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MACTEC GREEN · PRESERVE · CONSERVE

Low Impact Development For Stormwater Management

Today's Focus…

- *Section 438 – Energy Independence & Security Act*
- What's in the Tool Box?
- More Planning, Less Designing
- Obstacles and Incentives

Section 438…

Stormwater Magazine, April 2009:

- *“..the new era of green technology and business-based approach.”*

- *“This new law will allow federal facilities, ranging from military bases to post offices, the become some of the earliest adopters of green infrastructure.”*

Section 438…

EPA Interagency Sustainability Work Group, February 2008:

- Federal Development and Redevelopment
- Over 5,000 sf of disturbance (aka “footprint”)
- Use strategies to plan, design, & construct to maintain or restore predevelopment hydrology…

Section 438…

…"to the *Maximum Extent* ***<u>Technically Feasible</u>***"

No more *"Maximum Extent* ***<u>Practical</u>***"…

This now includes:

- Rate & volume
- Duration
- Temperature

Section 438…

EPA Technical Guidance on Implementing the Stormwater Runoff Requirements…Under Section 438:

- Option 1: Control the 95th Percentile Rainfall Event:
  - 1.5 inches +/- 0.25 inches
  - Manage on site
  - Infiltrate, evapotransporate, harvest and reuse

Section 438…

- Option 2: Preserve Predevelopment Hydrology
  - H&H analyses
  - Check rate, volume, duration & temperature…

- Option 3: METF…
  - Site restrictions
  - Good faith efforts
  - Good documentation!

Section 438…

Maximum Extent Technically Feasible Criteria

- Conditions:
  - Soils, rock and groundwater
  - Inability to amend the soil
  - Land use and vegetation conflicts
  - Harvesting has limited demand

Section 438…

Maximum Extent Technically Feasible Criteria

- Documentation:
  - Engineering calculations
  - Geologic reports
  - Hydrologic analyses site maps
  - Etc.
  - What if it is REDEVELOPMENT?....What is the baseline?

Stormwater Management & LID

Old School:

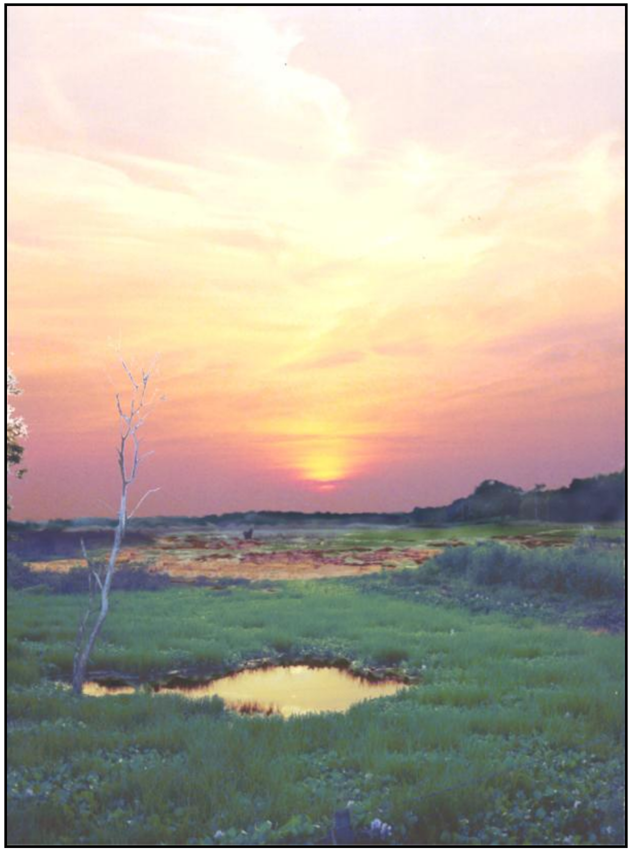
- Collect it, get rid of it

Newer School:

- Water quality and quantity

The Newest School:

