



Best Management Practices and Innovative Treatment

Cody Obropta, PE
Environmental Engineer
Stormwater Engineering Team

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Protecting Maine's Air, Land, and Water

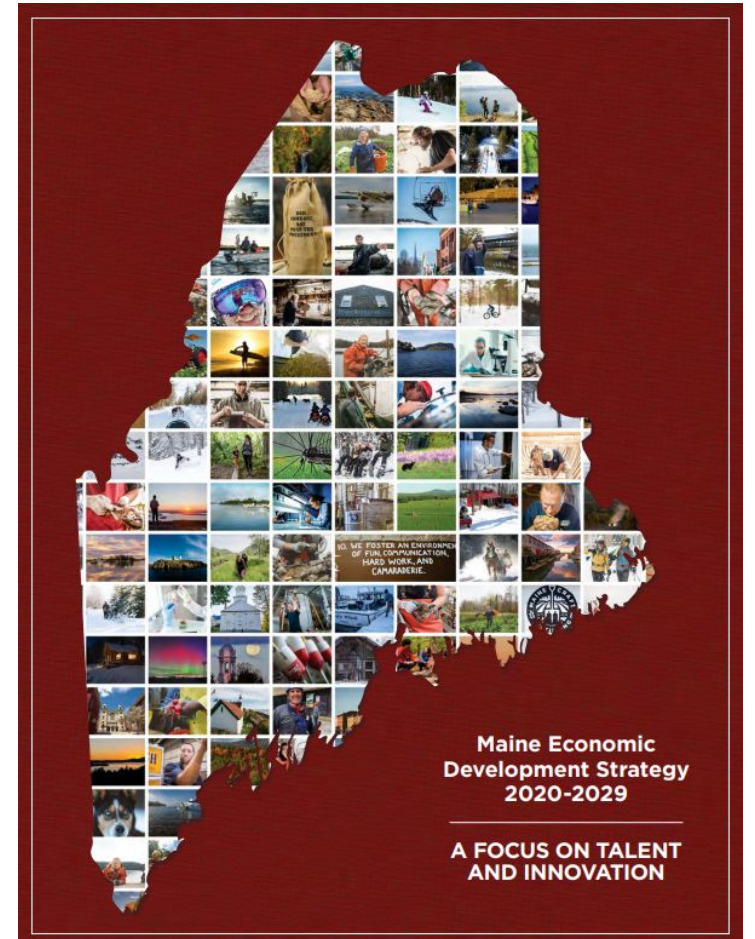
Overview

- Stormwater Management Goals Recap
- Grey vs. Green Infrastructure
- Overview of Practices
- Innovative Measures



Stormwater Management Assumptions

- We are going to build stuff.



Stormwater Management Assumptions

- We are going to build stuff.
- Flooding is bad.



WMTW

Flooding still possible in Maine through Noon

Snowfall reports were between .4" in Portland to 2" in Lewiston to 4.5" in Weld. Rainfall was around 1-2" and a few areas saw minor flooding.

3 weeks ago

Fox Bangor

Winter rainfall causes flooding problems across Maine | Local

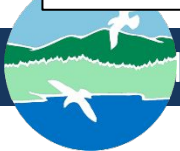
...

On Route 1A in Lincolnville, flooding has slowed traffic and damaged driveways along the road, where the Maine Department of Transportation...

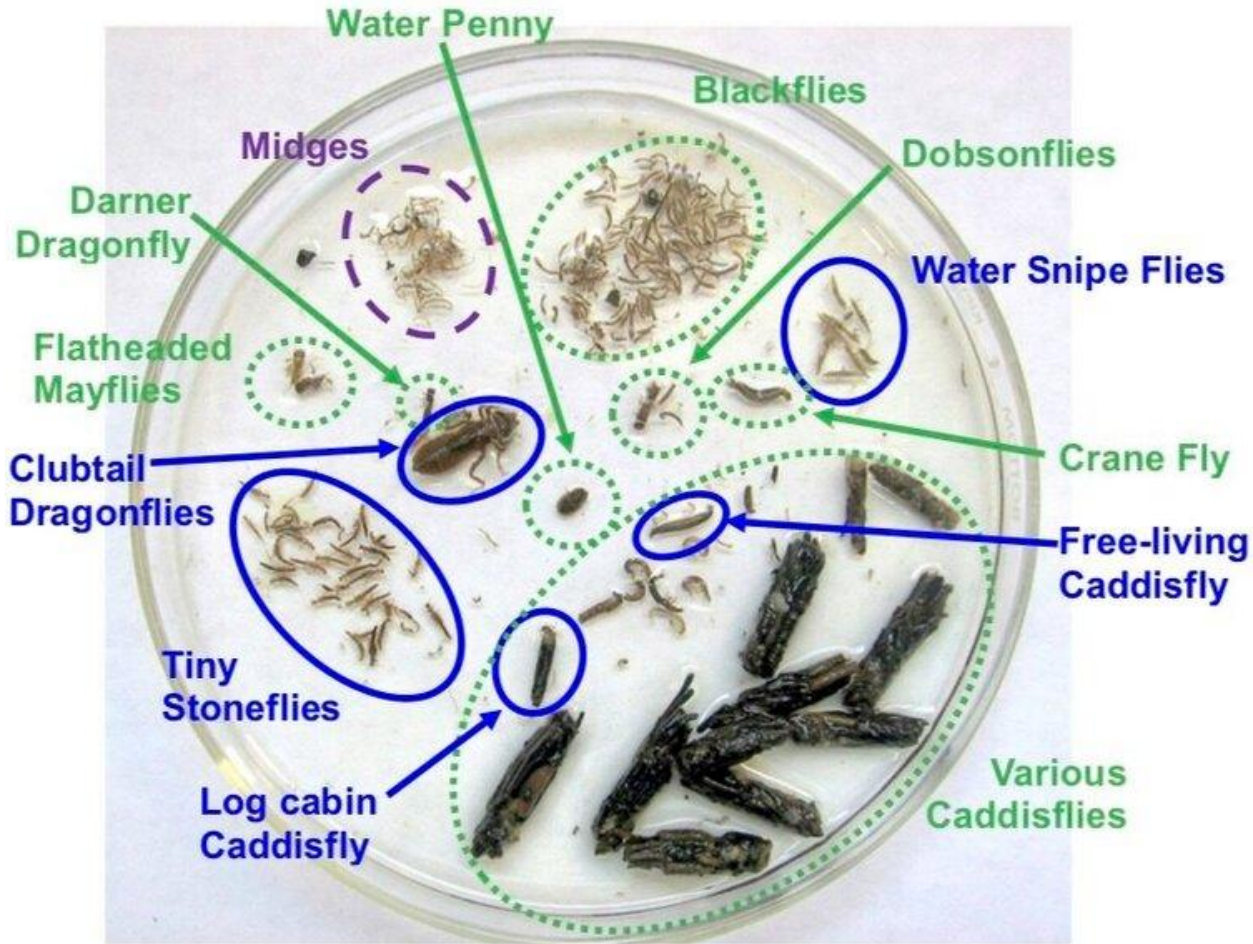
1 week ago



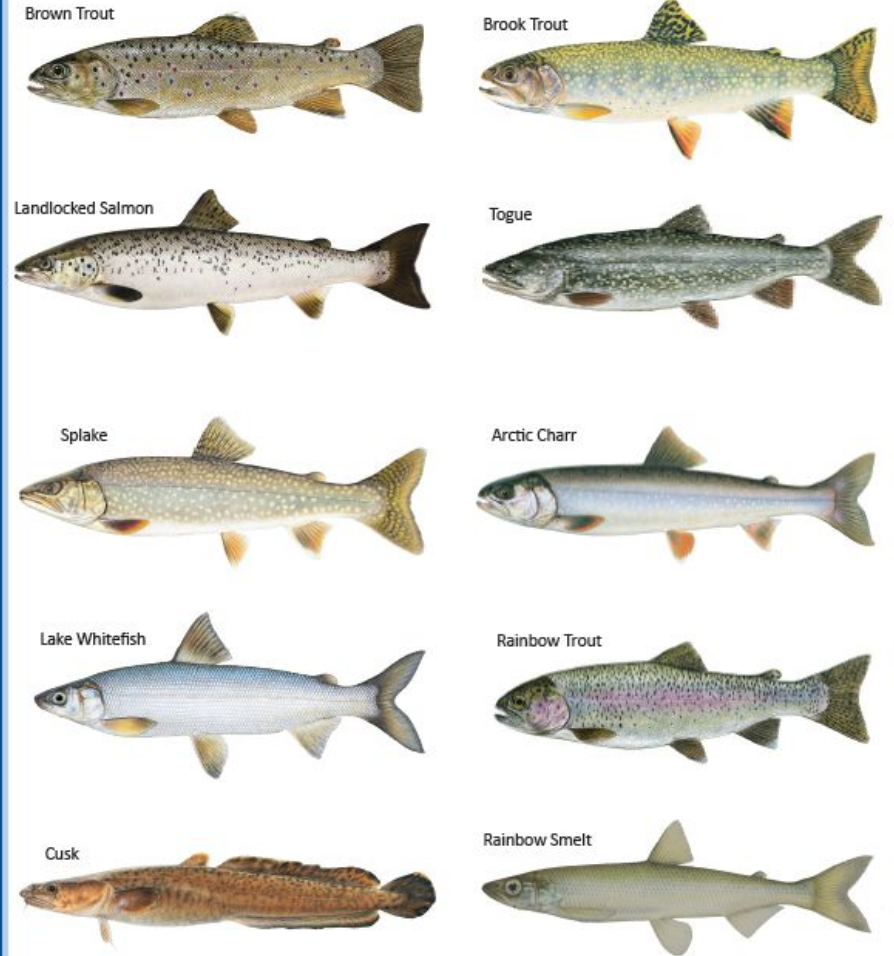
A portion of Pushaw Road in Glenburn collapsed last Saturday when heavy rain washed away one of culverts that carries a stream under the road. The Maine Department of Transportation is working to repair the damage, but it will likely take several days. Credit: Courtesy of Andy Ryder of the Glenburn Fire Department



Stormwater Management



Maine's Coldwater Game Fish



Maine Department of
Inland Fisheries and Wildlife



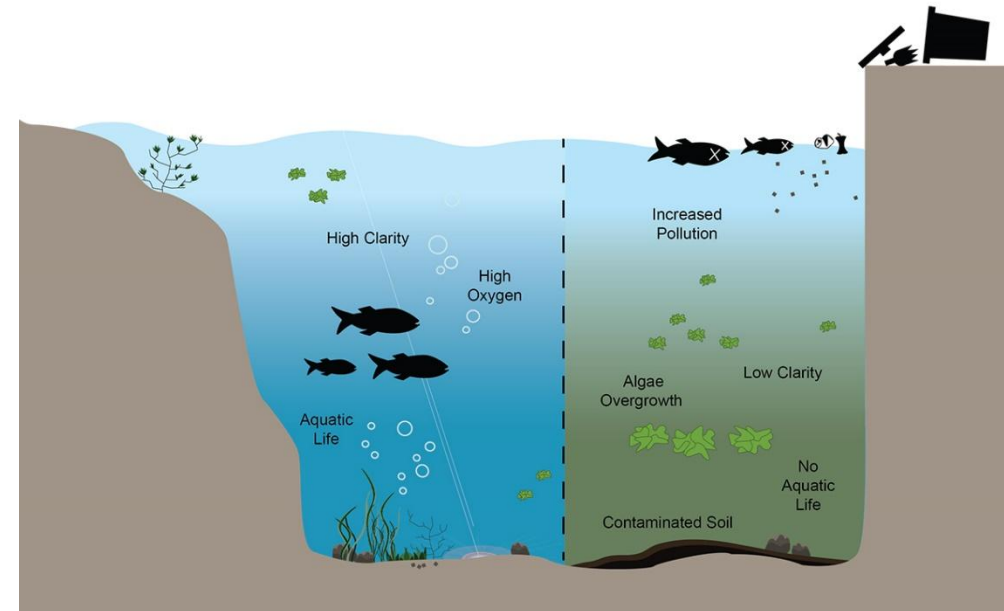
All in for the Maine Outdoors.

mefishwildlife.com



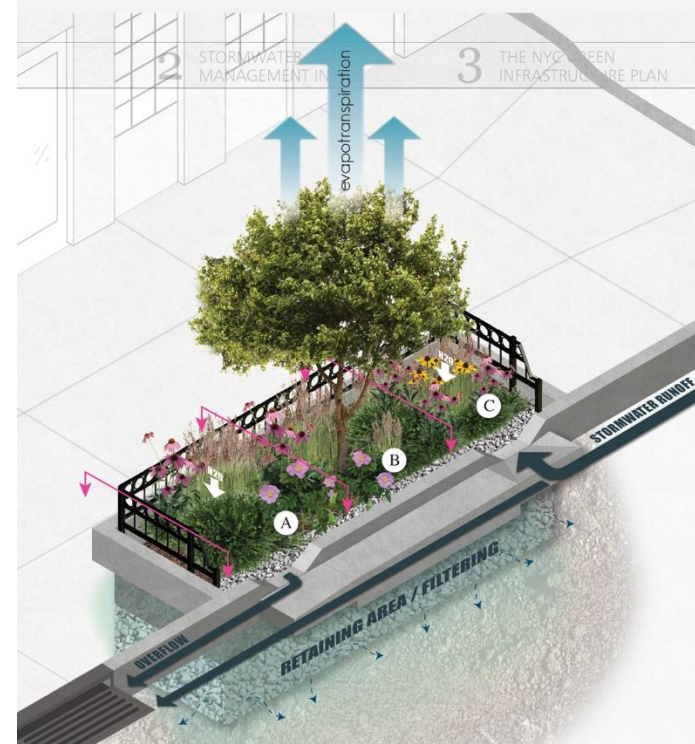
Goals of Stormwater Management

- Prevent Flooding & Erosion
 - Detain water on site
 - Slow release to reduce impact on waterbodies
 - Groundwater recharge (infiltration)
- Protect Water Quality
 - Remove TSS, nitrogen, & phosphorous
 - Remove Heavy metal, toxins, chlorides
 - Remove Plastic, litter, trash, refuse



Goals of Stormwater Management (cont.)

