Low Impact Development without Infiltration

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Reining in the Rain, Newport Beach

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Site Constraints Preventing Infiltration

- Hydrologic Soils Class C & D
- Shallow depth to groundwater
- Collapsible soils
- Ultra compacted soils

- Limiting Factor: Infiltration needs to occur within **96** hours to comply with the CA Dept. of Health requirements (July 2007)
  - Ponding depth/infiltration rate ≤ 96 hours

Low Impact Development

- Objective: To mimic the pre-development site hydrology by implementing site-design techniques that function similar to natural processes.

- Low soil infiltration rate in the pre-development condition

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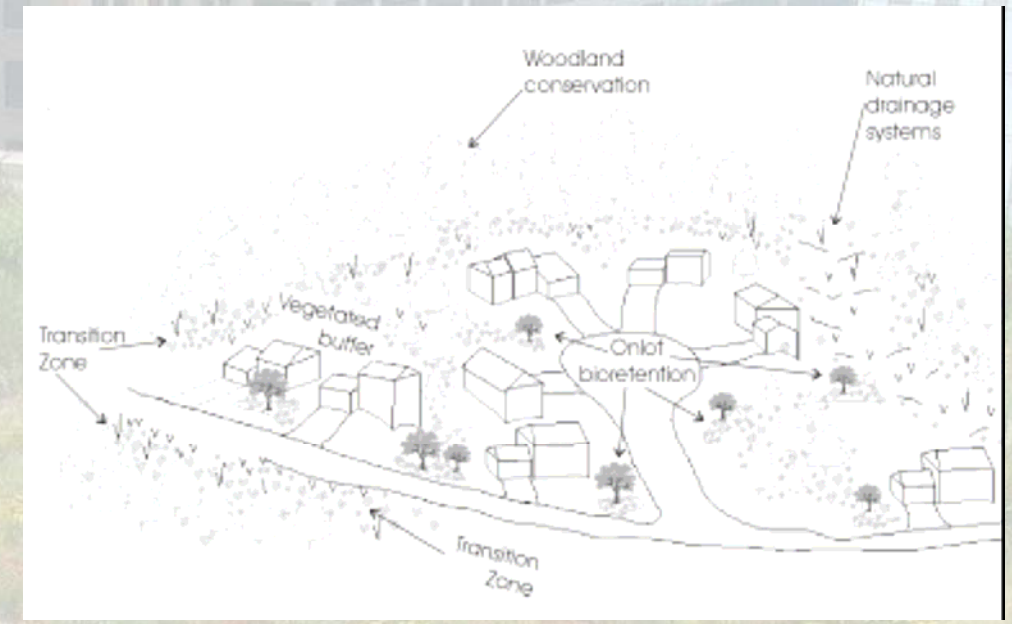
- Low soil infiltration rate in the post-development condition
- LID objective of mimicking the pre-development site hydrology can still be achieved with low infiltration rates

LID Measures

- Site Planning



- Integrated Management Practices




LID Site Planning

- Objective: Allow full development of a site while maintaining the hydrologic functions.
- Most LID site planning measures can be used where infiltration is not feasible.
- Hydrologic goals and objectives should be incorporated in the site planning process as early as possible

LID Site Planning Concepts

- Use Hydrology as an Integrating Framework
- Micromanagement
- Controlling Stormwater at the Source
- Simplistic Non-structural Methods
- Creating a Multifunctional Landscape

LID Site Planning Measures

Where Infiltration is an Issue

- Reduce/Minimize Total Impervious Areas
- Minimize Directly Connected Impervious Areas
- Limit use of sidewalks
- Reduce road/driveway length and width
- Modify/Increase Drainage Flow Paths
- Maximize overland sheet flow
- Conserve natural areas
- Minimize disturbance
- Preserve infiltratable soils
- Preserve natural depression areas
- Preserve vegetation
- All of these measures reduce volume

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LID Integrated Management Measures without Infiltration

- Green Roofs
- Bioretention
- Grassed Swales
- Vegetated Buffer Strip
- Rain Barrels
- Cisterns
- Porous Pavement