- Plan more, construct less
- It's a **resource** not a nuisance



Structural Stormwater Controls

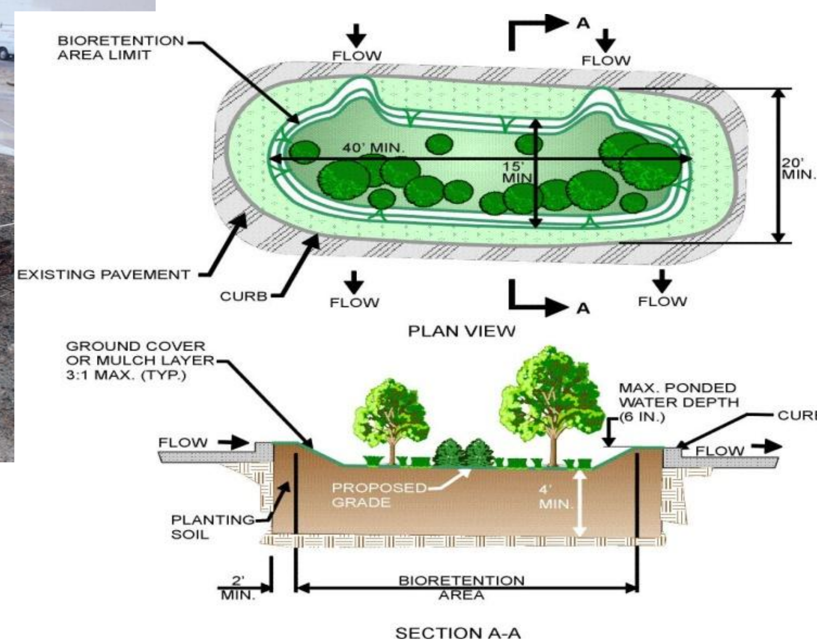
- Designed to mitigate the <u>effects</u> of increased pollutant loads, peak rate, volume or velocity
- Prefer to move from the bottom of the hill to the source.
- New = Different = More Effort/Cost?

Stormwater Ponds

Stormwater Wetlands

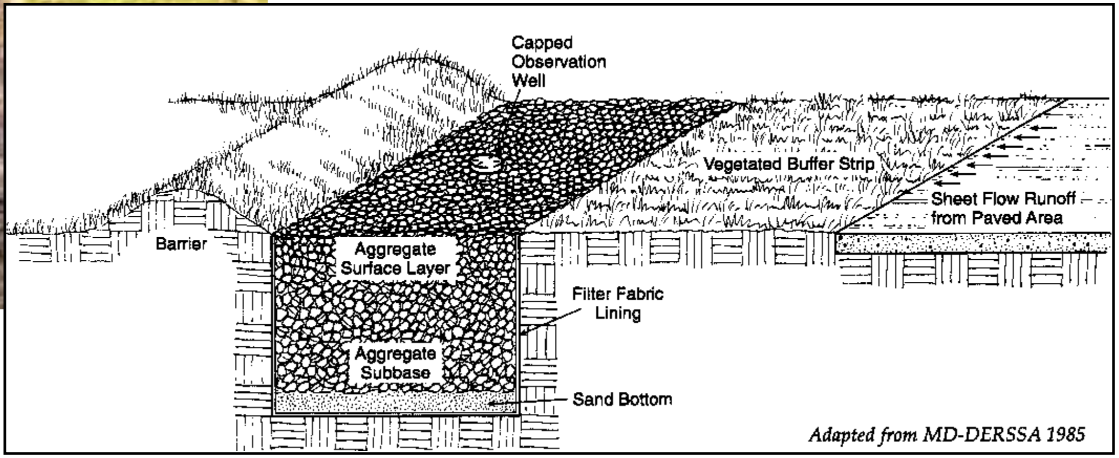
Bioretention Areas

- Landscaped areas which utilize engineered soils and vegetation to capture/treat runoff



Infiltration Trench

- Trench filled with stone to capture and infiltrate stormwater runoff



Enhanced Swales

- Open channels constructed to capture and treat runoff within dry or wet cells

Filter Strip

- Densely vegetated strips that serve as biofilters

Grass Channel

- Open channels designed to filter runoff

Porous Concrete

- Rapid infiltration to an aggregate reservoir

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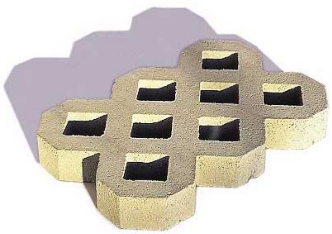
Modular Porous Paver Systems

- Structural units with void areas for infiltration

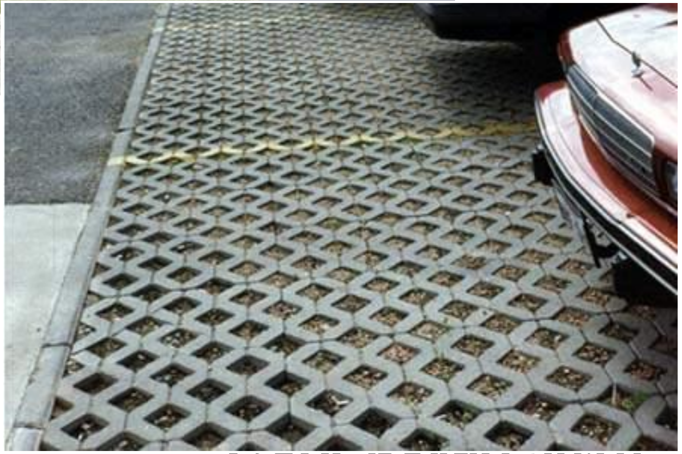


Concrete Paver Block

Castellated Block

Lattice Block

Grass / Gravel Paver Mat



Harvesting (Reuse)

- Irrigation
- Hydration of wetlands
- Low flow augmentation
- Cooling water
- Process water
- Wash water
- 5-25% of the cost of potable water

Recent LID Guidance

- *Public Works LID Technical Bulletins for the Army*
- *WERF Stormwater BMP Cost Estimating Tool*
- *Center for Neighborhood Technology LID Cost-Calculating Tool*
- *GA Coastal Stormwater Supplement*
- *FDEP Draft Applicants Handbook*
- Many others in your area…Center for Watershed Protection, etc.