- Prevent Combined Sewer Overflow
 - Direct stormwater into separate storm sewer
 - Slow entry into combined sewer via detention / peak flow controls
 - Infiltrate where available



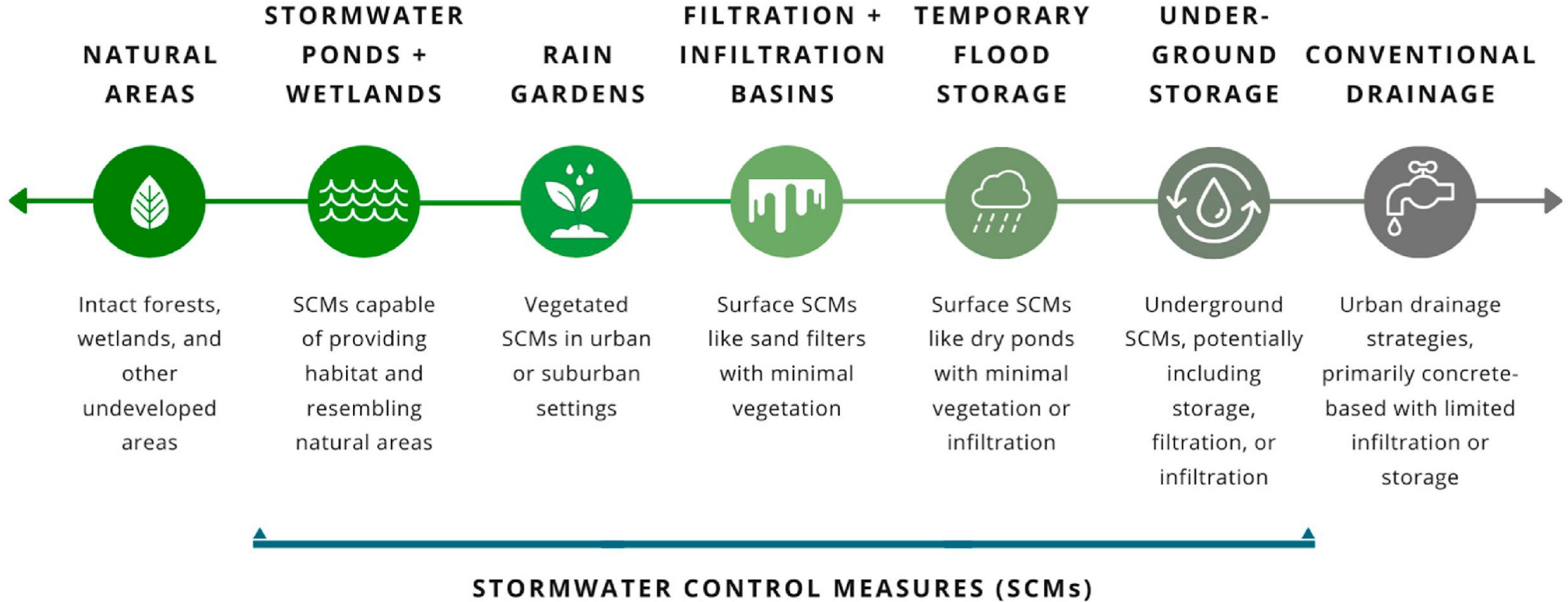
Definitions

- BMP – Best Management Practice
- SCM – Stormwater Control Measure
- GI / GSI – Green (Stormwater) Infrastructure
 - practices that use or mimic natural systems to manage stormwater runoff
- Grey Infrastructure - refers to structures such as dams, seawalls, roads, pipes or water treatment plants.



"GREEN" INFRASTRUCTURE

"GRAY" INFRASTRUCTURE



Green

vs.

Grey

- Co-benefits
 - Heat island effect
 - Biodiversity
 - Aesthetics
- Cost savings



- Space savings
- Scalability
- Efficiency
- Longevity
- Well understood

Both require maintenance for proper function.

Both can accomplish stormwater management goals.



Best Management Practices Overview



A top-down view of a workspace for engineering. In the center, a large metal vernier caliper is laid out horizontally, its ruler showing markings from 0 to 12 millimeters. To the left, a circular gear or bearing is partially visible. Above the caliper, a white ruler with black markings is placed diagonally. The background is filled with technical blueprints, showing various cross-sections of mechanical parts. Some drawings include labels like 'Rz40', '0.2x45°', 'R0.5', '0.5x45°', 'φ120', 'φ90', and 'φ55'. A black pen lies on the right side of the image. The overall scene is brightly lit, with a clean, professional appearance.

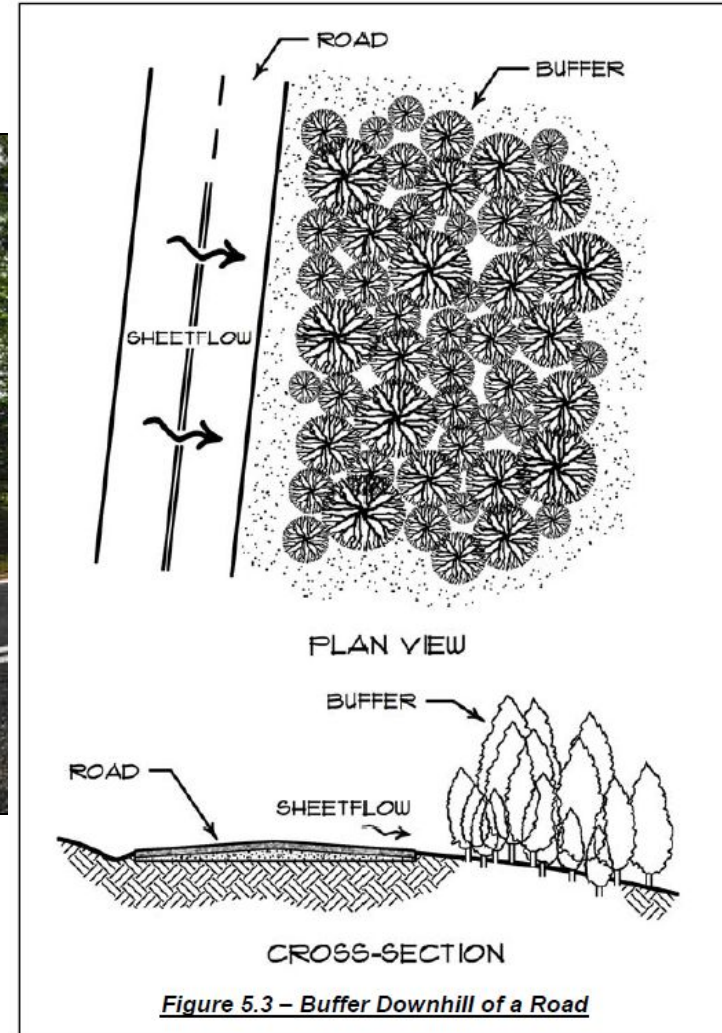
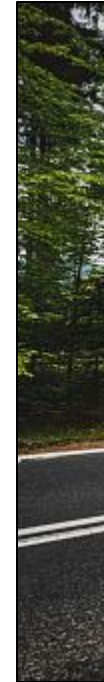
WARNING:

You will see lots of engineering details ahead.

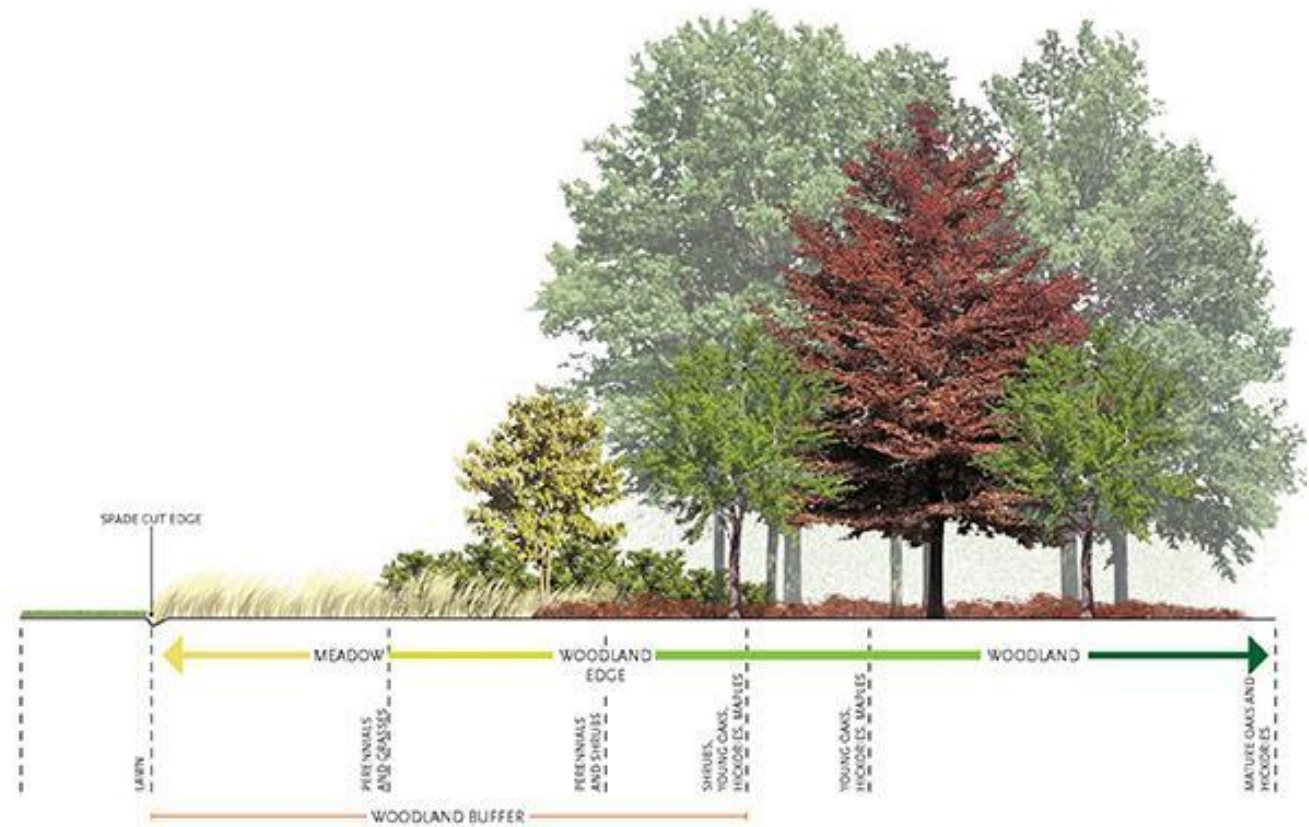
Prepare for cross-sections, arrows, and labels.

Vegetated Buffers

- Slow stormwater naturally
- Capture nutrients/pollutants
- Maintain existing hydrology
- Allow for infiltration
- Co-benefits (wildlife habitat, control heat island effect, etc).

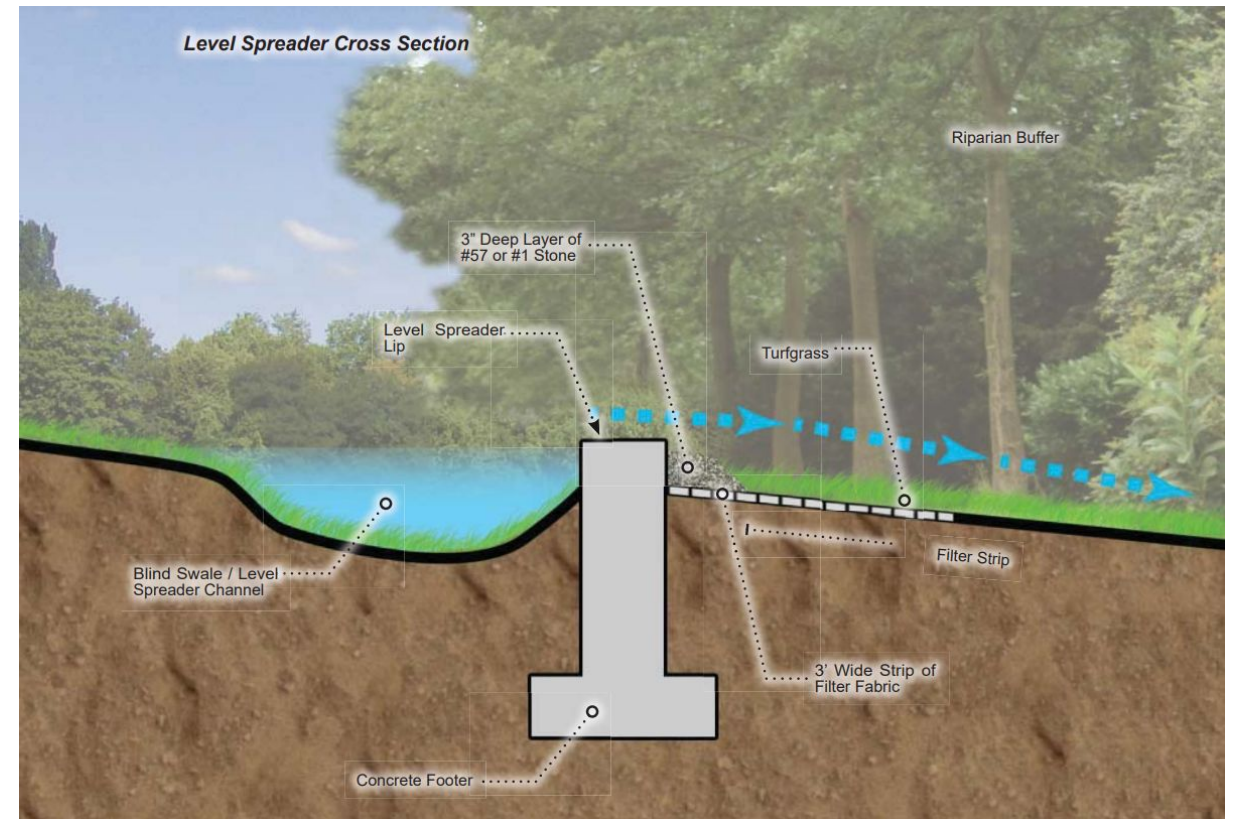
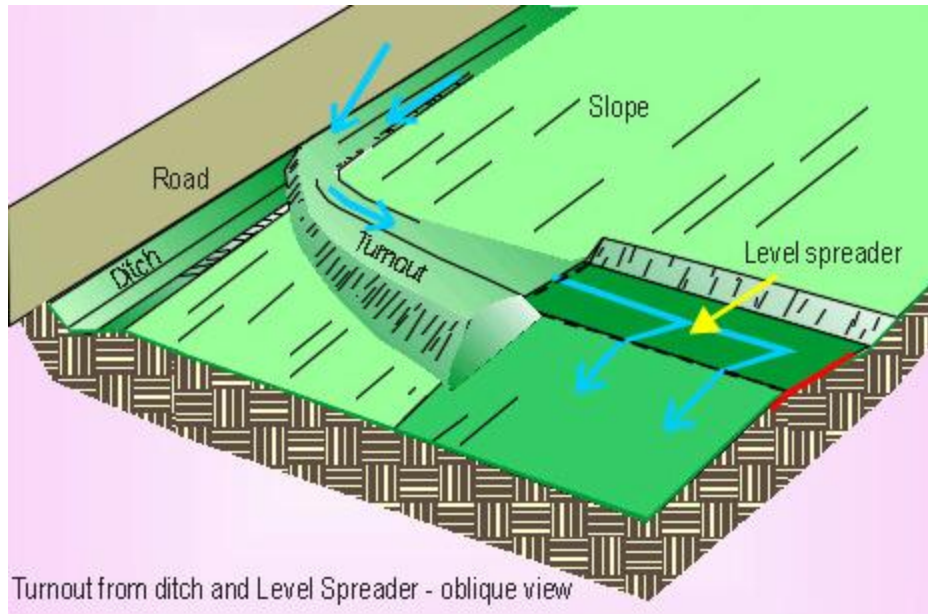