Green Roofs

Chicago City Hall Green Roof. *Photo courtesy of Roofscapes, Inc.*

Green Roof Cross Section

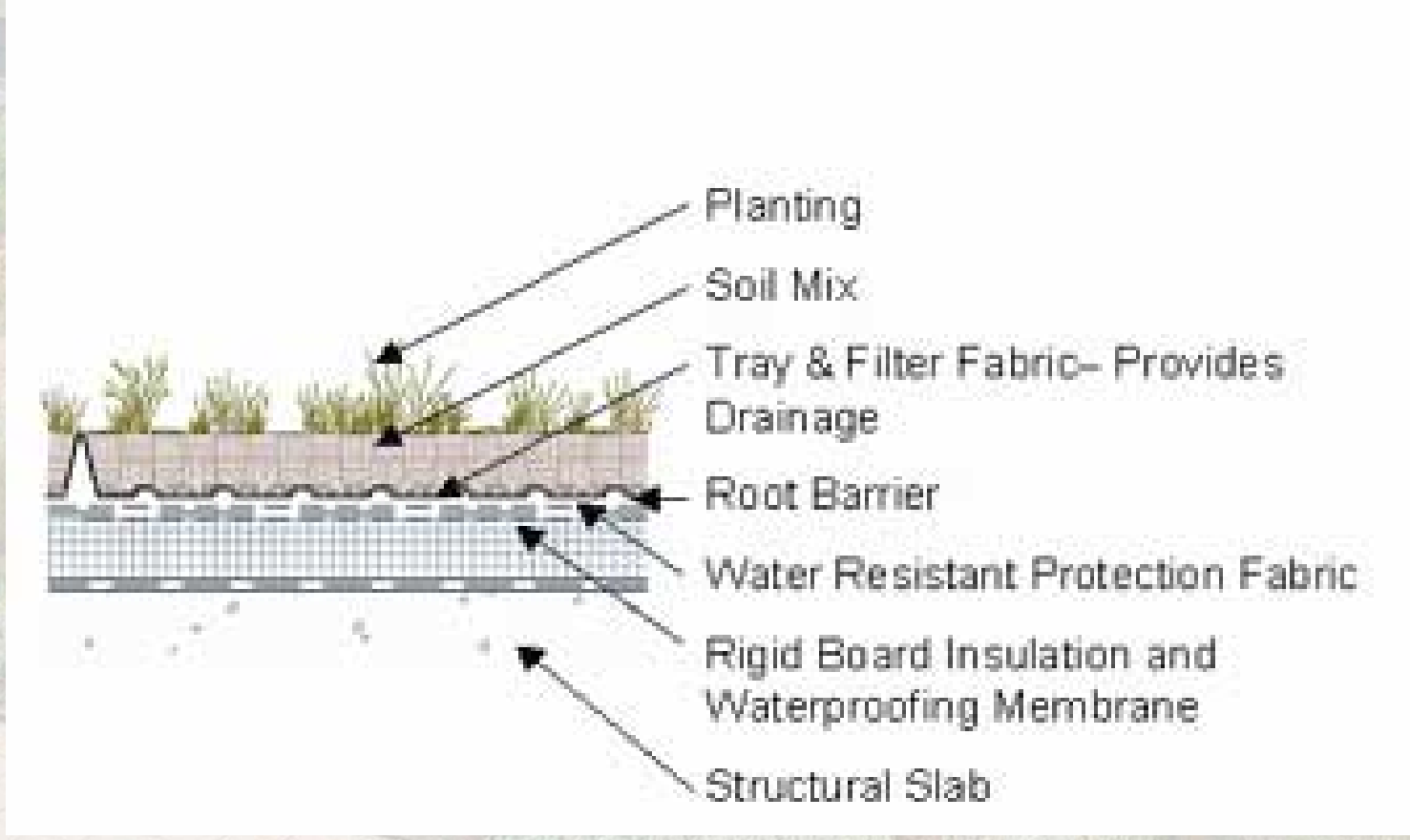

Diagram courtesy of USEPA

Green Roof Design Considerations

- **Structural Roof Support**
  - Additional weight of green roof
  - 15-150 pounds per square foot of saturated weight
- **Waterproof Membrane**
  - Can be various materials including:
    - Modified asphalts (bitumens)
    - Synthetic rubber (EPDM)
    - Reinforced PVC
- **Root Barrier**
  - Made of dense materials that inhibit root penetration
  - Need for a root barrier depends on the waterproof membrane used

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Green Roof Design Considerations

- **Drainage Layer**
  - Applied over the entire roof area to carry away excess water
  - Plastic sheets
  - Thin layer of gravel
- **Filter Fabric**
  - Needed for fine soils
- **Engineered Growing Medium/Soil Substrate**
  - Minimum of 2.5 inches thick
  - Usually 3-6 inches thick
  - Well drained
  - Weighs 15-150 pounds per square foot when saturated
  - Mix of 25% topsoil, 25% compost, 50% sand

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Green Roof Design Considerations

- **Plantings should have:**
  - **Shallow root system**
  - **Good regenerative qualities**
  - **Resistance to direct sunlight, drought, frost, and wind**
  - **Minimum of 90% vegetation coverage is recommended**
  - **Native plants are recommended**
- **Extensive**
  - **Soil depth is 1-6 inches**
  - **Weight load 15 – 50 pounds per square foot**
- **Intensive**
  - **Soil depth is typically 6-24 inches (or more)**
  - **Weight load is 80-150 pounds per square foot**

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Green Roof Runoff Quantity Reduction

- Green roofs can help to realize the intent of Low Impact Development
- Up to 60% of annual rainfall can be retained by a green roof
- Runoff reduction through:
  - Retaining rainwater through the soil and root uptake zone
  - Vegetation allows adsorption in the root absorption
  - Foliage transpires moisture
  - Evapotranspiration of rainfall

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Green Roof Water Quality

- **High Treatment Performance for:**
  - **Metals**
  - **Nutrients**
  - **Oil and Grease**
  - **Organics**
  - **Pathogens**
  - **Sediment**
  - **Trash**