Structural Control Selection

Step 1 -- Overall Applicability

- Stormwater Treatment Suitability
  - Quantity or quality? Both?
- Water Quality Performance
  - TSS, Nutrients, Bacteria?...
  - Hotspot runoff?

Structural Control Selection

Step 1 -- Overall Applicability

- Site Applicability
  - Drainage area
  - Space required (consumed)
  - Min. head vs. Water table
- Implementation Considerations

Structural Control Selection

Step 2 -- Specific Criteria

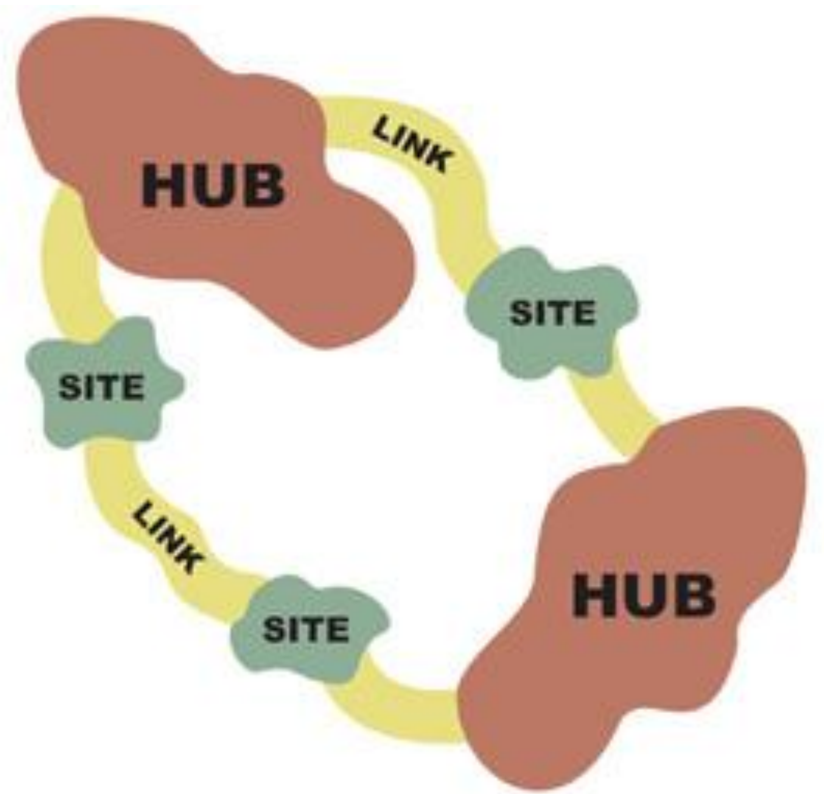
- Physiographic Factors
- Soils
- Special Watershed/Stream Considerations