Vegetated Buffers Examples



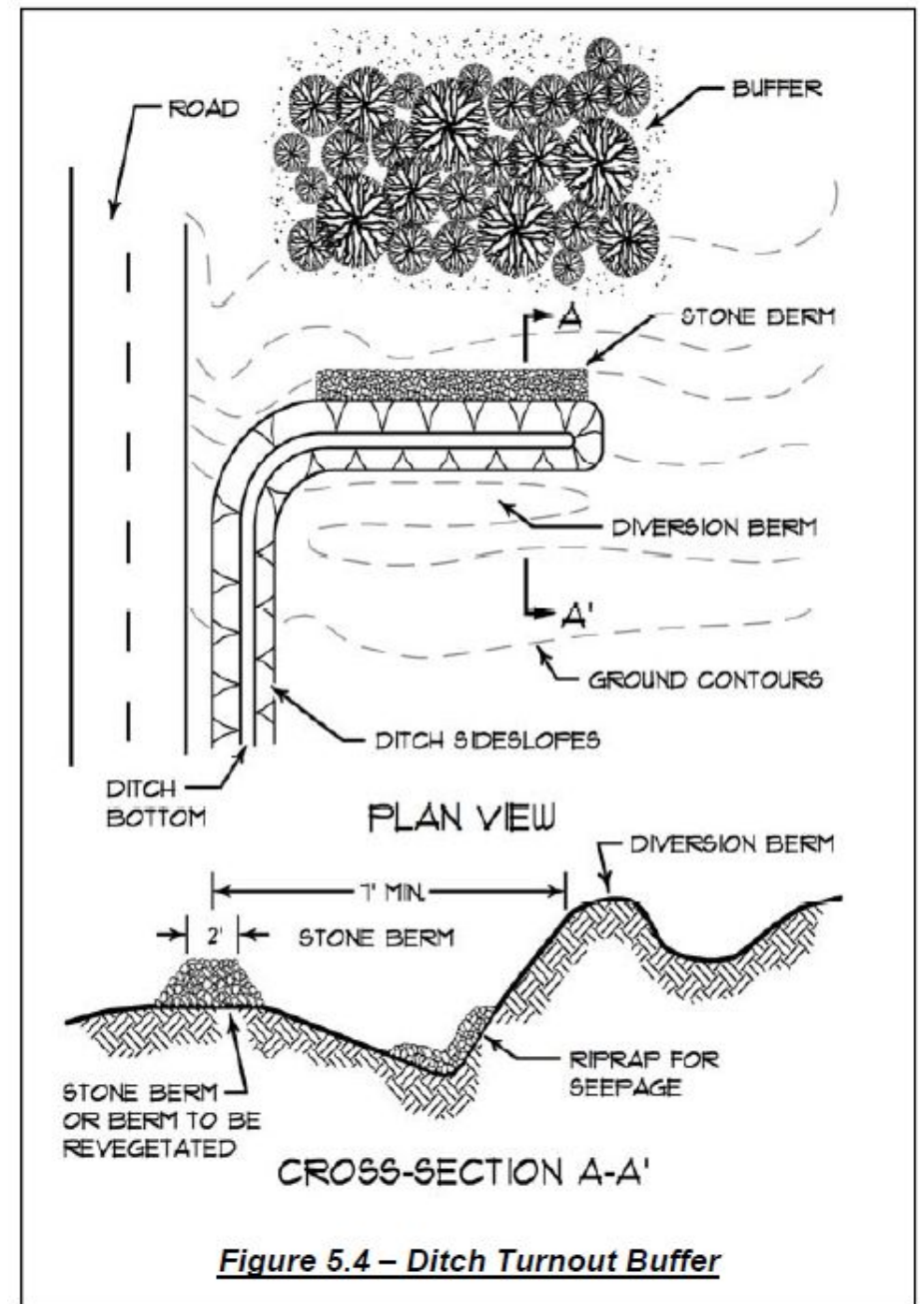
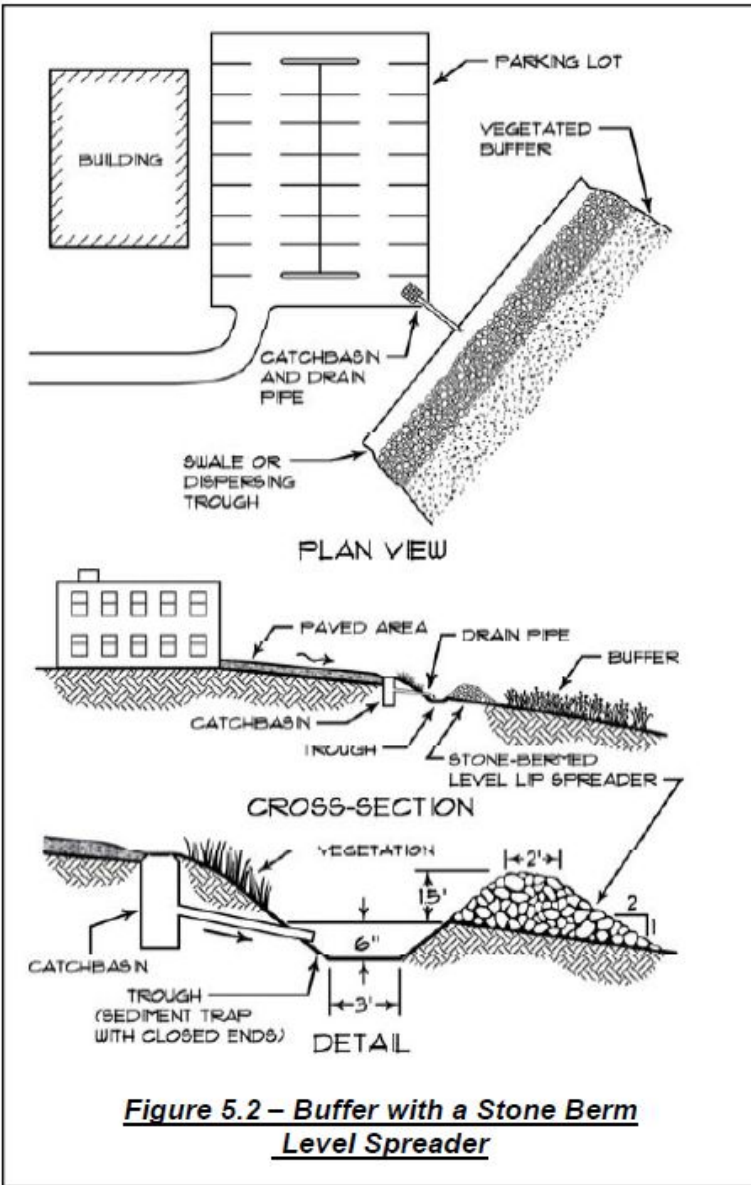
Vegetated Buffers

- Sheet flow is required for proper treatment.
 - A level spreader is often used



Vegetated Buffers

Important:
Often deed restricted or placed in a conservation easement.



Bioretention & Vegetated Filters



Bioretention & Vegetated Filters

Includes:

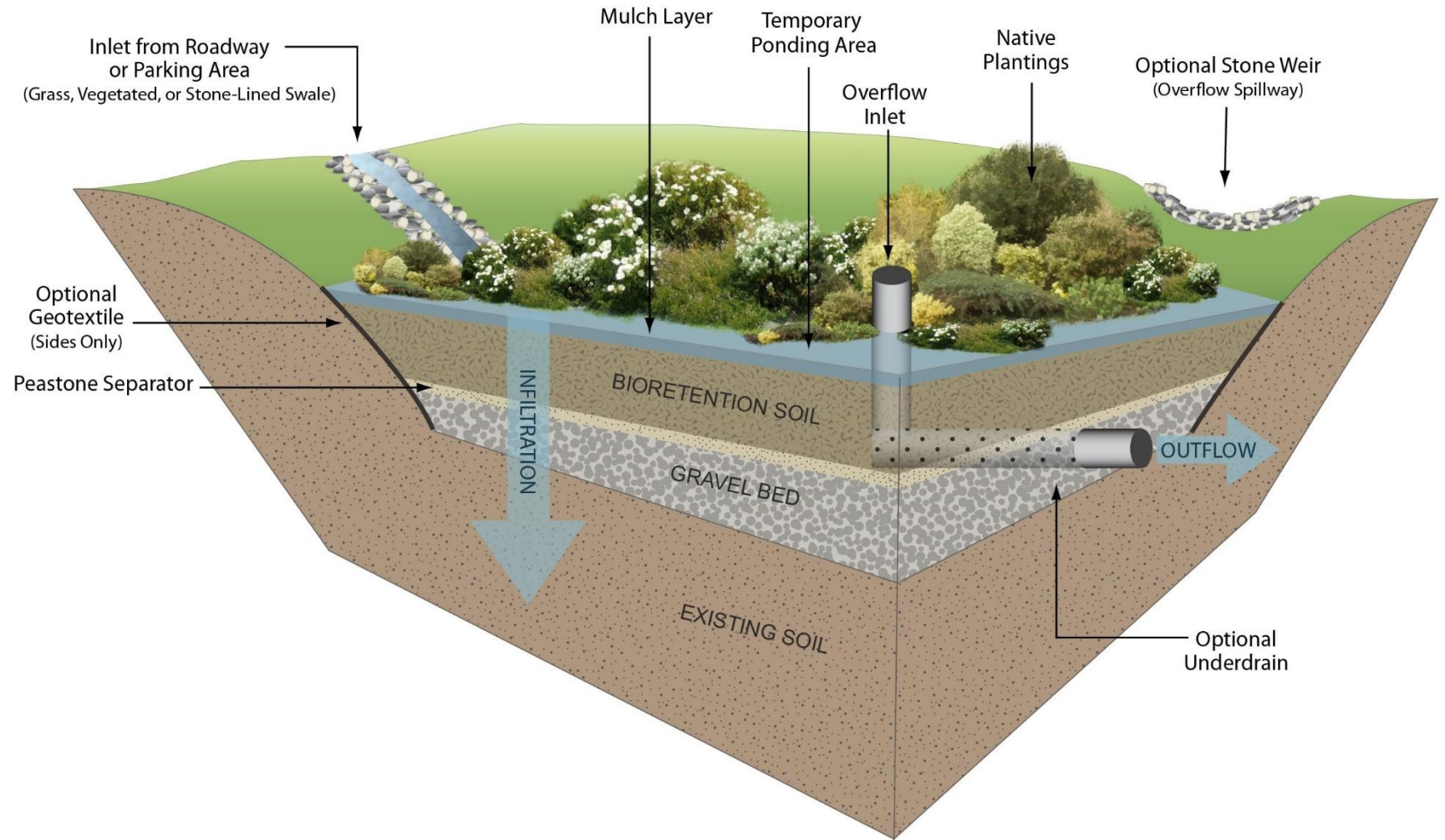
- Bioretention cells
- Grassed-underdrained soil filters
- Rain gardens
- Bioswales
- Meadow basins

****Sometimes Infiltration Basins****



Bioretention Mechanics

- Physical filtering
- Nutrient uptake (plants & soil microorganisms)
- Chemical breakdown
- Slows water by allowing ponding
- Additional time to pass through media



Bioretention & Vegetated Filters

- Can include infiltration
- Can be lined and have an underdrain to prevent infiltration
- High removal rates
- Highly scalable
- Co-benefits



Infiltration Considerations

- Contamination / Brownfields
- Drainage area use
 - Pretreatment whenever possible
- SHWT – seasonal high water table
 - Separation distance often required
 - Determined by test pits
- Native soil makeup
 - Karst (limestone)
 - Hydrologic soil group (HSG)
 - Test pits