Bioretention

Bioretention Cross Section

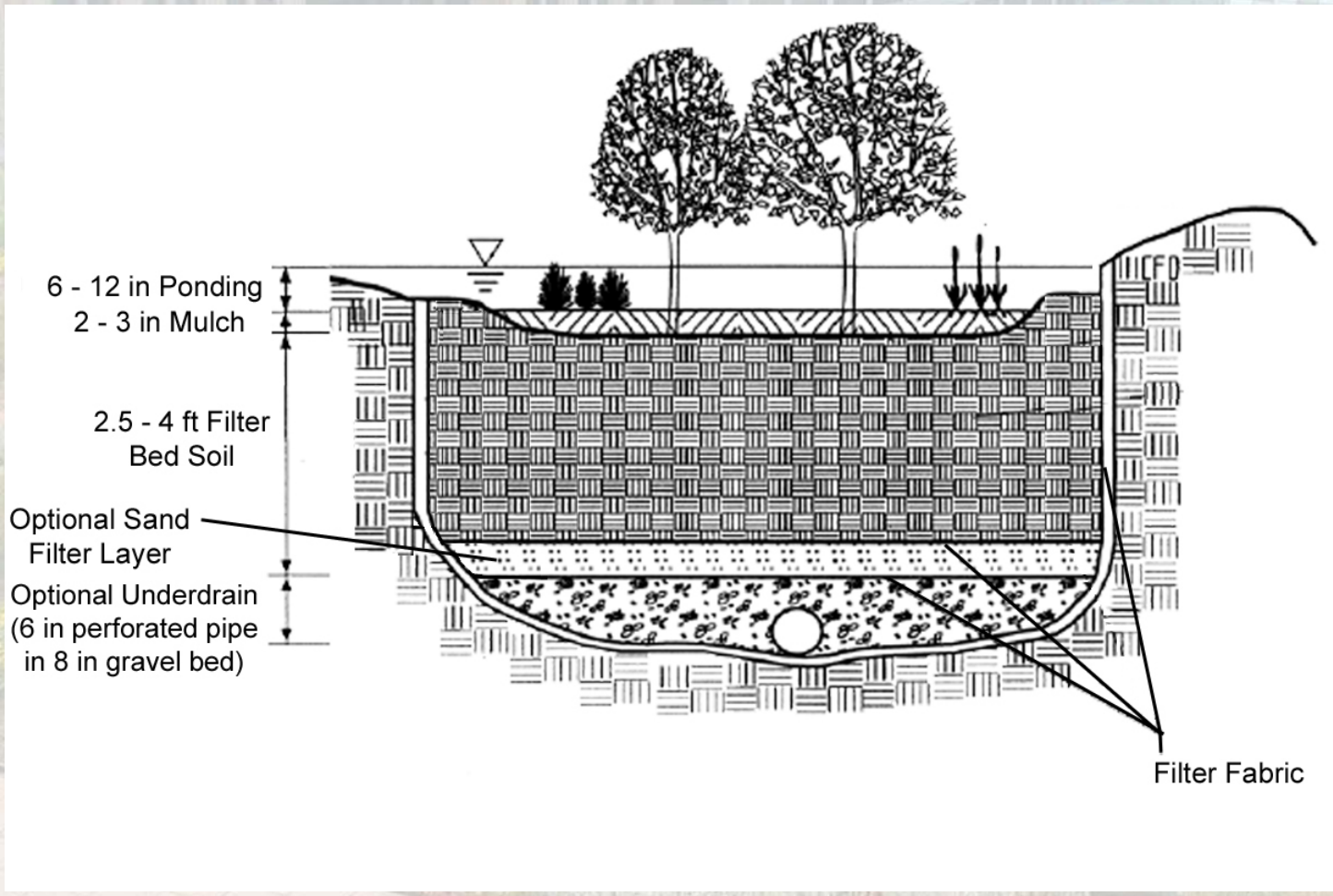

Diagram courtesy of Maryland Stormwater Design Manual

Bioretention Design Considerations

- Not recommended for slopes greater than 20%
- Not recommended in areas where mature tree removal would be required
- Size bioretention cell to capture the water quality volume
- Filter bed depth should be 2-4.5 feet
- Filter bed soil should consist 50-60% sand, 20-30% topsoil and 20-30% compost
- Apply 2-3 inches of recycled chipped or shredded wood mulch or sheet mulching over the topsoil to reduce erosion

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Bioretention Underdrain Design Considerations

- Place underdrain in a gravel bed
- Underdrain should consist of main collector pipe(s) and perforated lateral branch pipes
- Piping should be reinforced to withstand the weight of the soil media
- Internal diameters of lateral branch pipes should be six (6) inches or greater and perforations should be three-eights (3/8) inch.
- All piping is to be schedule 40 polyvinyl chloride (PVC) or greater strength
- Minimum grade of piping shall be one-eights (1/8) inch per foot