Structural Control Selection

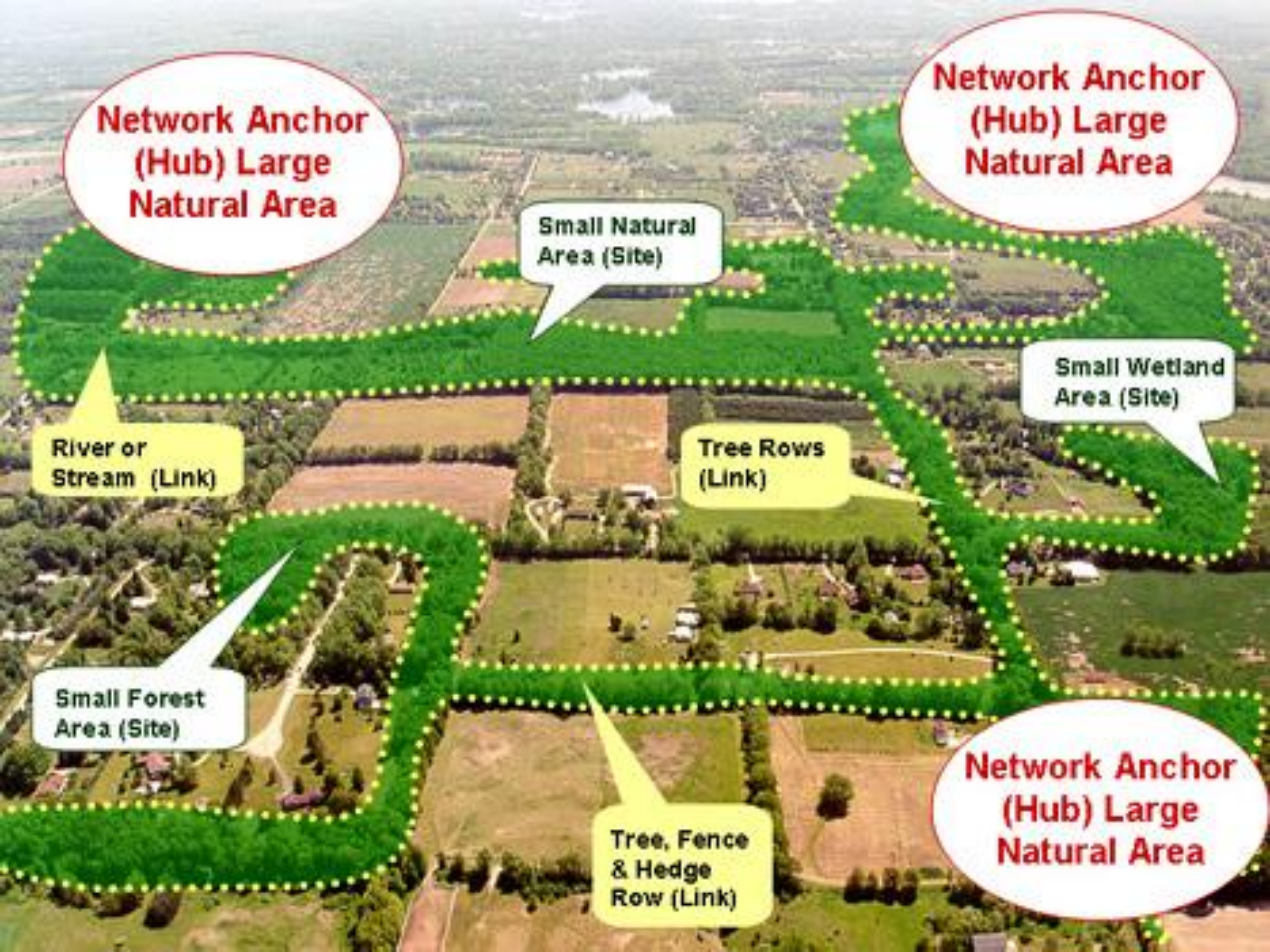
Step 3 -- Location and Permitting

- Jurisdictional Waters and Wetlands
- Floodplains
- Local Buffer Requirements
- Utilities, Roads, Structures, Wells, Septic…

Green Infrastructure Network



<u>Connectivity</u> of ecosystems and landscapes in a system of hubs, links, and sites.



Network Anchor (Hub) Large Natural Area
Network Anchor (Hub) Large Natural Area
Small Natural Area (Site)
Small Wetland Area (Site)
River or Stream (Link)
Tree Rows (Link)
Small Forest Area (Site)
Tree, Fence & Hedge Row (Link)
Network Anchor (Hub) Large Natural Area

Stormwater Better Site Design Practices and Techniques

Modifying the way we develop to:

- Reduce imperviousness
- Conserve natural areas
- Minimize pollution

Goals of Stormwater
Better Site Design

- Controlling Stormwater at the Source
- Simple, Nonstructural Methods
- Multifunctional Landscape
- Hydrology as a Framework for Site Design

Steps in Stormwater Better Site Design

1) Identify Natural Features and Resources – Delineate Site Conservation Areas

2) Design Site Layout to Preserve Conservation Areas and Minimize Stormwater Impacts

3) Use Various Techniques to Reduce Impervious Cover in the Site Design

4) Utilize Natural Features and Conservation Areas to Manage Stormwater Quantity and Quality

LID Design Criteria

<u>Better Site ***Planning*** Techniques</u>

- Preserve Primary Conservation Areas
- Preserve Secondary Conservation Areas

<u>Better Site ***Design*** Techniques</u>

- Reduce Clearing and Grading Limits
- Reduce Roadway Lengths and Widths
- Use Fewer or Alternative Cul-de-Sacs
- Smaller Parking Spots with Landscaped Areas
- Reduce Sidewalk Lengths and Widths
- Reduce Setbacks and Frontages

LID Design Criteria

<u>Green Structural Practices</u>

- Soil Restoration
- Site Reforestation/Revegetation
- Vegetated Filter Strips &Grass Channels
- Simple Downspout Disconnection
- Rain Gardens & Stormwater Planters
- Dry Wells & Rainwater Harvesting
- Green Roofs/Cistern Systems
- Pervious Pavement
- Florida-Friendly Landscaping