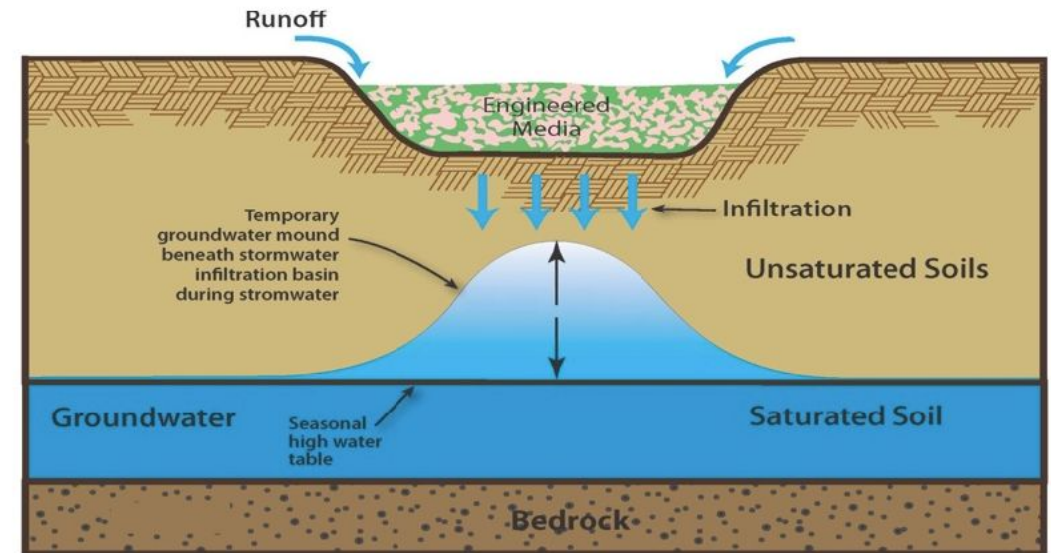
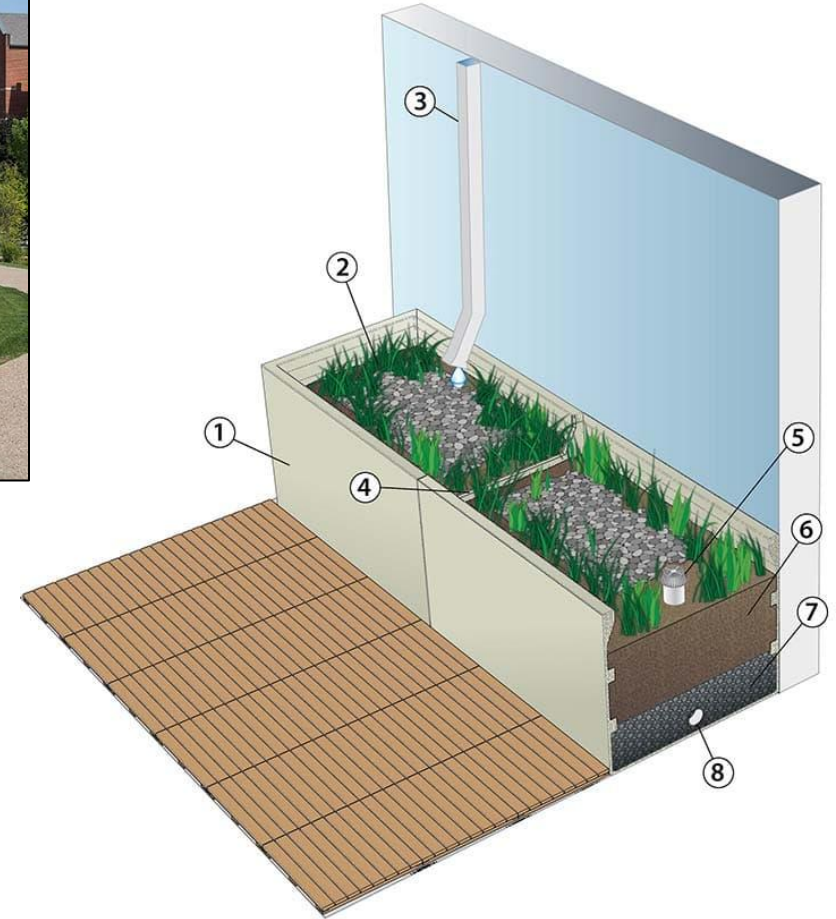
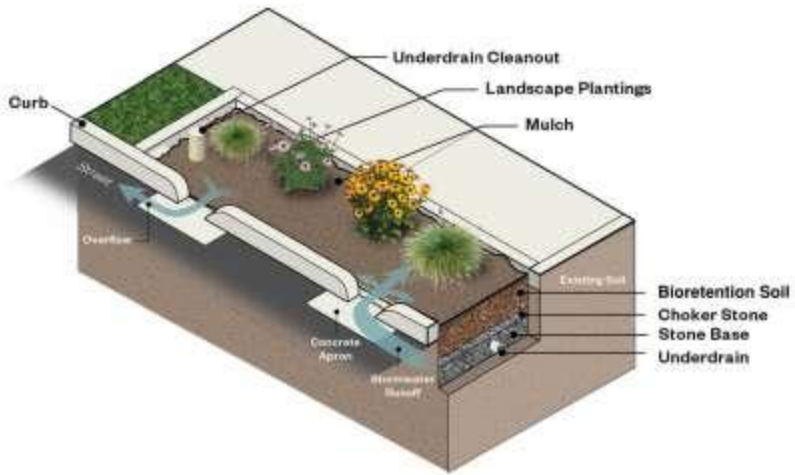


Figure 1 - Groundwater mounding resulting from infiltration of stormwater



Bioretention & Vegetated Filters



Constructed Wetlands



Constructed Wetlands

- Incredible for water quality treatment
 - Nutrient uptake + settling
- Large volume capacity
- Massive ecological benefits
- Incredibly complex to design
 - Requires water balance
 - Maintenance to ensure diversity of species
 - Monitoring requirements
- Concerns over regulation
- Large space requirements

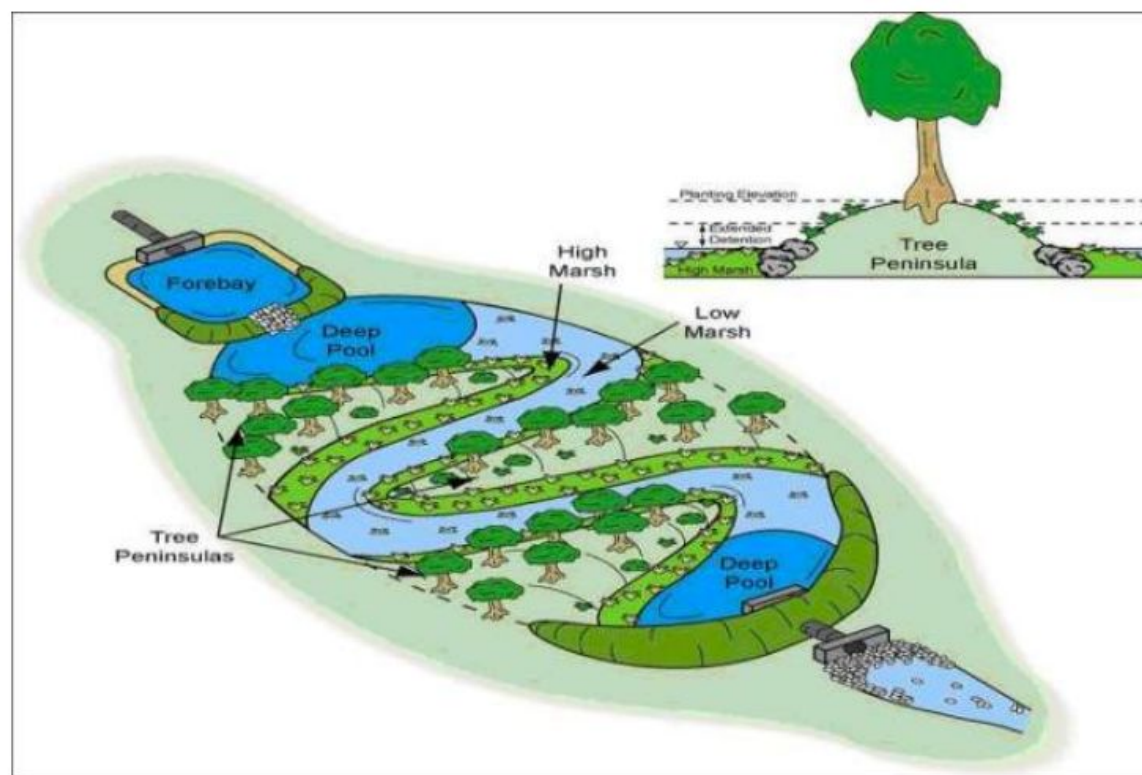
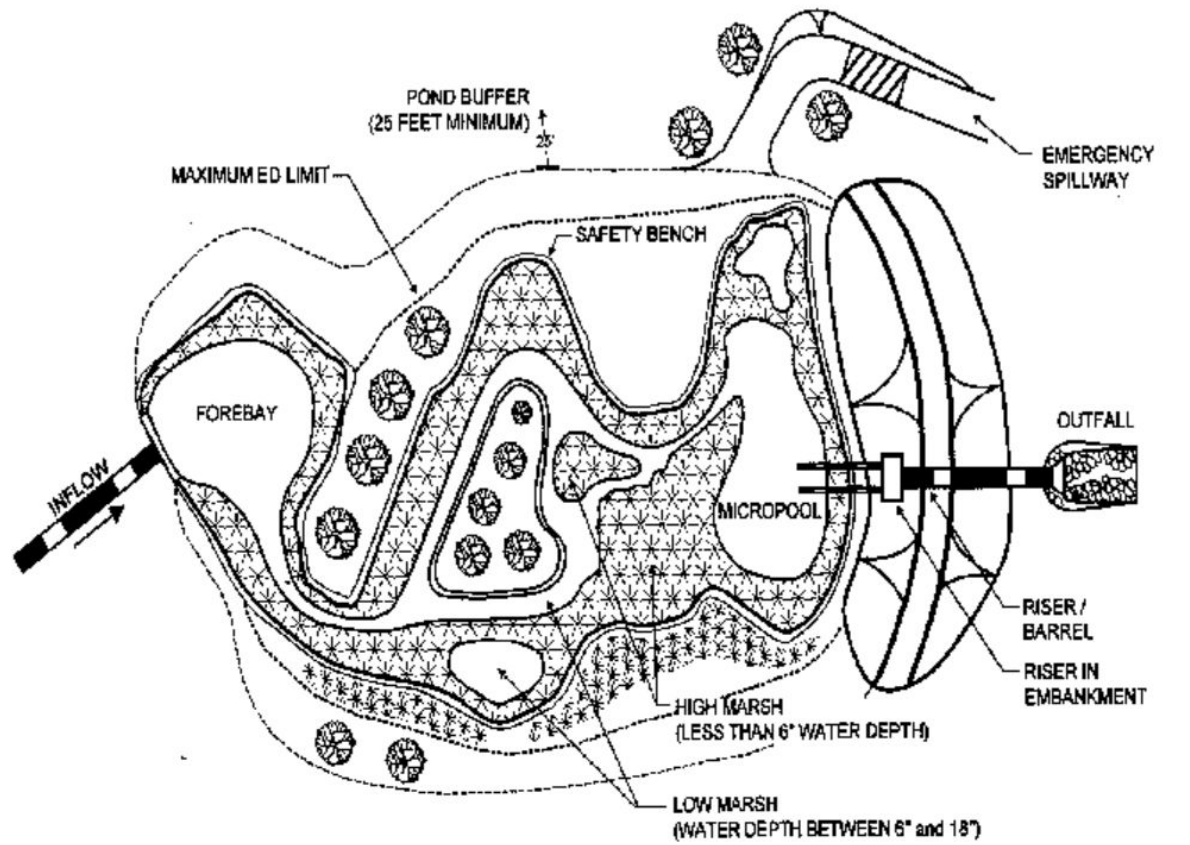


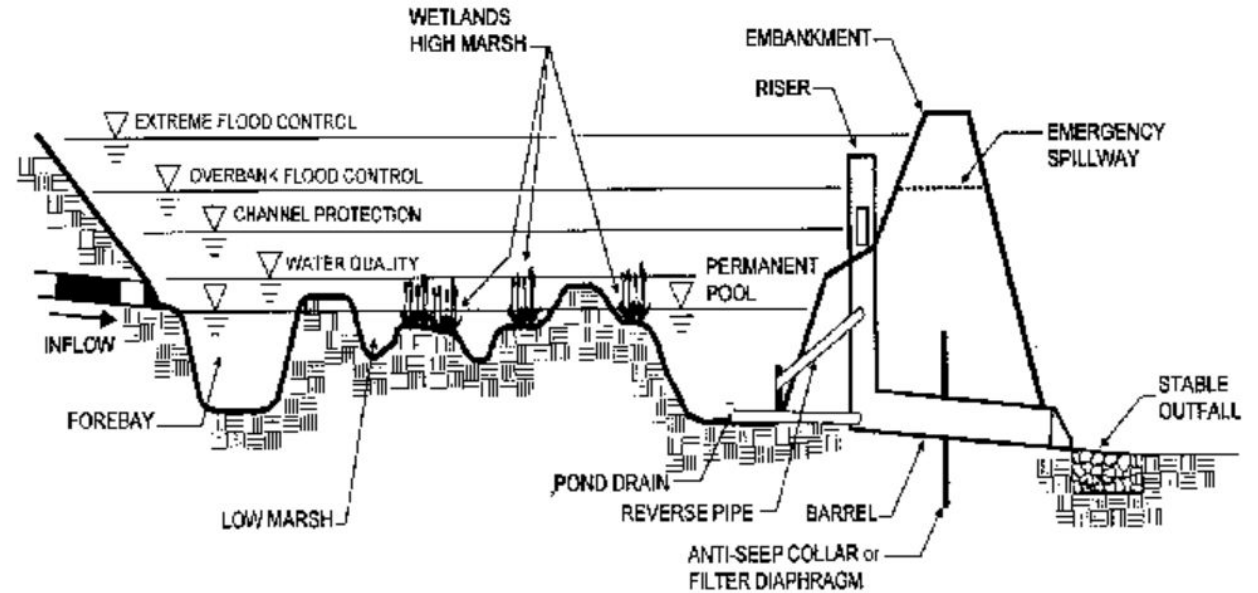
Figure 13.2. Mixed Wetland (Emergent and Forested) Basin