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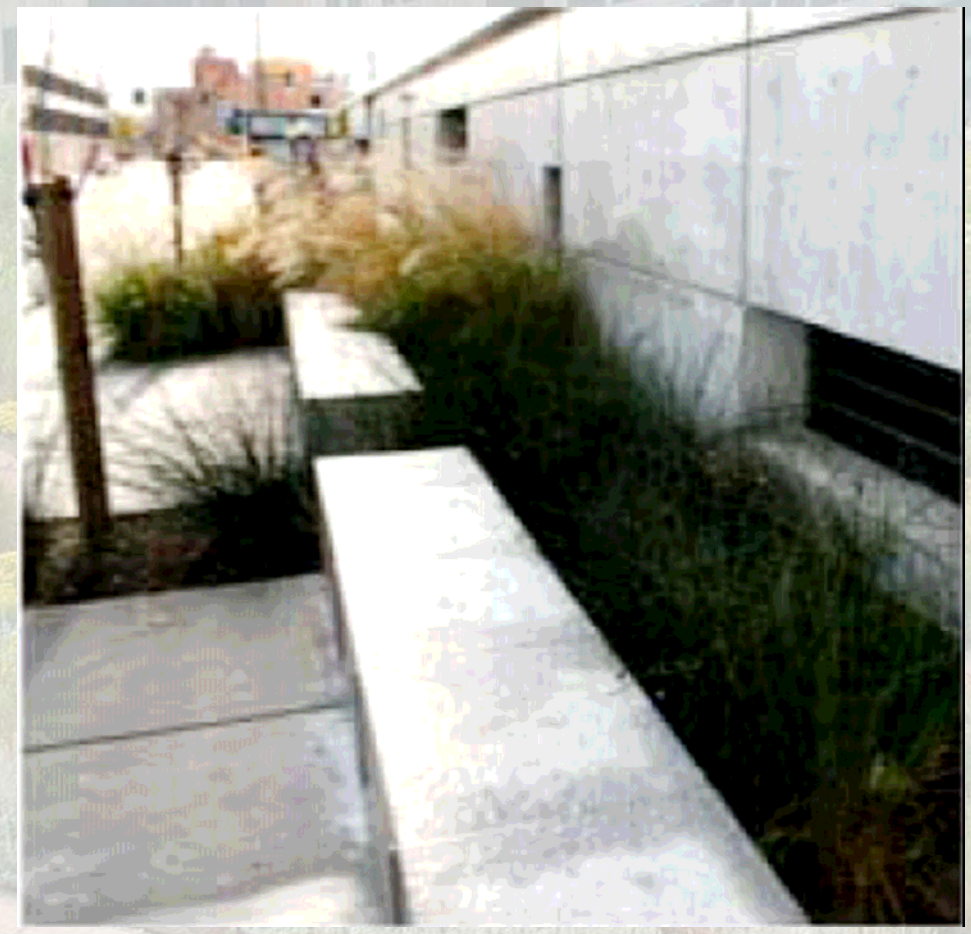
Bioretention Planter Box