Reduction of Impervious Cover




Reduce the Parking Footprint

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LID Design Criteria

6.8.12 Permeable Pavements

Description
Permeable pavements are alternc
that can be used to reduce the "
cover of a development site. They
runoff to pass through the surface
pavement surface) into an underl
where it is temporarily stored and
into the surrounding soils or conve
storm drain system through an unc

KEY CONSIDERA

DESIGN CRITERIA:
- Permeable pavement syst designed to drain within 48 rainfall event
- If the infiltration rate of the beneath the permeable p not meet or exceed 0.25 ir should be included in the
- Permeable pavement syst not be used to manage st adjacent contributing drai

BENEFITS:
- Help reduce post-develop runoff rates, volumes and consuming valuable land
- Particularly well suited for such as overflow parking l

LIMITATIONS:
- Relatively high constructio typically offset by savings infrastructure
- Permeable pavement syst by experienced contracto

Discussion
Permeable pavements are alterni
"effective" impervious cover of de
stormwater runoff and allowing it
pavement systems help reduce st

6.8.11 Green Roofs

Description
Green roofs (also known as
roofs) are alternative roof s
reduce the "effective" imp
development or redevelop
temporarily store stormwat
growing media, where it is
evaportation, transpiration
being conveyed into the st
reduce post-development
volumes and pollutant loac
means that green roofs ca
post-construction stormwa
Supplement.

KEY CON

DESIGN CRITERIA:
- Extensive green roo recommended ov expensive intensive
- Engineered growin weight mix and sho organic material
- Waterproofing me from root penetrat

BENEFITS:
- Helps reduce post- runoff rates, volum consuming valuab
- Particularly well sui development and

LIMITATIONS:
- Can be difficult to harsh growing con rooftops in coastal
- Green roofs can b slopes of 10% or gr
- Requires the used installers

Discussion
Green roofs typically consi
growing media that is desi
types of green roof system
(also known as *rooftop gar*

6.8.10 Rainwater Harvesting

Description
Rainwater harvesting is the ancient
management practice of intercepti
storing rainfall for later use. In a typic
harvesting system, rainfall is collecte
downspout system, screened and "
conveyed into an above- or below-
tank or cistern. In the storage tank o
later used for non-potable indoor or
properly designed, rainwater harves
help reduce post-development stor
volumes and pollutant loads on dev
redevelopment sites. Rainwater har
reduce the demand on public wate
such as groundwater aquifers, from

KEY CONSIDERATIC

DESIGN CRITERIA:
- Rainwater harvesting system based on the size of the con area, local rainfall patterns c demand for the harvested r
- Pretreatment must be provic leaves and other debris from

BENEFITS:
- Helps reduce post-developn runoff rates, volumes and pc
- Can be used on nearly all de redevelopment sites
- Reduces demand on public which helps protect ground drawdown and seawater int

LIMITATIONS:
- Rain barrels may not be usec small drainage areas
- Stored rainwater must be us to maintain system storage c

Discussion
There are two basic types of rainwa
supply water for non-potable outdo
washing and fire fighting, and syster

6.8.9 Dry Wells

Description
Dry wells are subsurface low impact development practices designed to temporarily store and infiltrate stormwater runoff. They consist of an excavated area filled with stone that is designed to capture and treat stormwater runoff by allowing it to infiltrate into the soils surrounding the bottom and sides of the excavation. If properly designed, they can help replicate pre-development site hydrology and reduce post-development stormwater runoff rates, volumes and pollutant loads.


Source: Portland, OR, 2008

KEY CONSIDERATIONS

DESIGN CRITERIA:
- Dry wells must be designed to drain within 24 hours of the end of a rainfall event
- The distance from the bottom of a dry well to the top of the water table must be at least 2 feet
- Dry wells should be designed with slopes that are as close to flat as possible

BENEFITS:
- Helps replicate existing hydrology on development sites and reduces post-development stormwater runoff rates, volumes and pollutant loads
- Particularly well suited for use on small development sites

LIMITATIONS:
- Can only be used to treat runoff from relatively small drainage areas
- Cannot be used on development sites that have soils with infiltration rates of less than 0.5 inches per hour or on development sites that have high water tables

STORMWATER MANAGEMENT BENEFITS

☑ Runoff Reduction
✪ Aquatic Resource Protection
✪ Overbank Flood Protection
✪ Extreme Flood Protection

✪ = can be used to help address, but not fully satisfy criterion

STORMWATER MANAGEMENT PRACTICE PERFORMANCE

Runoff Reduction
80% - Annual Runoff Volume
Varies[2] - Runoff Reduction Volume

Pollutant Removal[1]
80% - Total Suspended Solids
80% - Total Phosphorus
80% - Total Nitrogen
90% - Metals
90% - Pathogens