Constructed Wetlands



PLAN VIEW



PROFILE

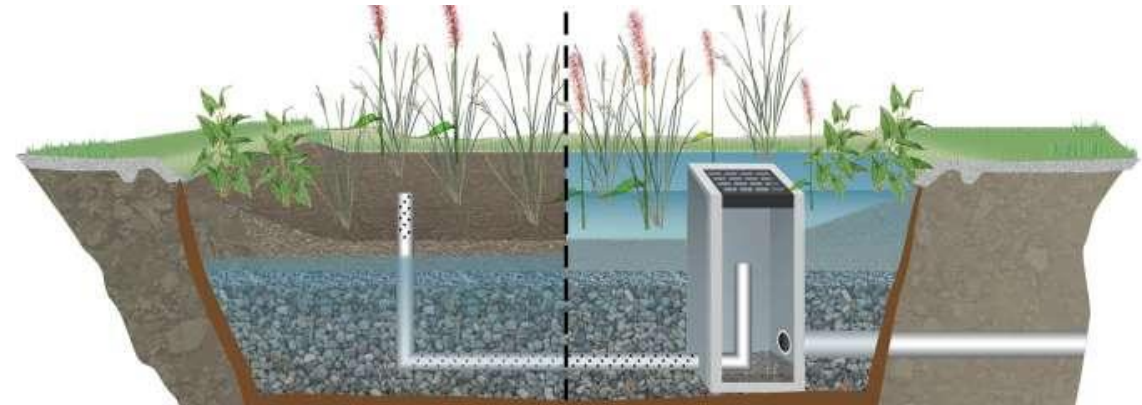


Subsurface Gravel Wetlands

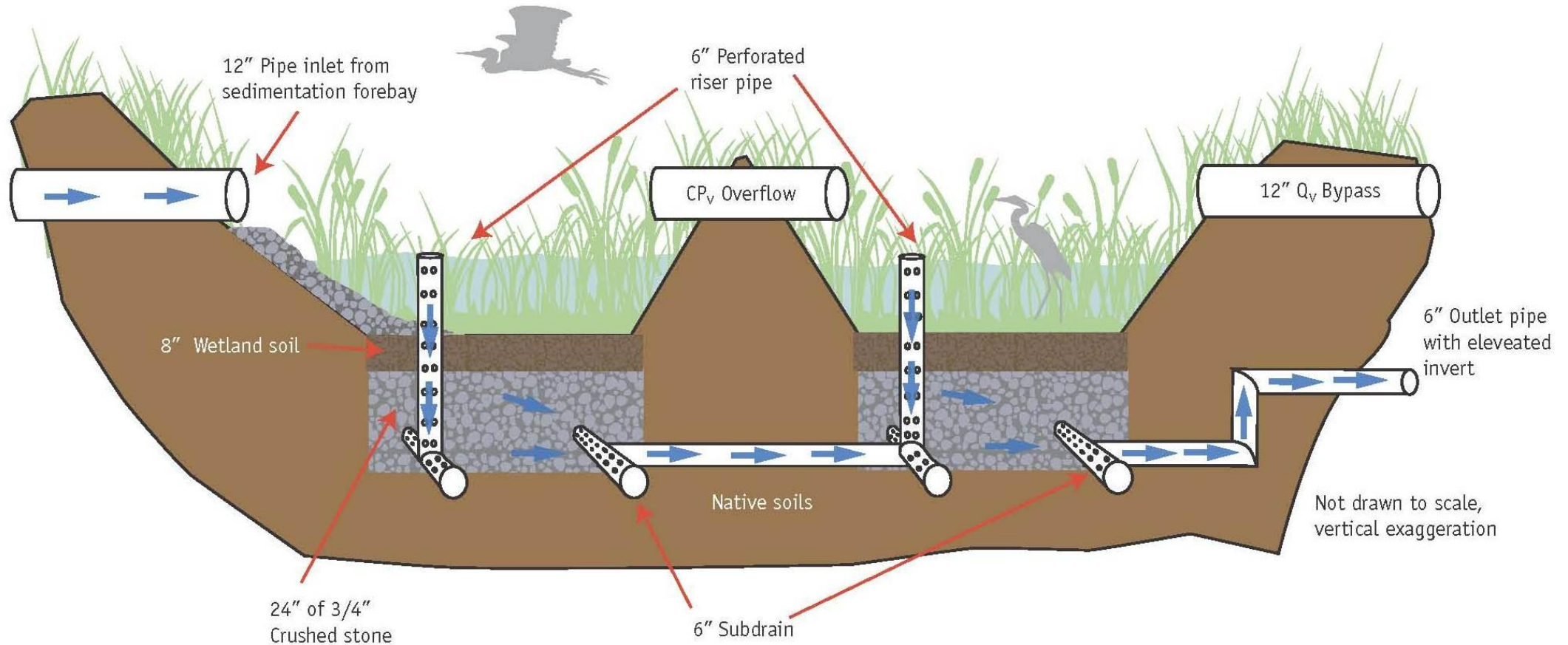


Subsurface Gravel Wetlands

- Subtype of constructed wetlands that is easier to design and construct
- Nutrient uptake in vegetation
- Settling of suspended particles
- Denitrification in subsurface gravel bed
- Good for retrofits
 - Low hydraulic head requirements



Subsurface Gravel Wetlands

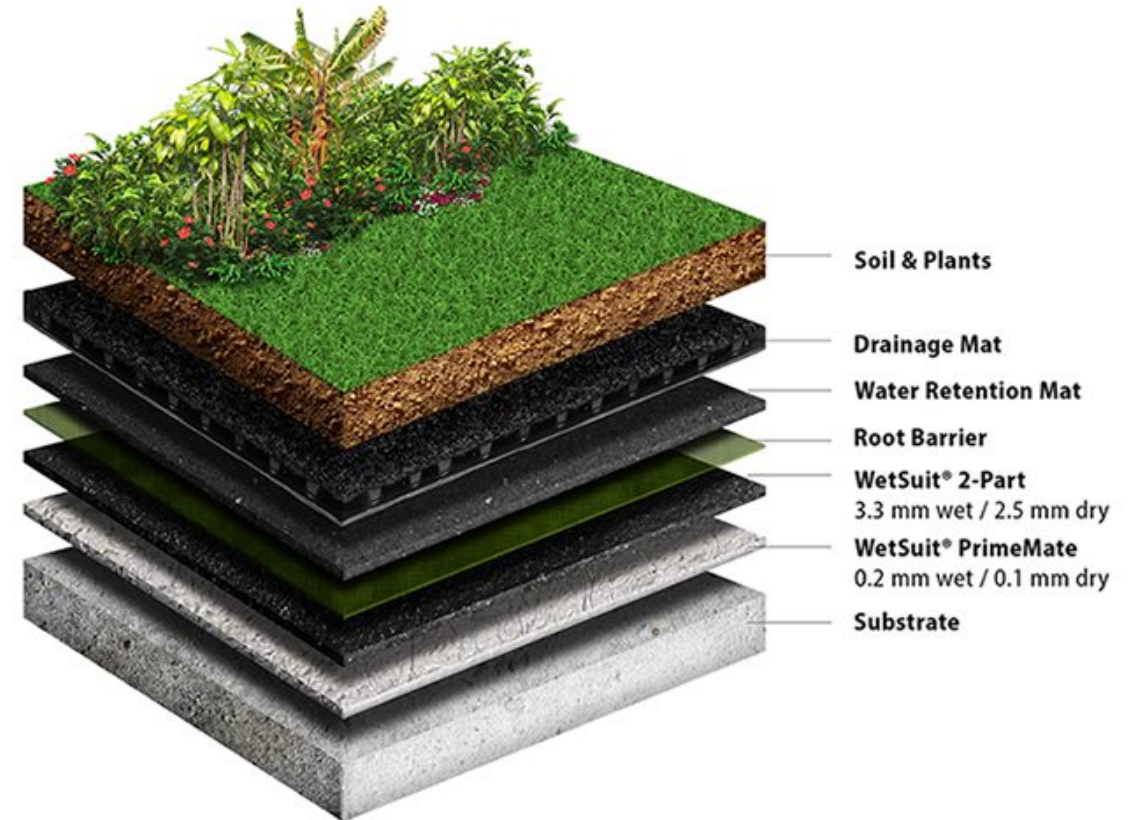


Green Roof



Green Roof

- High aesthetic value
- Effective treatment-in-place
- Mimics site in natural state
- Effectively slows water
- Large maintenance requirement
- Costlier than traditional roof types
 - Additional weight / loading considerations
 - Multiple layers of material

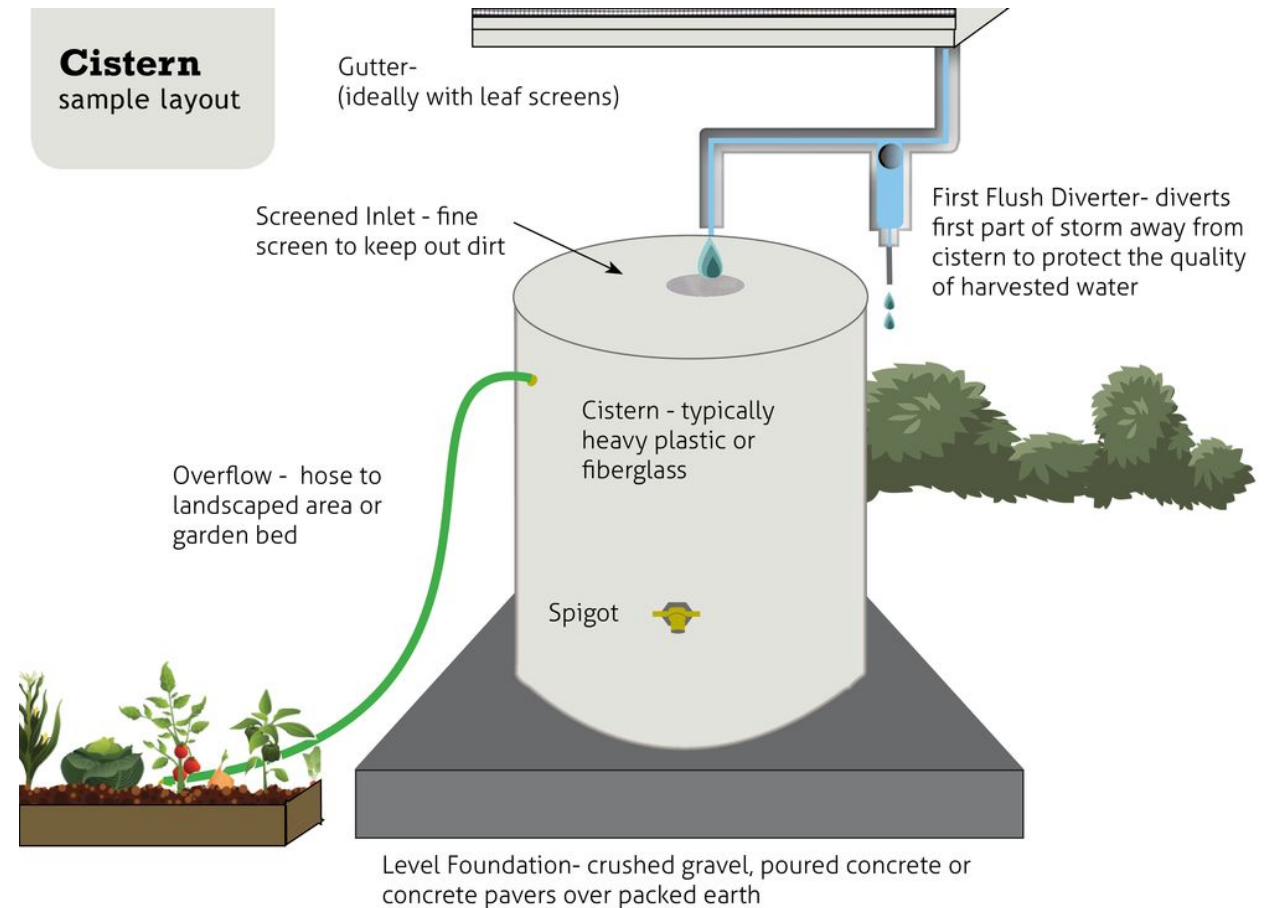


Cisterns & Rain Barrels



Cisterns & Rain Barrels

- Beneficial re-use
- Resiliency during drought
- Situationally limited
- Winterization challenges
- Does not address water quality treatment