Bioretention Planter Box Cross Section

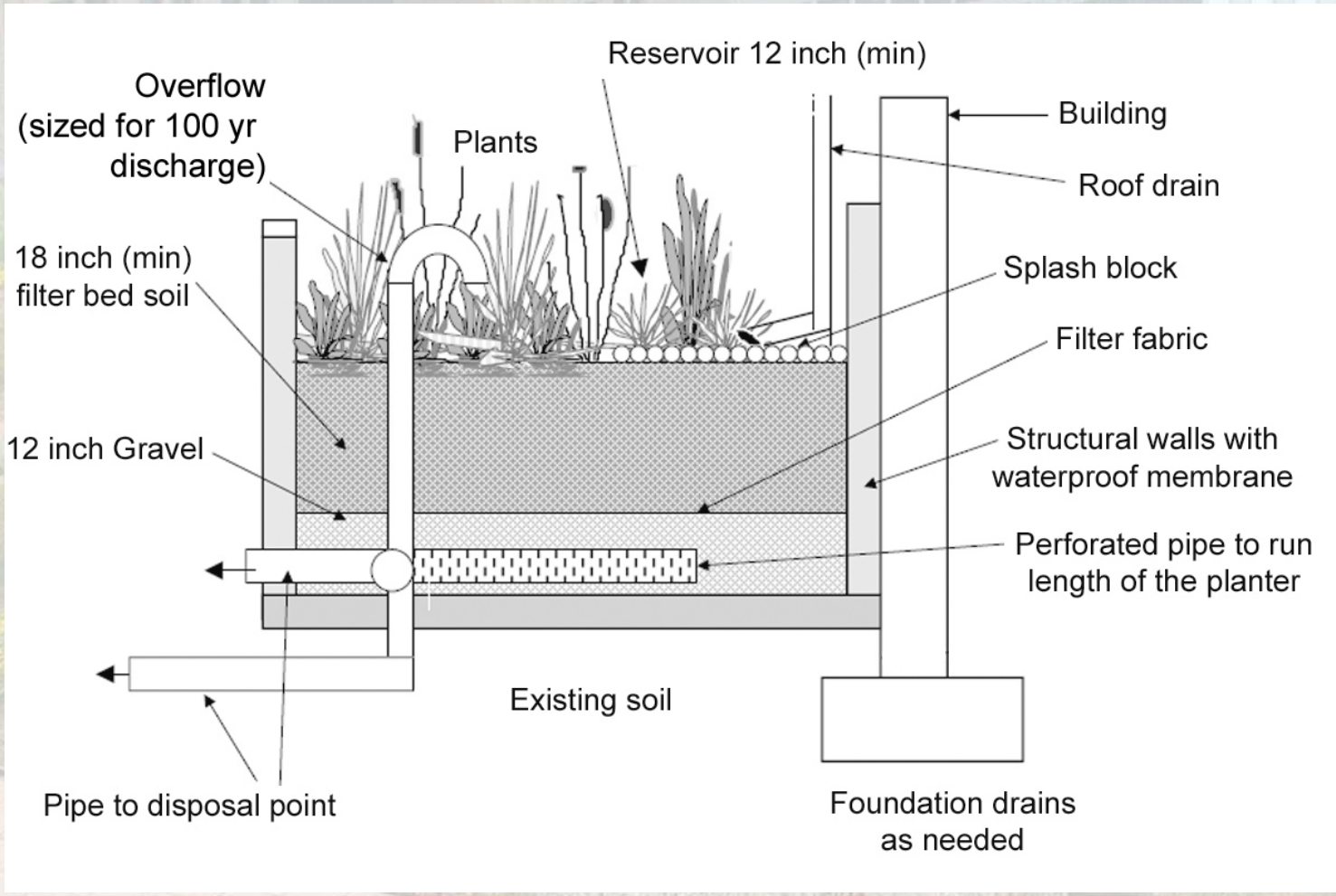


Diagram courtesy of Portland Bureau of Environmental Services

Bioretention Planter Box Design Considerations

- All planter boxes must contain suitable waterproofing to ensure they are watertight over the life of the project.
- The planter walls can be incorporated into the building foundation plans, but must be watertight
- Flow-through planters can be used over all soil types.
- Filter bed depth should be between 18 inches and 2.5 feet.
- Filter bed soil should consist 50-60% sand, 20-30% topsoil and 20-30% compost.

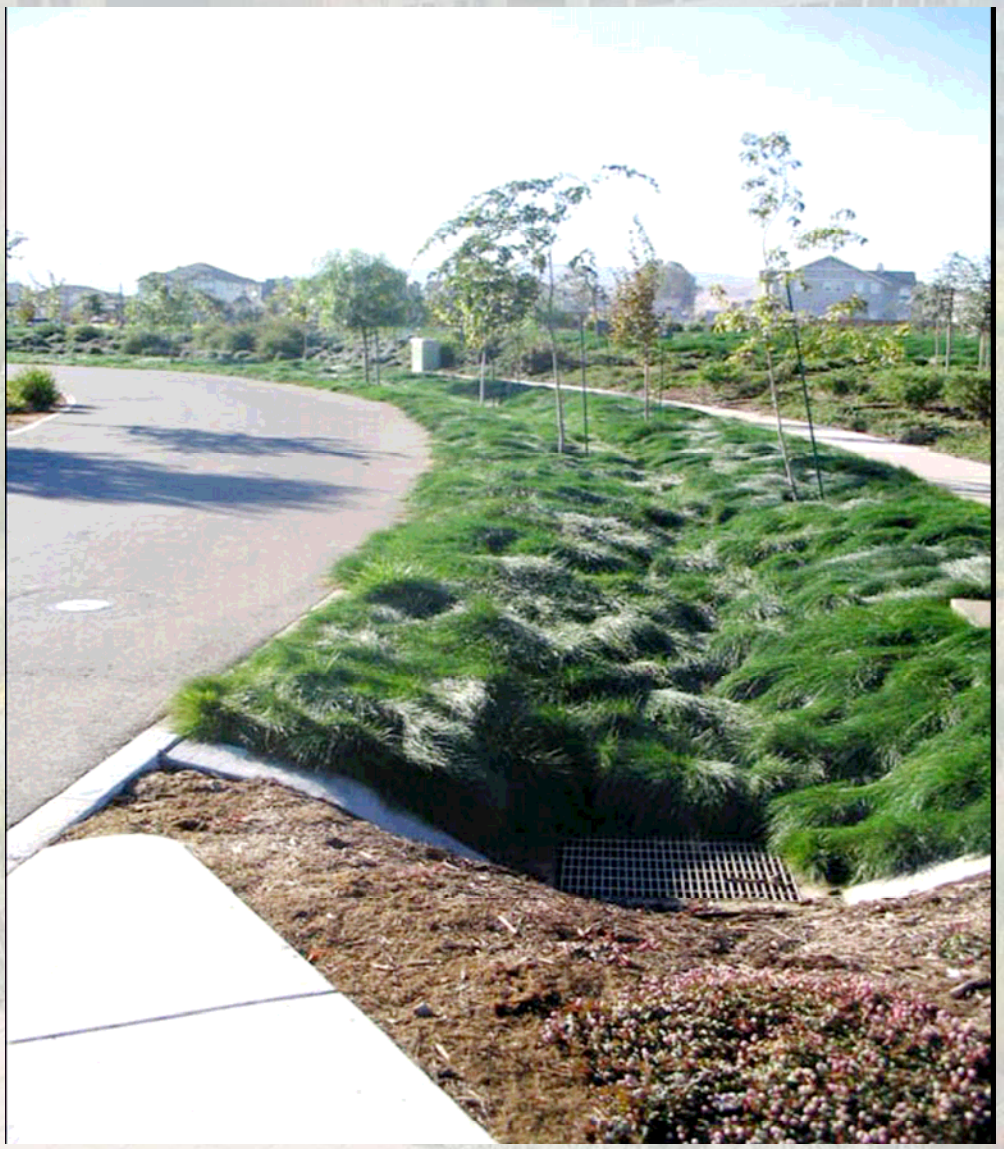
Bioretention Planter Box
Design Considerations

