Adapting Stormwater Practices to Island Environments

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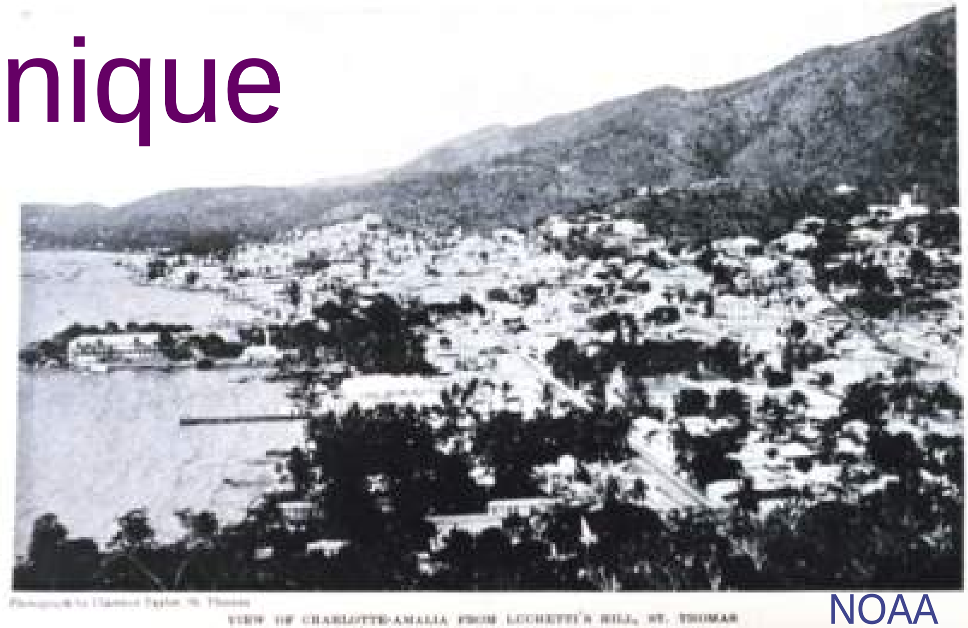
Key Themes

- Review -- Why USVI is Unique
- Review -- Stormwater Design Objectives
- Designing Innovative Practices
  - Bioretention
  - Infiltration
  - Swales
  - Ponds

Why USVI is Unique

- History of significant land use alterations
- Sensitive near-shore ecosystems
- 3 different islands
  - (culture, staffing, patterns of development)
- Intra-island rainfall variations
- Dry guts (few perennial)
- Steep terrain
- Erodible soils
- Limitations on material imports/exports
- Others...