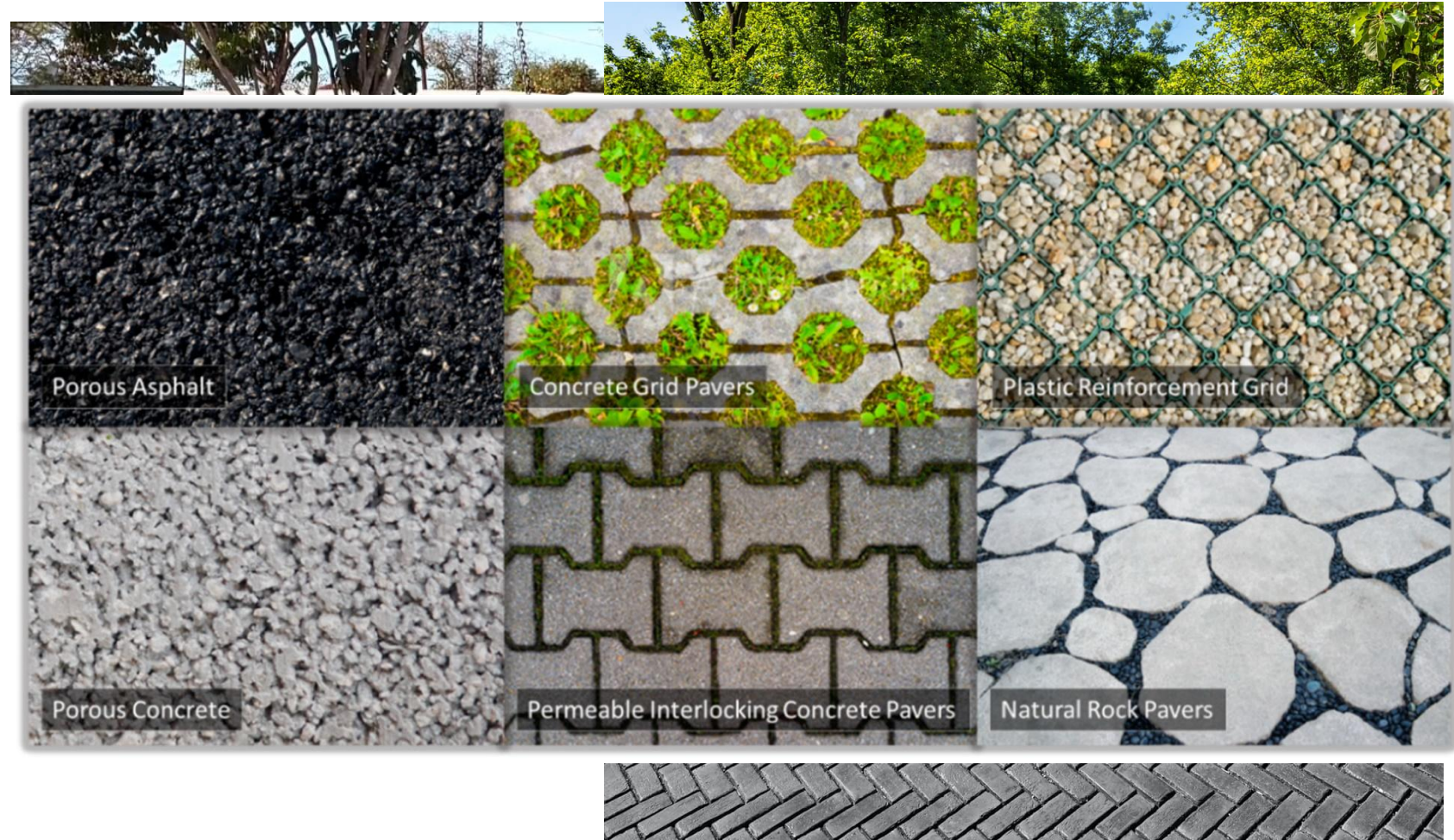
Pervious Pavement



Pervious Pavement

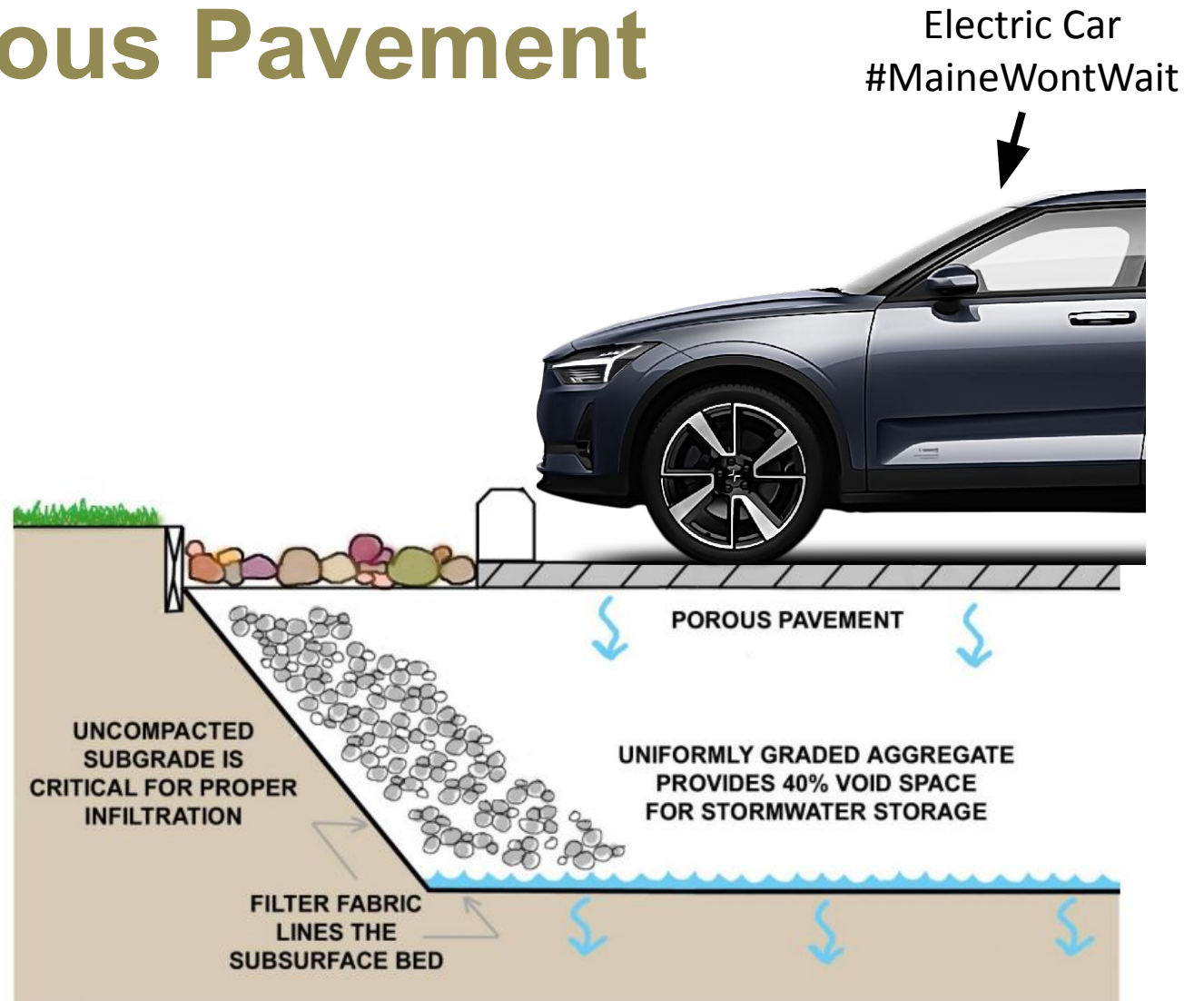
Versions:

- Porous pavement
- Pervious concrete
- Permeable pavers
- Grass pavers
- Paver stones



Pervious Pavement

- Physical filtering
- Mimics natural hydrology
- Good for volume storage
 - Sometimes paired with subsurface storage systems
- Potential for groundwater recharge (infiltration)
- Co-benefits
 - Faster snow melt
 - No black ice
 - Cooler in summer



Pervious Pavement

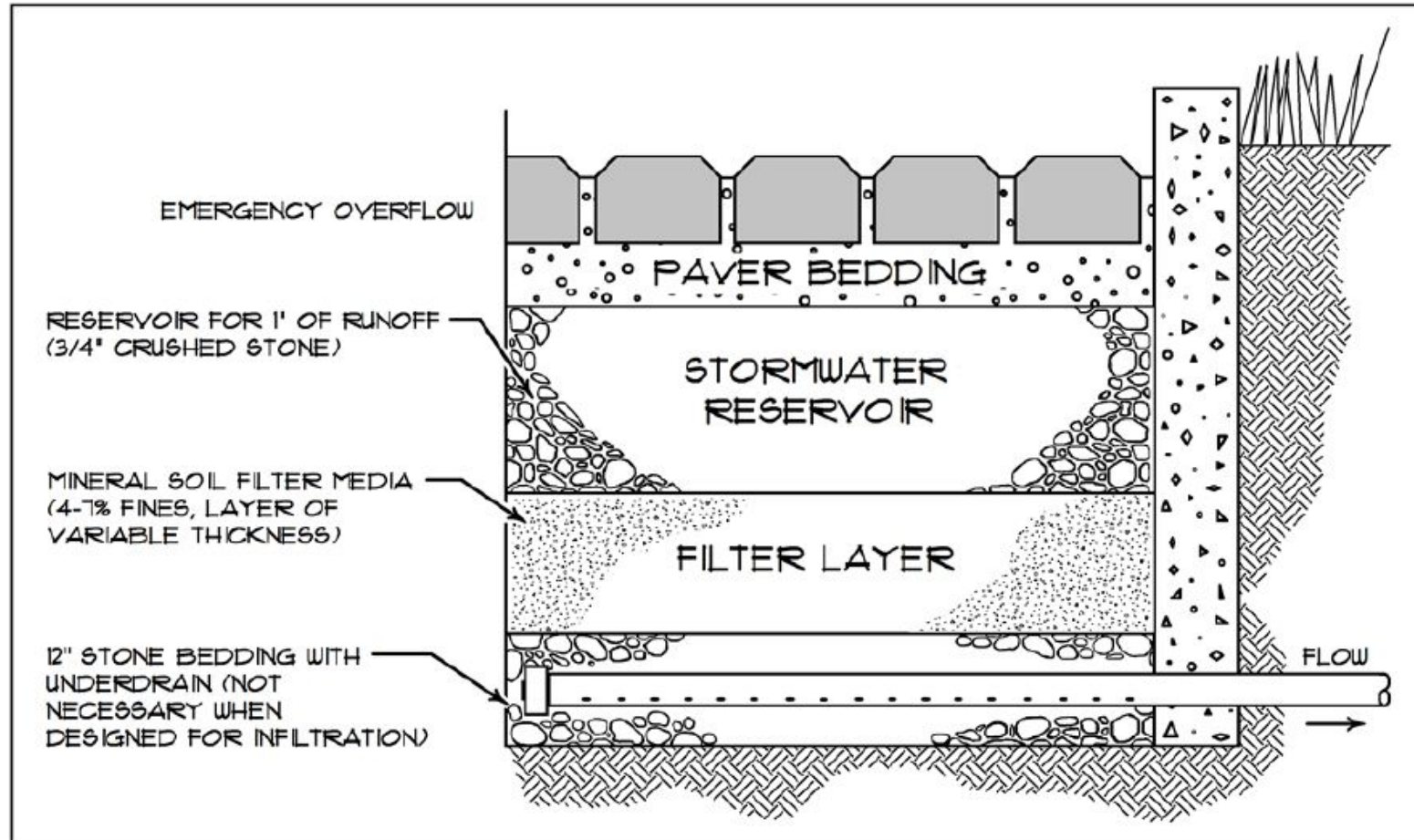


Figure 7.7.2 – Pervious Pavement Cross-Section



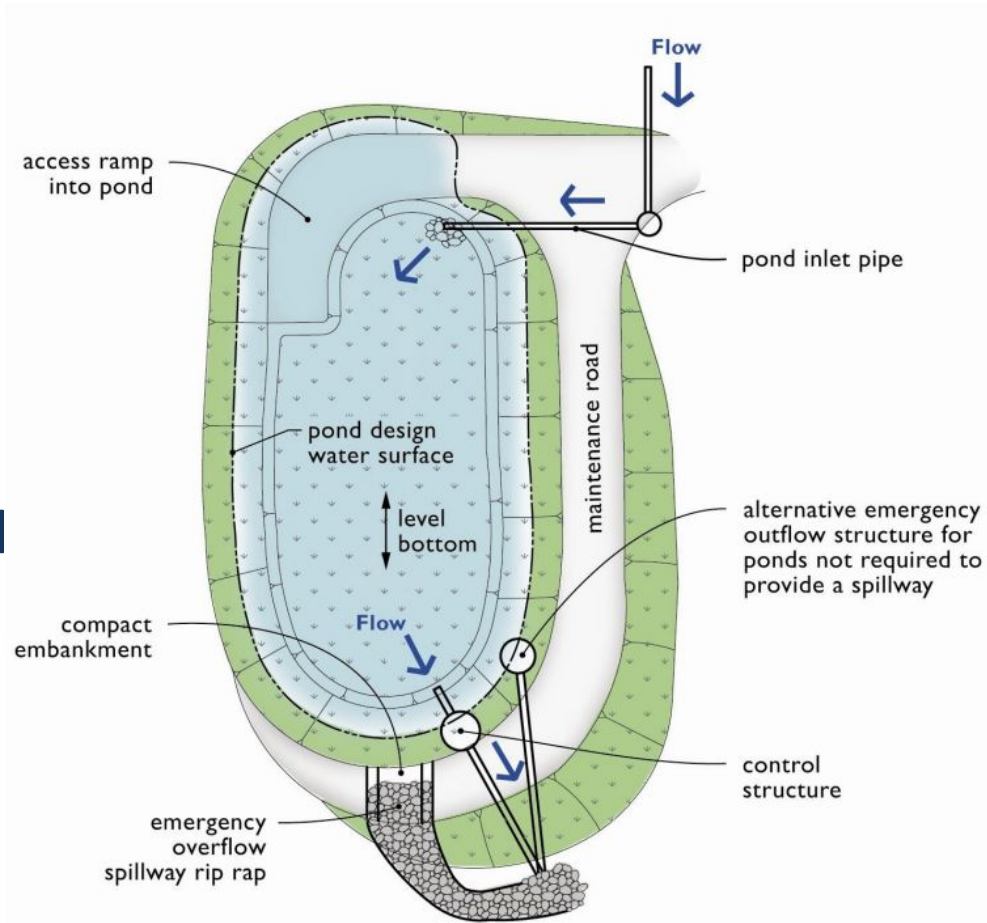
Wet Pond



Wet Pond

Also known as:

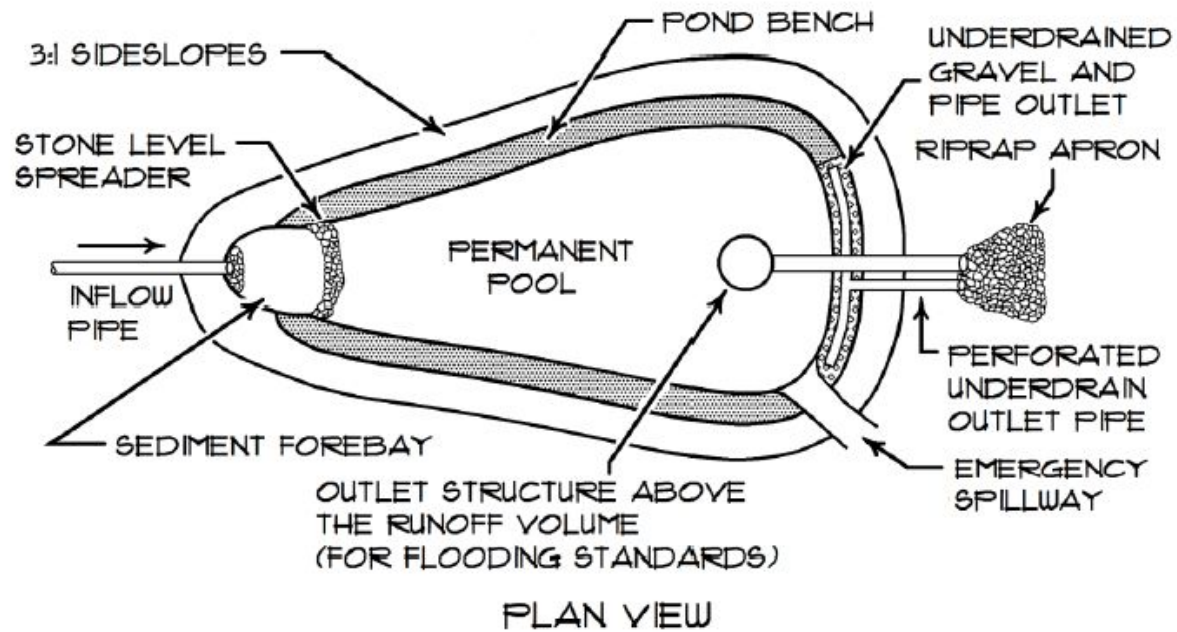
- Retention pond
- Retention basin
- Stormwater pond
- Detention pond



- Treatment via settling and biological processes
- Useful for volume control
- Potential for water re-use
- Co-Benefits
 - Wildlife
 - Aesthetics