- **Apply 2-3 inches of shredded hardwood mulch over the filter bed soil.**
- **Minimum planter width is 18 inches.**
- **Planter slopes shall be less than 0.5%.**
- **Provide a secondary outlet for discharge of the 100-year event.**

Bioretention Water Quality

- **High Treatment Performance for:**
  - Metals
  - Oil and Grease
  - Organics
  - Pathogens
  - Sediment
  - Trash
- **Medium Treatment Performance for:**
  - Nutrients

Grassed Swales



Grassed Swale Design Considerations

- For the design storm, the depth of water in the swale should be a maximum of 1/2 the height of the grass or 4 inches
- Longitudinal slope should be between 1% and 6%.
- Minimum width is 2 feet and maximum width is 8 feet.
- Swales wider than 8 feet are allowed if a divider berm is used
- Cross section / bottom width of the swale must be flat to promote even flow across the entire width of the swale.

Grassed Swale Design Considerations

- Swale side slopes should be 3:1 or flatter
- For the water quality design storm the minimum hydraulic residence time is 7 minutes for one point of entry and one point of exit.
  - Determines swale length
- The maximum velocity is 1 ft/s for the water quality design storm.
- The maximum flow velocity through the swale under a peak 10-year flow conditions depends on soil type, vegetation uses and slope.
- Vegetation: Low growing grasses that thrive under the specific site, climatic and water conditions.

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Grassed Swale Water Quality

- **Medium Treatment Performance for:**
  - Metals
  - Oil and Grease
  - Organics
  - Sediment
- **Low Treatment Performance for:**
  - Nutrients
  - Pathogens
  - Trash

Vegetated Buffer Strip

Vegetated Buffer Strip Design Considerations

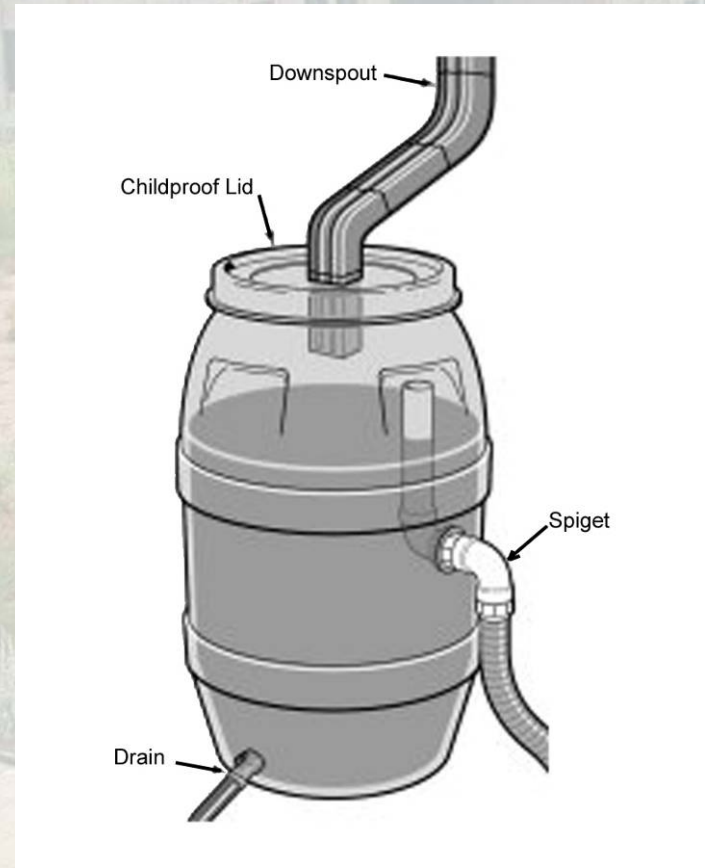
- Low growing grasses that thrive under the specific site, climatic and water conditions should be specified
- Vegetation should have a growing season that corresponds to the wet season.
- Minimum vegetative cover of 65%
- Width of the drainage area tributary to the vegetated strip should not exceed 150 feet.
- Runoff entering the strip must be sheet flow.
- A minimum length (in the direction of flow) of 15 feet