1 = expected annual pollutant load removal
2 = varies according to storage capacity of practice

Discussion
Dry wells (also known as *seepage pits* and *french drains*) are subsurface low impact development practices primarily used to manage rooftop runoff, but can also be used to manage post-construction stormwater runoff from other small drainage areas, such as driveways, plazas and small parking lots. They consist of an excavated area filled with stone that

LID Design Criteria

Georgia Coastal Stormwater Supp
For Review Purposes Only

6.8.8 Stormwater Planters

Description
Stormwater planters are landscap are specially designed to manag development and redevelopmen an engineered soil mix that is plan shrubs and/or other vegetation. S capture and temporarily store sto subjecting it to the processes of fil evapotranspiration and plant upt it back into the storm drain system underdrain.

KEY CONSIDERA

DESIGN CRITERIA:
- Stormwater planters must completely drain within 2 rainfall event
- A maximum ponding dep recommended to preven nuisance ponding conditi planters
- Planting beds should be c unless a shallow water tab

BENEFITS:
- Helps replicate existing hy development sites and re development stormwater and pollutant loads
- Can be integrated into d attractive landscaping fe
- Particularly well suited for development sites

LIMITATIONS:
- Can only be used to treat small drainage areas
- Relatively high constructio

Discussion
Stormwater planters are landscap stormwater runoff on developme drainage materials and an engin other vegetation. They are essent with waterproof liners and underd

Georgia Coastal Stormwater Sup

Georgia Coastal Stormwate
For Review Purposes Only

6.8.7 Rain Gardens

Description
Rain gardens are small, land are filled with amended nati soil mix and planted with tre vegetation. They are design temporarily store stormwater infiltrated or absorbed by the garden. If properly designed pre-development site hydrol development stormwater ru pollutant loads.

KEY CONS

DESIGN CRITERIA:
- Rain gardens must b drain within 24 hours
- A maximum ponding recommended to pr nuisance ponding c
- Planting beds should unless a shallow wat

BENEFITS:
- Helps replicate existi development sites a development storm and pollutant loads
- Can be integrated i attractive landscapi

LIMITATIONS:
- Can be difficult to p in stormwater runoff sites that have that h permeabilities
- Can only be used to small drainage area

Discussion
Rain gardens are typically us suited to treat rooftop runoff drainage areas, such as loc disturbed pervious areas (e.g

Georgia Coastal Stormwate

Georgia Coastal Stormwater Supplement
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6.8.6 Simple Downspout Disconnection

Description
Simple downspout disconnection spreads roo from individual downspouts across lawns and densely vegetated pervious areas, where it is filtered and allowed to infiltrate into the grou properly designed, simple downspout discon can help replicate pre-development site hyd reduce post-development stormwater runoff volumes and pollutant loads.

KEY CONSIDERATIONS

DESIGN CRITERIA:
- Width of contributing drainage areas feet or less
- Width of pervious areas below down disconnections must be equal to or g the width of their contributing draina
- Must be designed to convey stormw away from buildings to prevent dam building foundations

BENEFITS:
- Helps replicate existing hydrology on development sites and reduces post development stormwater runoff rate and pollutant loads
- Relatively low construction and main costs

LIMITATIONS:
- Can only be used to treat runoff from small rooftop areas of 2,500 square fe

Discussion
As its name implies, simple downspout discon management practices that can be used to from individual downspouts across lawns and effectively disconnects rooftops from the sto site hydrology and reduce post-developmen loads. If applied on a large scale, simple dow

Georgia Coastal Stormwater Supplement

Georgia Coastal Stormwater Supplement
For Review Purposes Only
Draft – October 2008

6.8.5 Grass Channels

Description
Where site characteristics permit, grass channels, which are densely vegetated stormwater conveyance features, can be used to convey and treat stormwater runoff on development and redevelopment sites. If properly designed, grass channels can help replicate pre-development site hydrology and can be used to address the post-construction stormwater management criteria presented in this Coastal Stormwater Supplement.

KEY CONSIDERATIONS

DESIGN CRITERIA:
- Grass channels must be designed to accommodate the peak discharge generated by the runoff reduction (e.g. 1.2 inch) rainfall event and be able to safely convey the local design storm event (e.g. 10-year, 24-hour event)
- Grass channels may be designed with slopes of between 0.5% and 3%, although slopes of between 1% and 2% are recommended

BENEFITS:
- Helps replicate existing hydrology on development sites and reduces post-development stormwater runoff rates, volumes and pollutant loads
- Relatively low construction and maintenance costs

LIMITATIONS:
- Should not be used on development or redevelopment sites with slopes of less than 0.5%

STORMWATER MANAGEMENT BENEFITS

- ✪ Runoff Reduction
- ✪ Aquatic Resource Protection
- ✪ Overbank Flood Protection
- ✪ Extreme Flood Protection