Wet Pond



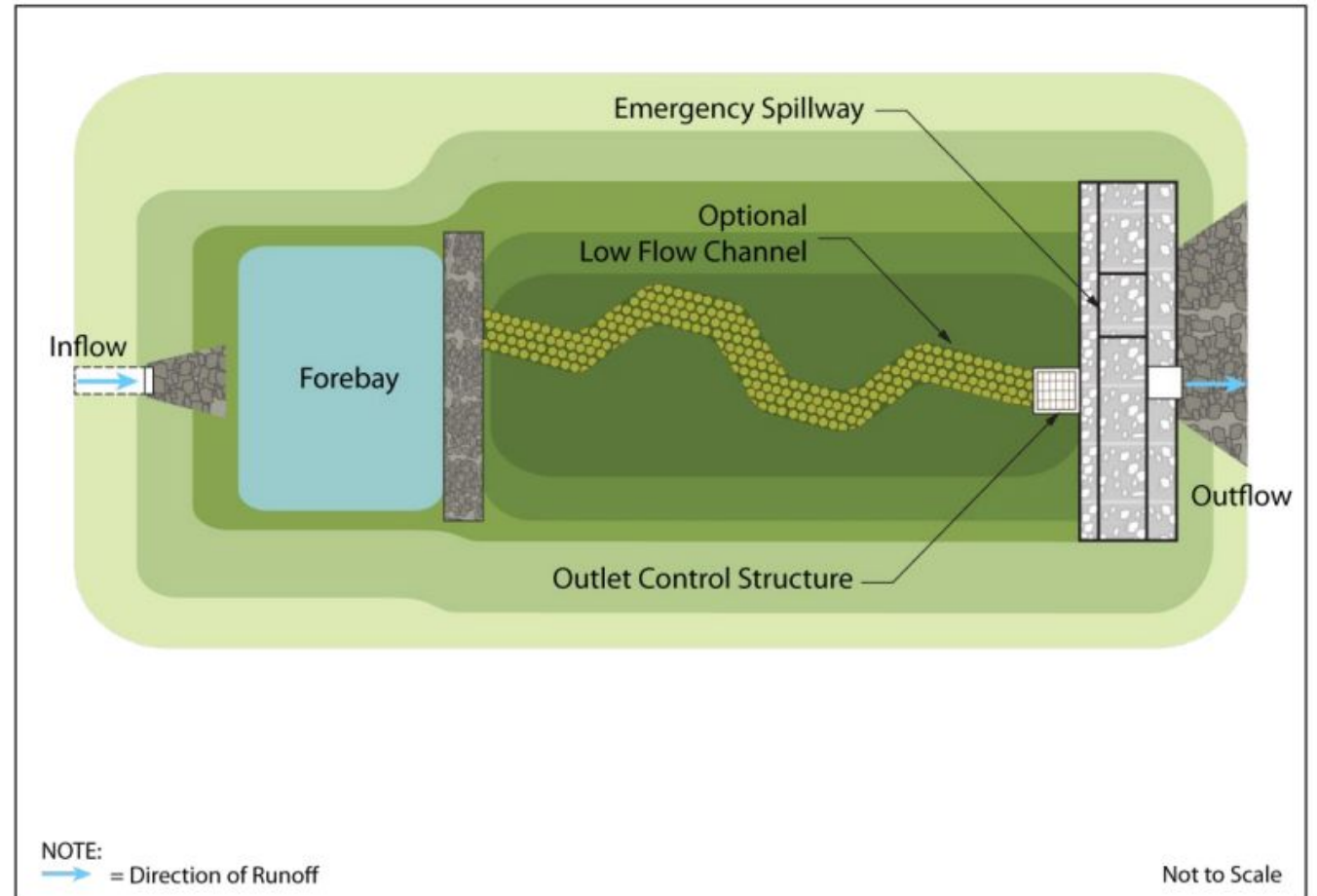
Detention Basin



Detention Basin

- Primarily for flood control
- Falling out of favor
- Typically mowed
- Large potential for retrofitting

Surface Extended Detention Basin – Plan View



Detention Basin Retrofits

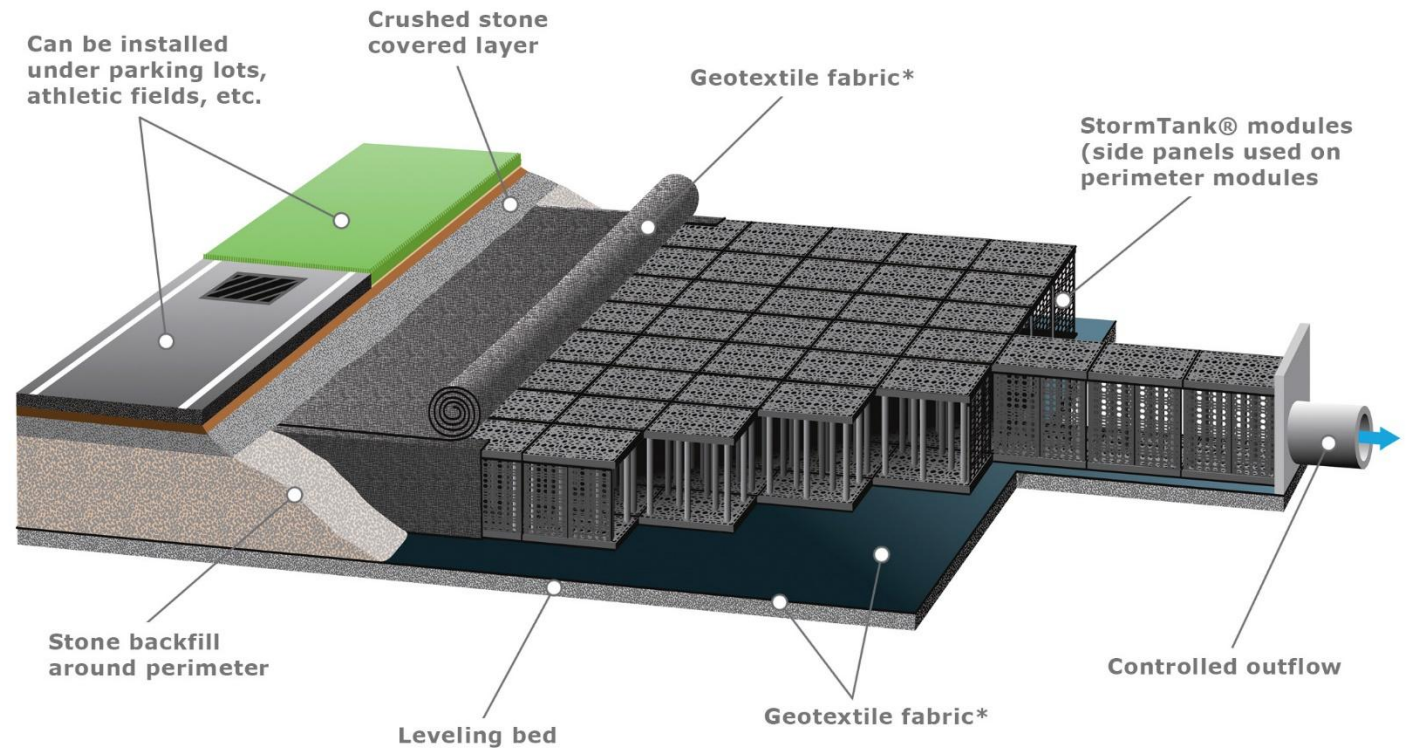


Subsurface Detention / Filters



Subsurface Detention / Filters

- Great for large quantity storage
- Often paired with porous pavement
- Less ecological value
- Expensive
- Corrective maintenance can be a challenge



Subsurface Detention / Filters



Dry Well

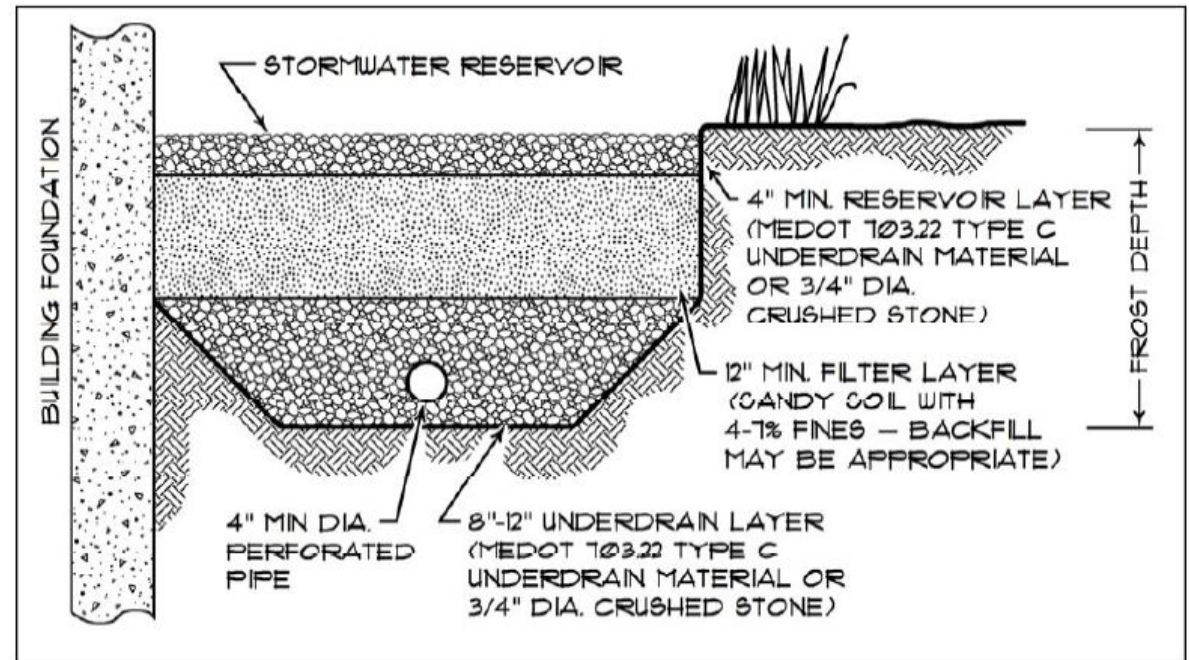
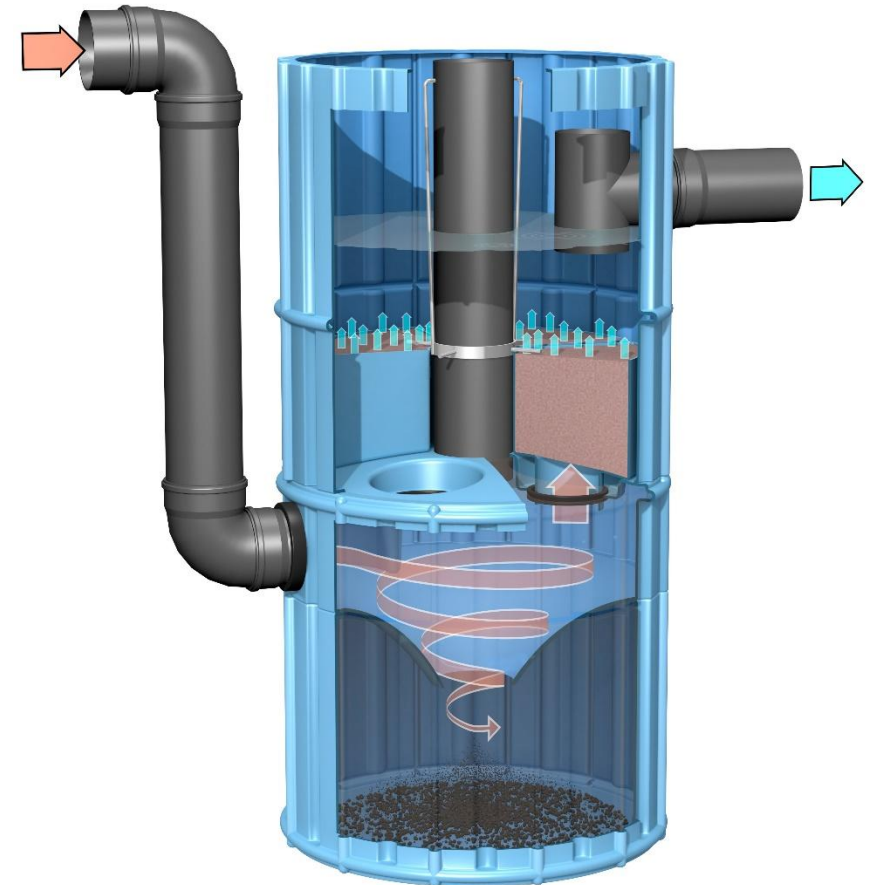


Figure 7.5.1 – Roof Dripline Cross-Section

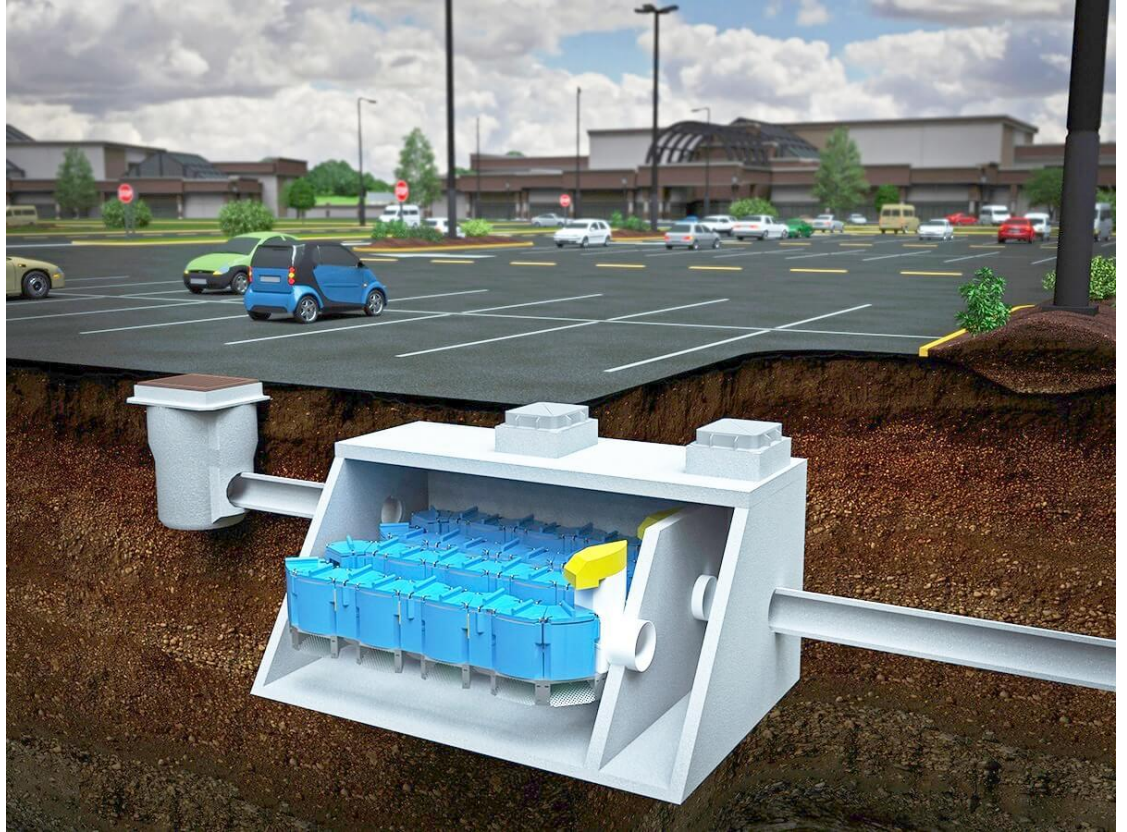


Innovative Stormwater Management



Innovative Stormwater Management: Minimize Space, Maximize Treatment

- Redevelopment of urban spaces
- Manufactured treatment devices
- Engineered media
- Pre-constructed modules
- Beneficial re-use
- Hybrid GI systems



Innovative Measures: Filters

- Replaceable cartridges
- Engineered media
- Try to maximize pollutant removal in a smaller footprint or below ground