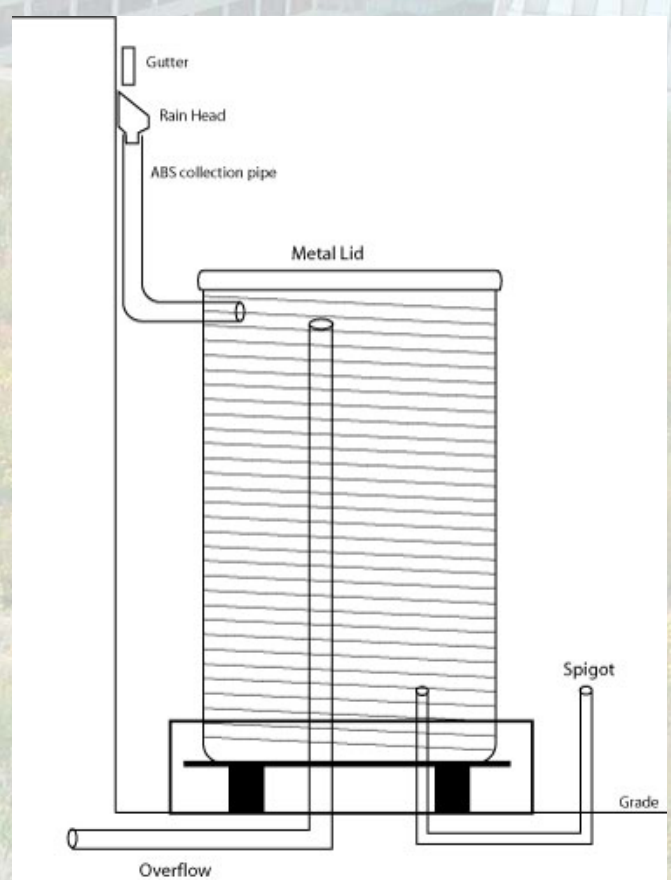
Vegetated Buffer Strip Water Quality

- **High Treatment Performance for:**
  - Metals
  - Oil and Grease
  - Sediment
- **Medium Treatment Performance for:**
  - Organics
  - Trash
- **Low Treatment Performance for:**
  - Nutrients
  - Pathogens

Rain Barrels/Cisterns

Rain Barrel & Cistern Schematics





Rain Barrel/Cistern Design Considerations

- Provide screens on gutters and downspouts to remove gross solids as the water enters the barrel
- Provide a drain at the bottom to empty the system for maintenance.
- Rain barrel should be covered with a child resistant lid but still allow for easy access for cleaning
- Cisterns can be put below grade with a pump
- Water can be used for non-potable uses: irrigation, toilet flushing, clothes washing

Rain Barrel/Cistern Water Quality

- **High Treatment Performance for:**
  - Metals
  - Nutrients
  - Oil and Grease
  - Organics
  - Pathogens
  - Sediment
  - Trash