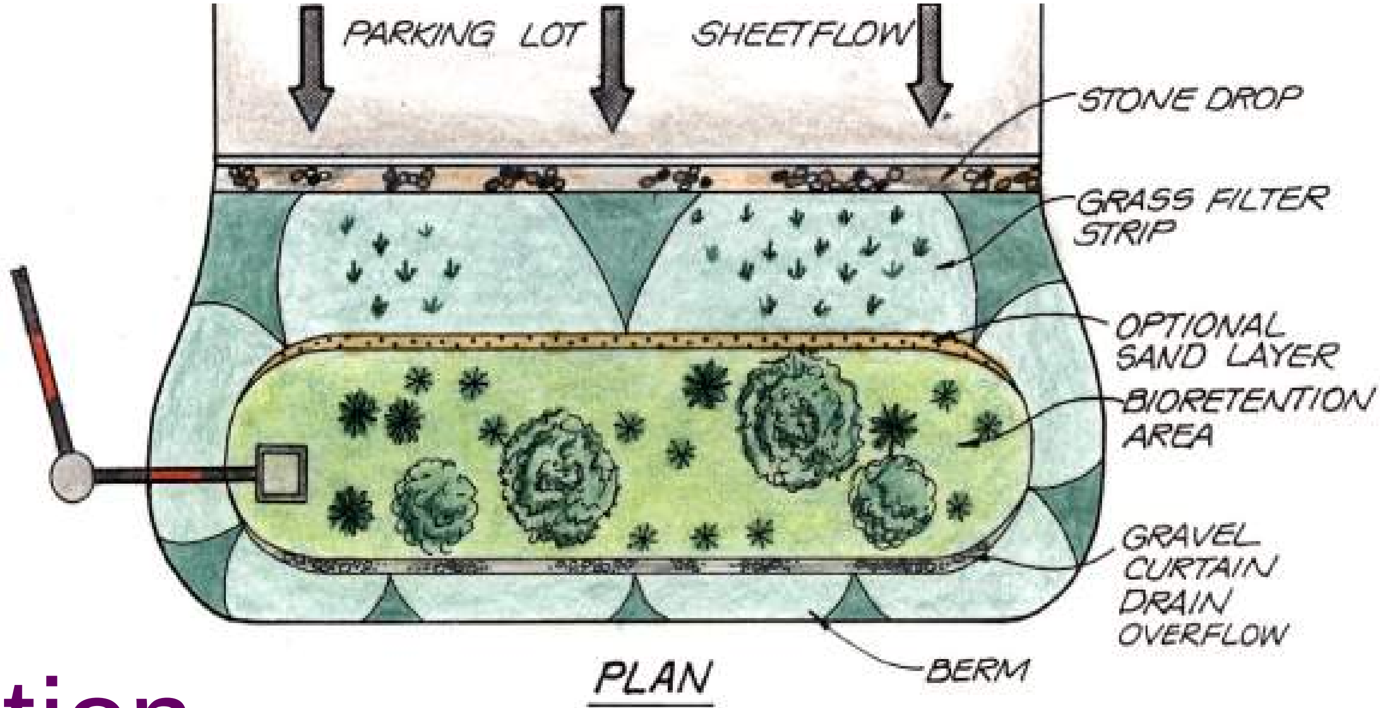
NOAA

Some Possible USVI Stormwater Design Objectives...

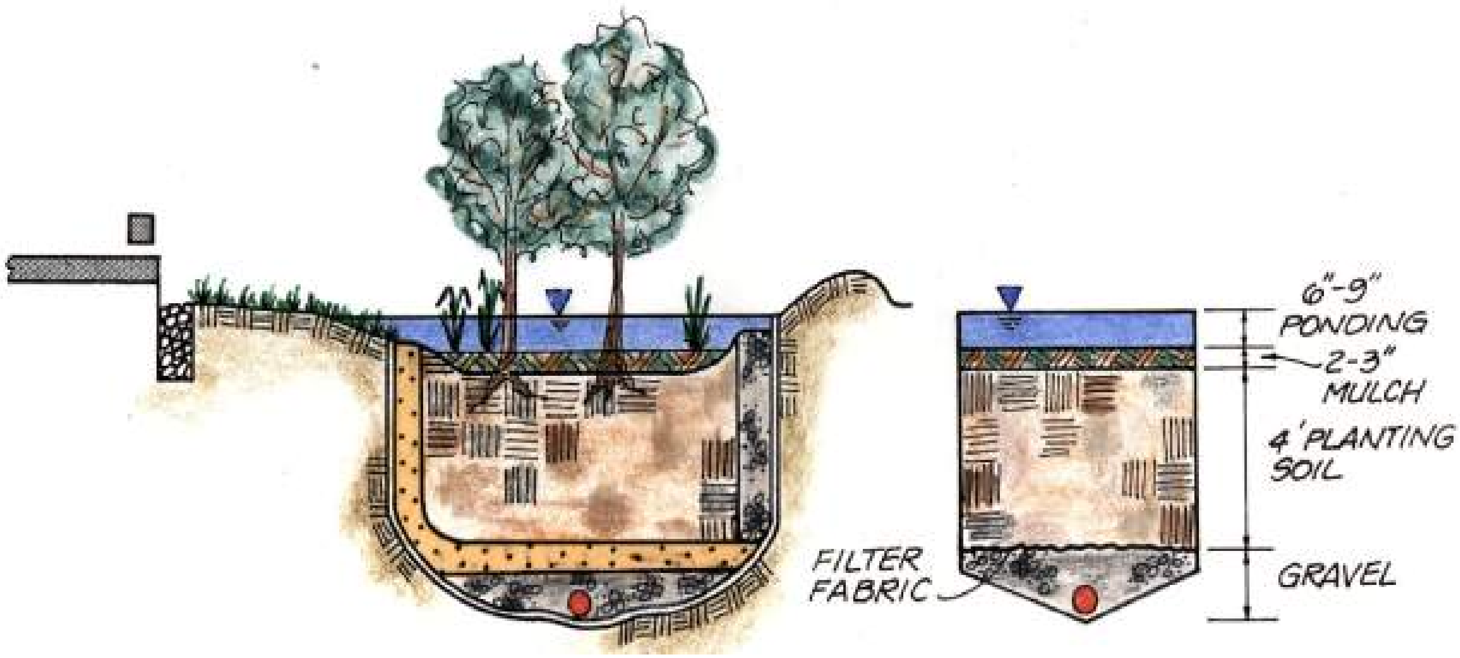
- Treat rainfall as a resource (and runoff as a waste)
- Promote recharge rates to replenish groundwater resources
- Keep pollutants from entering groundwater
- Keep sediment and pollutants out of coral reefs
- Prevent serious floods