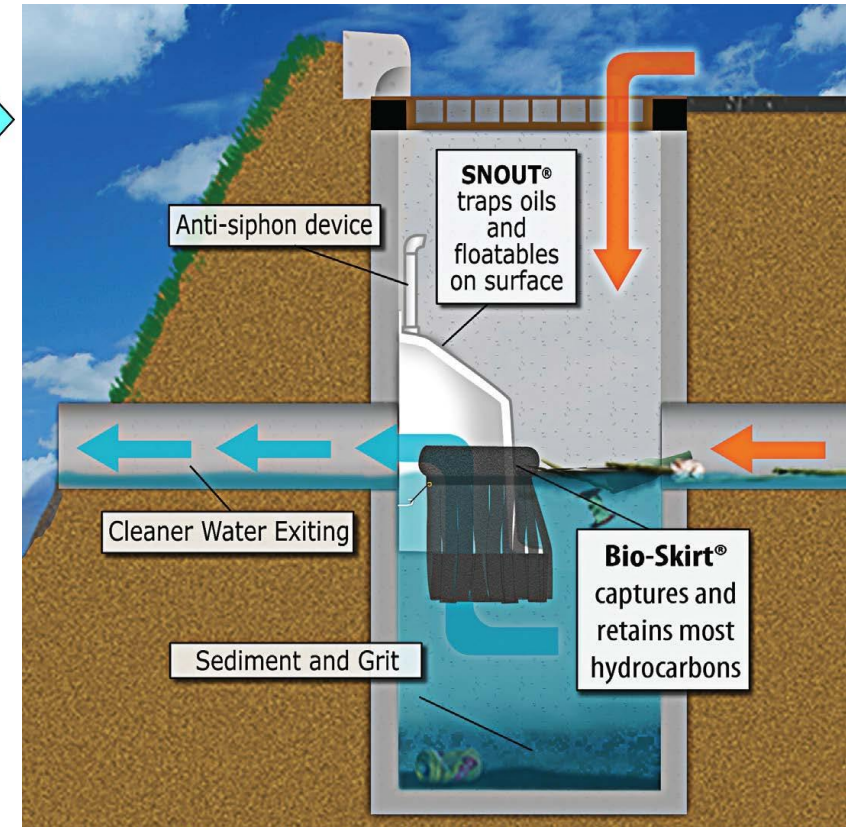
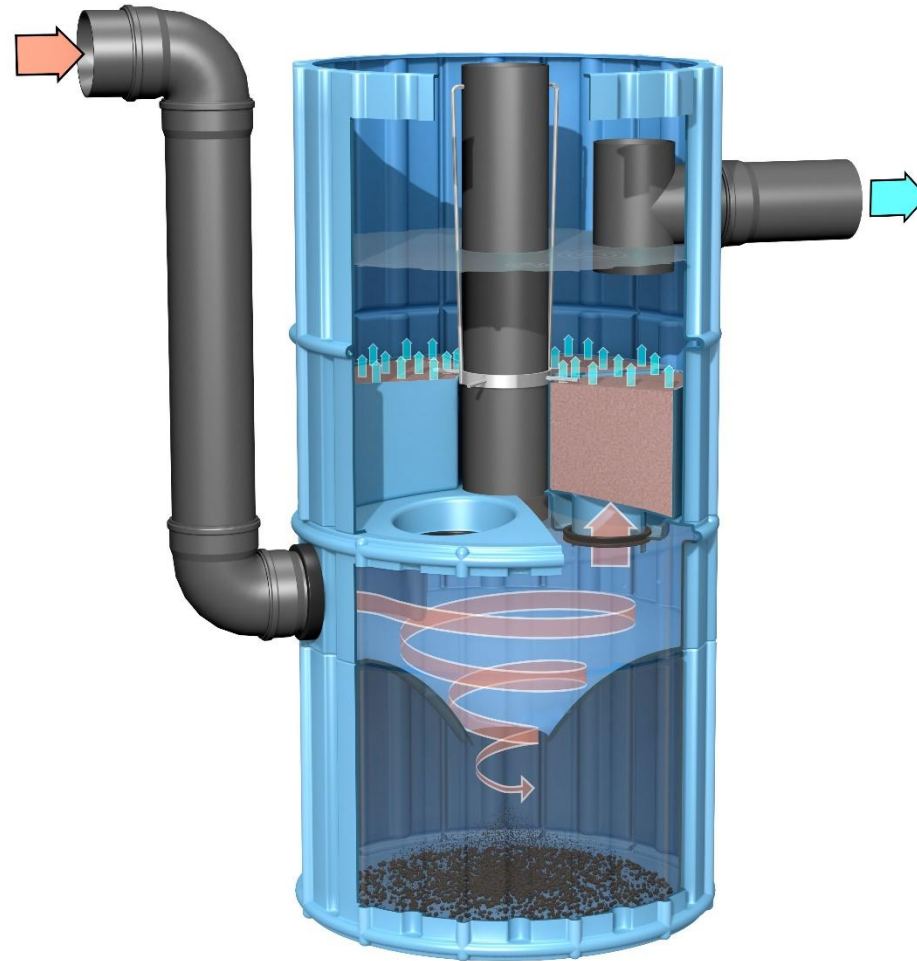
PhosphoSorb® Filter Media

Designed for targeting
high levels of phosphorus



Innovative Measures: Separators

- Excellent for pre-treatment
- Effective sediment removal
- Straightforward cleaning / maintenance



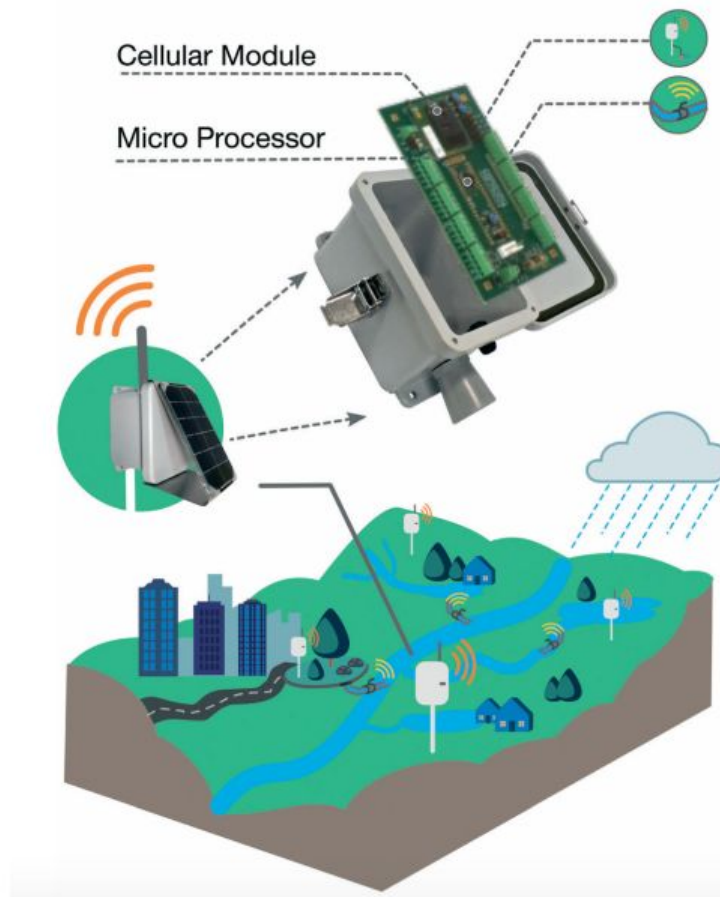
Innovative Measures: Modular Green Infrastructure

- Good for urban environments
- Self contained
- Scalable
- Provide benefits of green infrastructure
- May require bypass for large storms
- Little volume retention



Adding Technology to Stormwater Infrastructure

- Corresponds with smart cities initiatives
- Real-time monitoring
- Effective data collection informing future treatment recommendations
- Potential for flood reduction
- Complications can add additional failure points

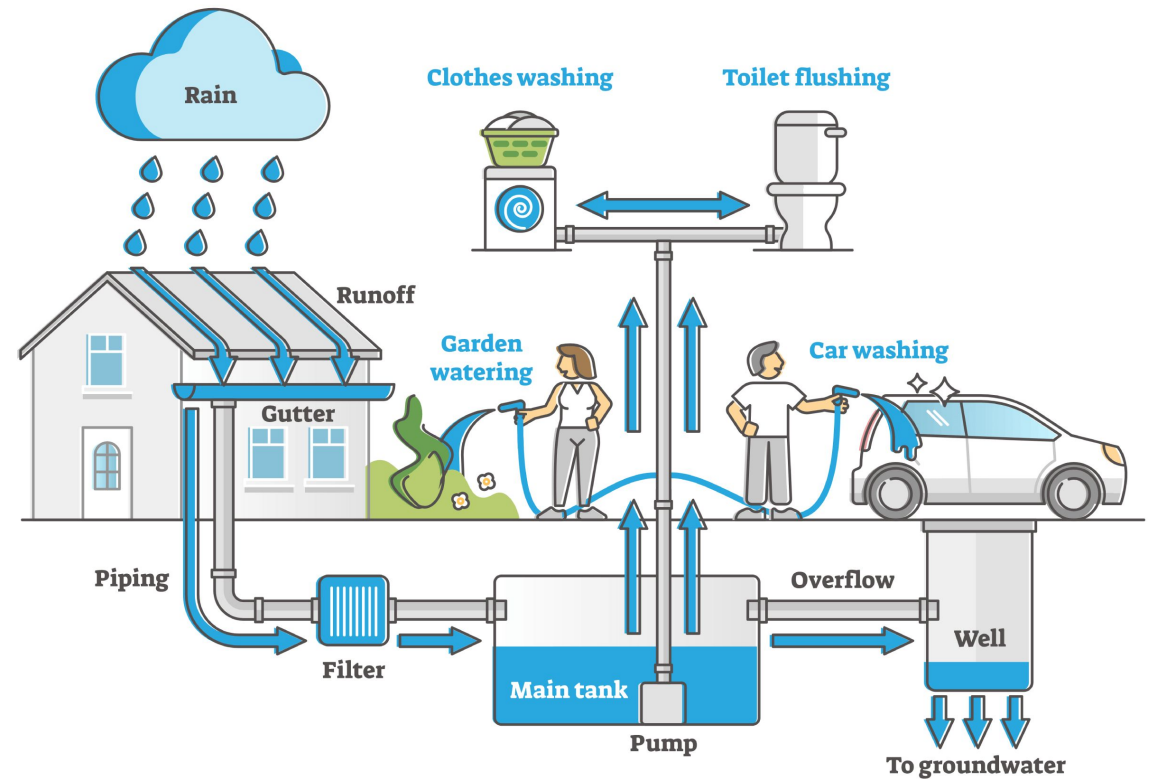


Rainwater Re-Use

- Capture, store, and re-use
- Drought resilience
- Advanced recycling



RAINWATER HARVESTING



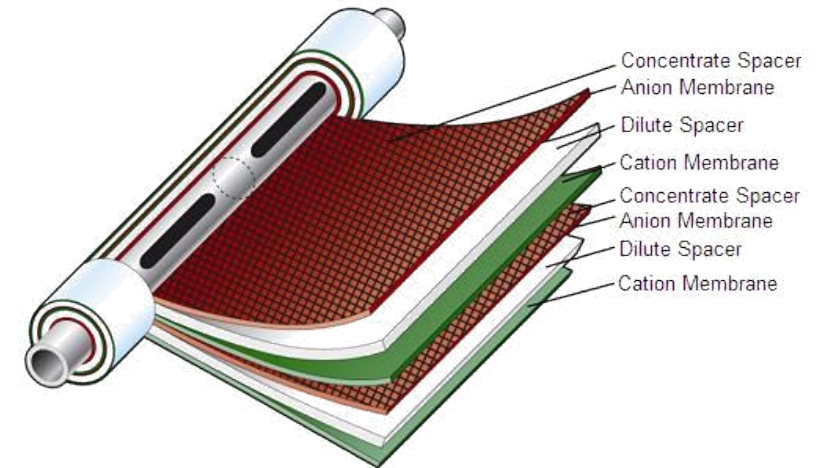
Floating Treatment Wetlands

- Additional nutrient uptake
- Increase contact time in wet ponds
- Green Infrastructure Co-Benefits
- Can be built inexpensively



Chloride Treatment Units

- No BMPs effectively remove chlorides
- Topic of active study
- Dilution?
- Electrodialysis?
- Evaporation?



Journal of Environmental Management



Volume 308, 15 April 2022, 114553



Chloride removal capacity and salinity tolerance in wetland plants


Maria Schück  , Maria Greger


Show more 

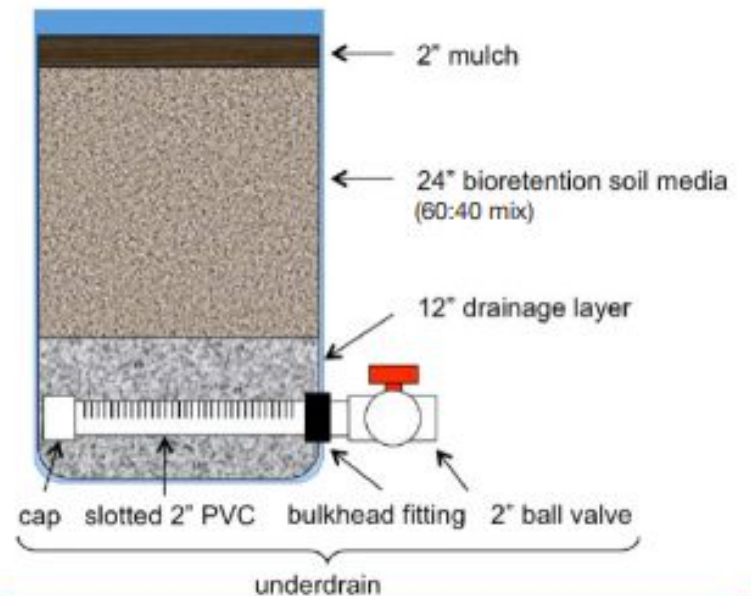
+ Add to Mendeley  Share  Cite

<https://doi.org/10.1016/j.jenvman.2022.114553>

[Get rights and content](#)

Under a Creative Commons license 

 [open access](#)



Wrapping Up

- There are a variety of measures available for the treatment and control of stormwater
- Green vs. Grey infrastructure
- The field is evolving to fit needs



Moving Forward

Stormwater Maintenance 101

The Future of Stormwater Management in Maine





Contact:
Cody Obropta, PE
Stormwater Engineering Team
207-356-1481
cody.obropta@maine.gov

www.maine.gov/dep