Pervious Concrete Pavement

Pervious Concrete Subdrain Cross Section

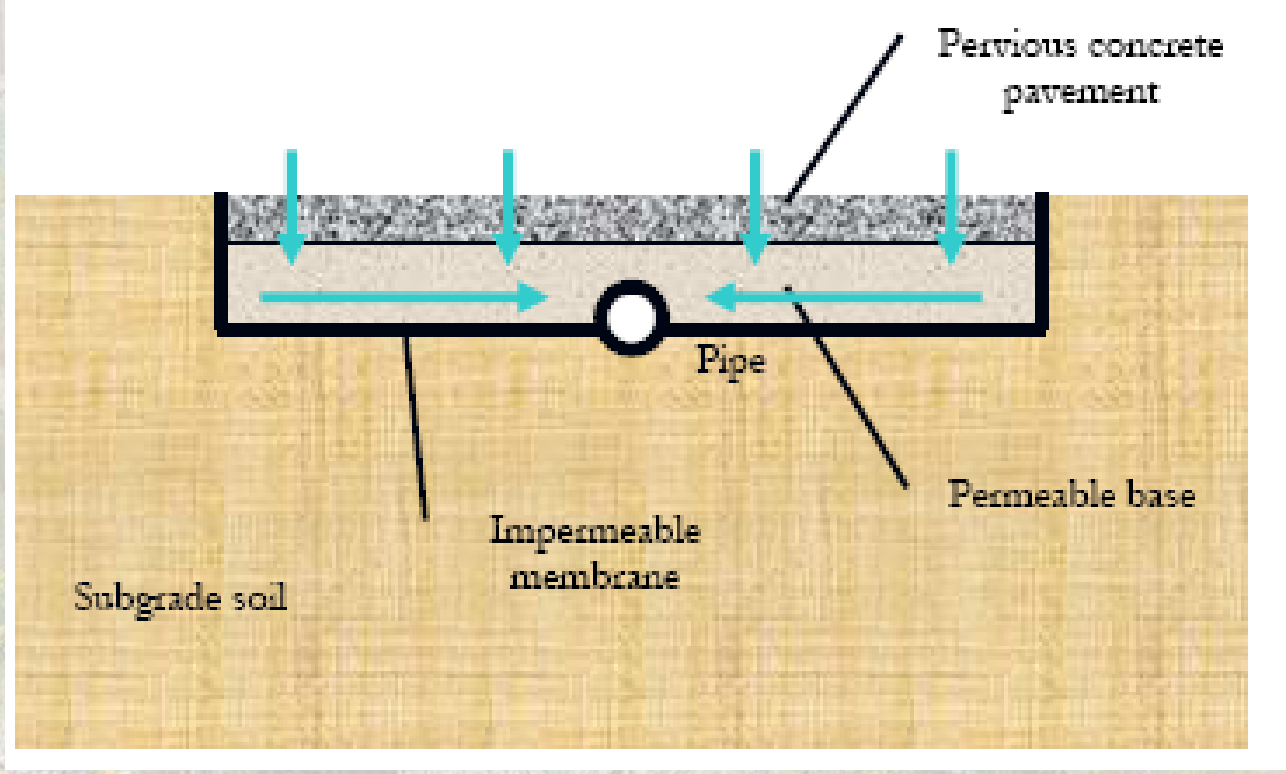


Diagram courtesy of RMC Research & Education Foundation

Pervious Concrete Pavement Design Considerations

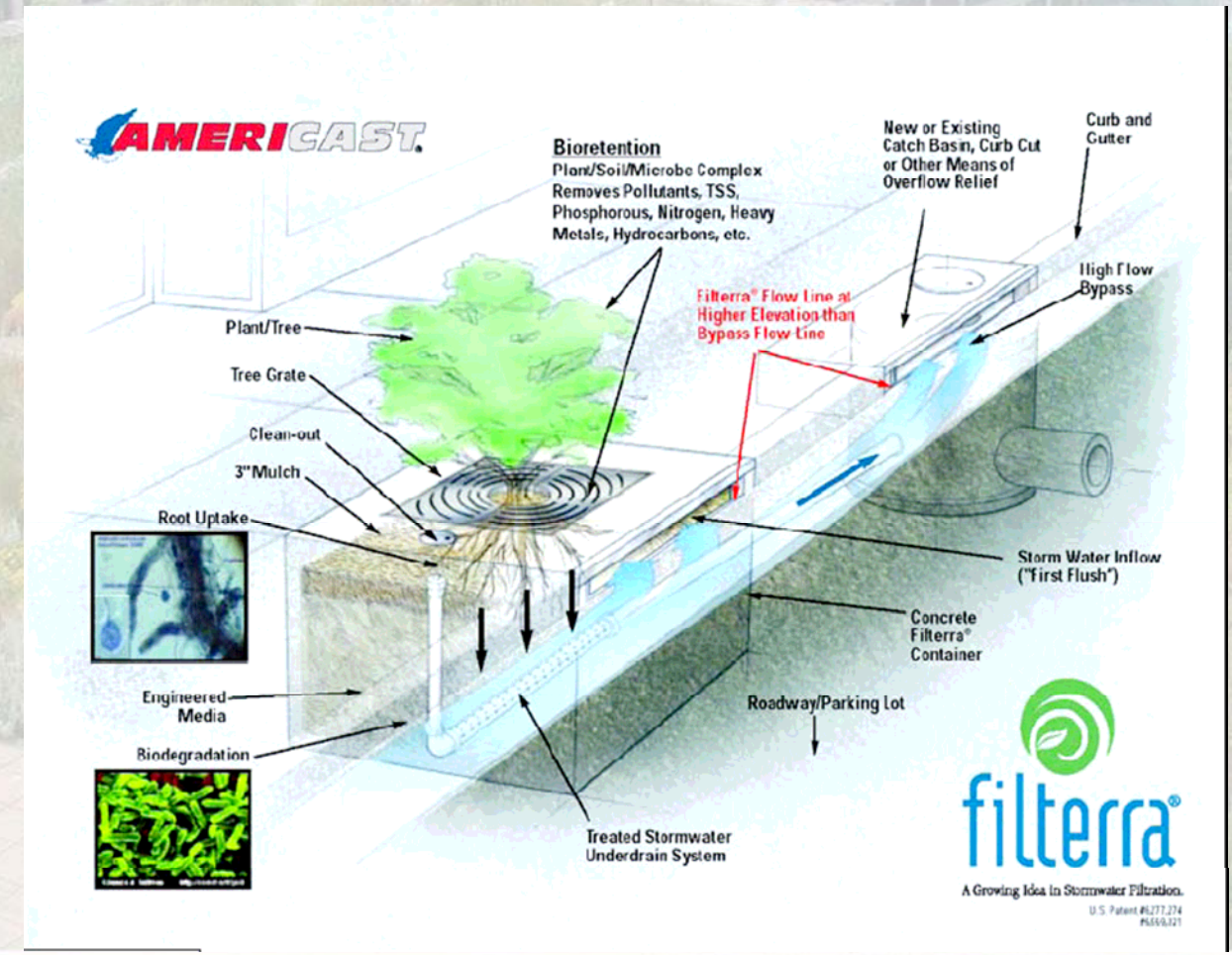
- Below the pervious pavement there should be a layer of stone sized to hold the 85th percentile – 24-hour storm within the void spaces
- Used to treat rainfall that falls directly onto the area of pervious pavement.
- Run-on from adjacent areas can also be directed to the pervious pavement area
- Sediments in runoff can can cause clogging
- Installation should be performed by a certified contractor

Alternative LID Measures that can have Prolonged Infiltration

Filterra

Alternative LID Measures that can have Prolonged Infiltration

Filterra



Alternative LID Measures that can have Prolonged Infiltration

Underground Infiltration

Questions?

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