.

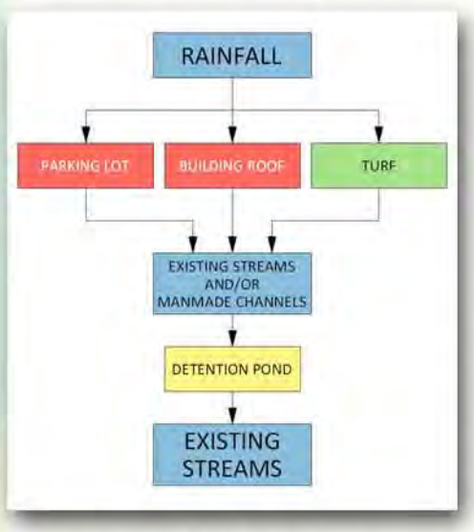
Where Does the Water Go?

Protecting Downstream Channels with LID



Flow Through the Landscape

All of the rain that falls on WSSI's landscape is treated by at least one, and up to four, LID facilities before being released to natural streams. This makes the flow paths very convoluted (as shown above), similar to what they would look like in a forest. In contrast, the flow paths for a conventional site tend to be linear as water travels from the land surface to a pond, and then to the stream (as shown below).



The Effect of High Flows on Downstream Channels

The conventional flow model to the left offers no channel protection for the streams between the site and the detention pond. If the detention pond is a regional facility, miles of streams can be degraded by undetained water after a rain event. Because the majority of the water flows off the site rather than infiltrating or evapotranspiring, the volume is increased over the forested condition, and because there is no on-site detention, the peak rate of runoff also increases. These two factors exert high shear stresses on downstream channel banks, which causes erosion. This is sometimes referred to as Urban Stream Syndrome, the symptoms of which include incised, wide channels; scoured, sloughing banks; sediment deposits in the detention pond; and other environmental problems.

The Effect of LID on Stormwater Flows

The LID flow path (top image) provides detention in gravel substrate, behind checkdams, and in ponding areas to decrease the rate of flow from the site. It also provides opportunities for volume reduction through water harvesting and reuse, infiltration, and evapotranspiration. The resulting flows experienced by the streams more closely mimic a natural forest, streams have no need to enlarge, and Urban Stream Syndrome is reduced.

Because the streams remain remain stable, less sedimentation occurs in the downstream water bodies, reducing the cost of dredging and maintenance. Similarly, habitat is retained, and less valuable land is lost along the stream channels themselves.

Longer flow paths give water more time to infiltrate or be used by plants.

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