✪ = can be used to help address, but not fully satisfy criterion

STORMWATER MANAGEMENT PRACTICE PERFORMANCE

Runoff Reduction
10%-20% - Annual Runoff Volume
12%-25% - Runoff Reduction Volume

Pollutant Removal[1]
60% - Total Suspended Solids
25% - Total Phosphorus
30% - Total Nitrogen
30% - Metals
N/A - Pathogens

1 = expected annual pollutant load removal

Discussion
Conventional storm drain systems are designed to quickly and efficiently move post-construction stormwater runoff off of and away from impervious surfaces and into rivers, streams and other aquatic resources. When these systems are used to replace the natural drainage features and patterns found on development and redevelopment sites, post-development stormwater runoff rates, volumes and pollutant loads are automatically increased. An alternative to the replacement of natural drainage features and patterns with structural storm drain systems (e.g. curb and gutter systems, storm sewers, concrete channels) is the use of grass channels.

Georgia Coastal Stormwater Supplement 6-80

LID Design Criteria

6.8.4 Vegetated Filter Strips

Description
Vegetated filter strips are uniforr vegetated areas of land design stormwater runoff and reduce st volumes and pollutant loads. If p undisturbed natural areas can h development site hydrology anc address the post-construction st criteria presented in this Coastal Supplement.

KEY CONSIDEI

DESIGN CRITERIA:
- Surface runoff must ente strip as overland sheet fl
- Width of contributing dr 150 feet or less (pervious feet or less (impervious c
- Vegetated filter strips m least 0.5% to ensure ade

BENEFITS:
- Helps replicate existing I development sites and r development stormwat and pollutant loads
- Relatively low constructi costs

LIMITATIONS:
- Can be difficult to main within a vegetated filter provided to ensure prop

Discussion
Vegetated filter strips (also know attractively integrated into deve are well suited to treat stormwat downspouts, small parking lots o open spaces). They are ideal fo landscaped buffer strips comm incompatible land uses (e.g. res

6.8.3 Undisturbed Natural Areas

Description
Undisturbed natural areas, such as rip floodplains, maritime forests and stan other vegetation, can be used to mar construction stormwater runoff gener parts of development and redevelop properly designed, these undisturbed function as stormwater management significantly reduce post-developmen runoff rates, volumes and pollutant lo development and redevelopment site

KEY CONSIDERATIO

DESIGN CRITERIA:
- Surface runoff must enter the area as overland sheet flow
- Width of contributing drainag 150 feet or less (pervious drain feet or less (impervious draina
- Width of undisturbed natural manage stormwater must be

BENEFITS:
- Helps replicate pre-developm development sites and reduc development stormwater run and pollutant loads
- Helps preserve riparian ecosys

LIMITATIONS:
- Must be managed in a natur protected from future land de acceptable conservation inst

Discussion
Stormwater runoff can be conveyed t riparian buffers, floodplains, maritime were delineated and conserved earli vegetation found in these undisturbe which encourages infiltration and sha can function as post-construction sto

6.8.2 Site Reforestation/Revegetation

Description
Site reforestation/revegetation involves p shrubs and/or other native vegetation in pervious areas with the goal of establishi native plant community (e.g. forest) that restore pre-development site hydrology reducing post-development stormwater volumes and pollutant loads. It can be u the hydrologic conditions of pervious are been or will be disturbed by land develo activities.

KEY CONSIDERATIONS

DESIGN CRITERIA:
- Ideal for use in pervious areas th will be compacted by land deve activities
- Methods used for revegetation n least 75% canopy cover within te installation
- Reforested/revegetated areas n protected in perpetuity as natur conservation areas

BENEFITS:
- Helps replicate pre-developmen development sites and reduces development stormwater runoff and pollutant loads
- Helps restore ecosystems and ha

LIMITATIONS:
- Must have a minimum contiguo square feet
- Must be managed in a natural s protected from future land deve activities

Discussion
Site reforestation/revegetation involves p disturbed pervious areas with the goal of forest). Recent research has demonstrat reforestation/revegetation (Figure 6.31) c redevelopment sites (Hirschman et al., 2 increase evaporation and transpiration r

6.8.1 Soil Restoration

Description
Soil restoration refers to the process of tilling and adding compost and other amendments to soils to restore them to their pre-developed conditions, which increases their porosity and improves their ability to reduce stormwater runoff rates and volumes. The process can be used to improve the hydrologic conditions of pervious areas that have been or will be disturbed by land development activities and to increase the stormwater management benefits provided by other low impact development practices.

KEY CONSIDERATIONS

DESIGN CRITERIA:
- Ideal for use in pervious areas that have been or will be disturbed by land development activities
- To properly restore disturbed pervious areas, soil amendments should be added to native soils to obtain an organic matter content of 8 to 12%
- Restored pervious areas need to be protected from future disturbance and compaction

BENEFITS:
- Improves soil porosity and infiltration rates
- Promotes root growth and improves plant health, which stabilizes soil to protect against erosion

LIMITATIONS:
- Cannot be used on areas that have slopes of greater than 10%
- To prevent soil erosion, landscaping must be installed immediately after the soil restoration process is complete

STORMWATER MANAGEMENT BENEFITS

- ✪ Runoff Reduction
- ✪ Aquatic Resource Protection
- ✪ Overbank Flood Protection
- ✪ Extreme Flood Protection

✪ = can be used to help address, but not fully satisfy criterion

STORMWATER MANAGEMENT PRACTICE PERFORMANCE

Runoff Reduction
N/A[1] - Annual Runoff Volume
N/A[1] - Runoff Reduction Volume

Pollutant Removal
N/A[1] - Total Suspended Solids
N/A[1] - Total Phosphorus
N/A[1] - Total Nitrogen
N/A[1] - Metals
N/A[1] - Pathogens

1 = helps restore site hydrology, which implicitly reduces stormwater runoff volumes and pollutant loads

Discussion
Soil restoration refers to the process of tilling and adding compost and other amendments to soils to restore them to their pre-developed conditions. It is ideal for use on lawns and other pervious areas that have been or will be disturbed and compacted by clearing, grading and other land development activities. Compost (Figure 6.30) and other amendments can be tilled into the

Arguments…

- •Cost…to construct
- •Cost…design
- •Cost…operate/maintain
- •Time = Cost…

Arguments…

<u>Site Challenges</u>

- *Poorly drained soils…*Ability to reduce runoff volumes.
- *Well drained soils…*Pollutants reaching groundwater easier.
- *Steep Terrain…its leave too quickly*
- *Flat terrain, water table, tidal influence…*ponding…

Incentives…

Credits for better site design techniques intended to **reduce** the size and **cost** of structural controls.

Proof…

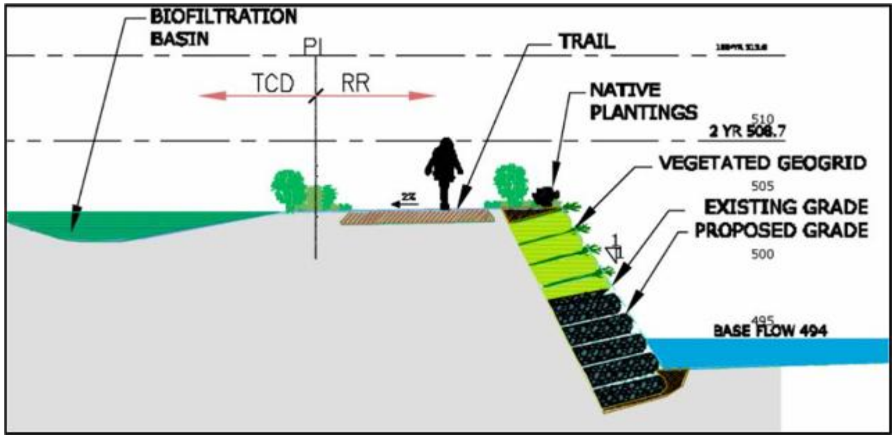
EPA Technical Guidance:

- 8 case studies
- Nation-wide distribution
- Cost savings identified
- Constraints and alternatives explained

Incentives…

Developer:

- Added Value
- Less gray construction
- Reduced User Fees



Incentives…

<u>Designer:</u>

- Offer a specialty skill
- Address water quantity
- Redevelopment sites

Incentives…

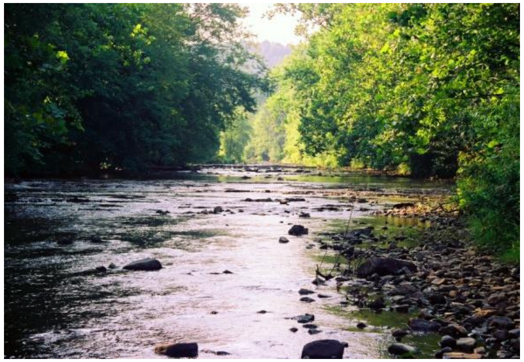
Everyone:

- Think more, do less
- Clear and construct less
- Design, permit & maintain less
- Increase value

Incentives…

Everyone:

- Cleaner water
- Reduced water treatment costs
- More trees, cleaner air



Proof…

LID Cost Savings:

- *Reducing Stormwater Costs Through LID Strategies and Practices* (EPA, Dec. 2007)
- *WERF Post-Project Monitoring of BMPs to Determine Performance and Whole-Life Costs* (2004)
- *Center for Neighborhood Technology LID Cost Calculator:* http://greenvalues.cnt.org