Designing Innovative Practices

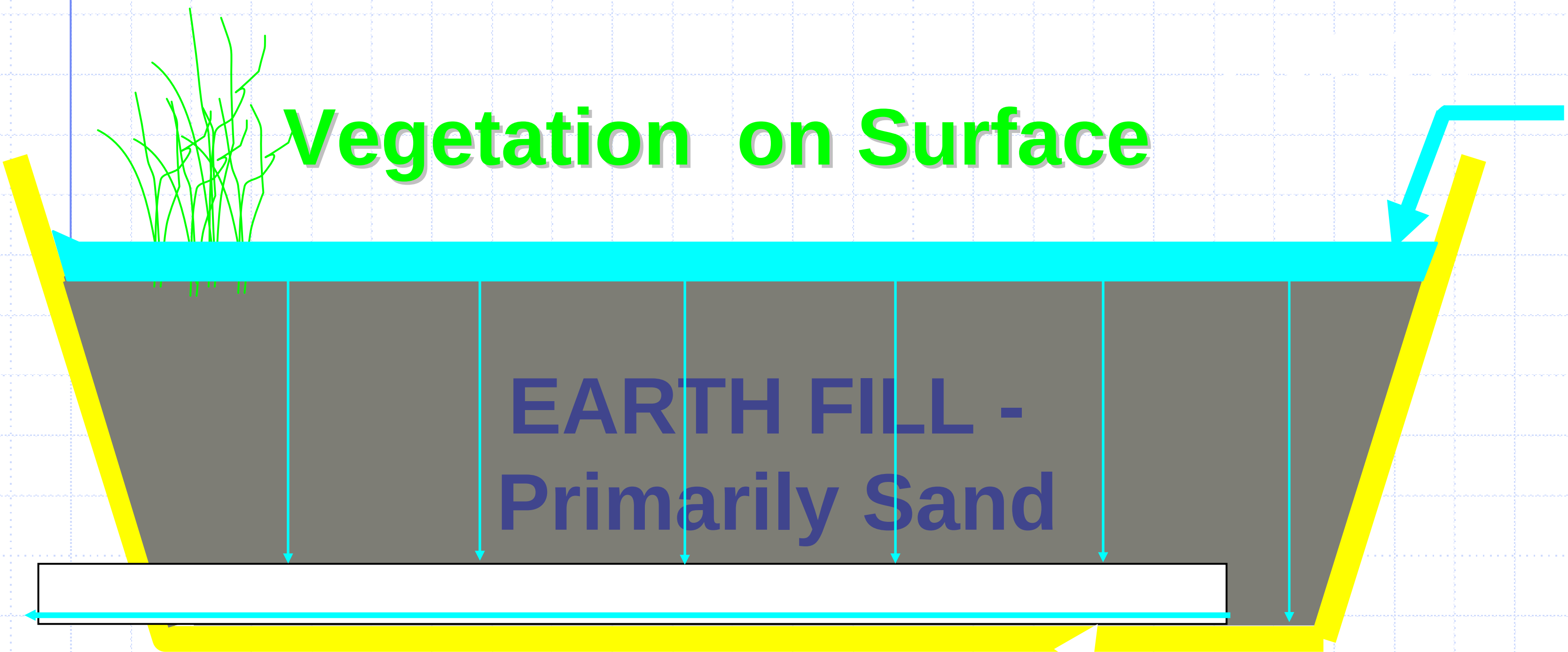
- Bioretention
- Infiltration
- Swales
- Ponds



Bioretention



Bioretention Schematic






2000

Vegetation Management Is Key Maintenance Task

2003

Source: B. Hunt, NCSU, 2005

Maintenance: Replacement of Mulch Layer and Spring Cleanup

Bioretention can fail when:

Un-stabilized contributing drainage area

Poor media

Bad elevations and grades

Underdrain

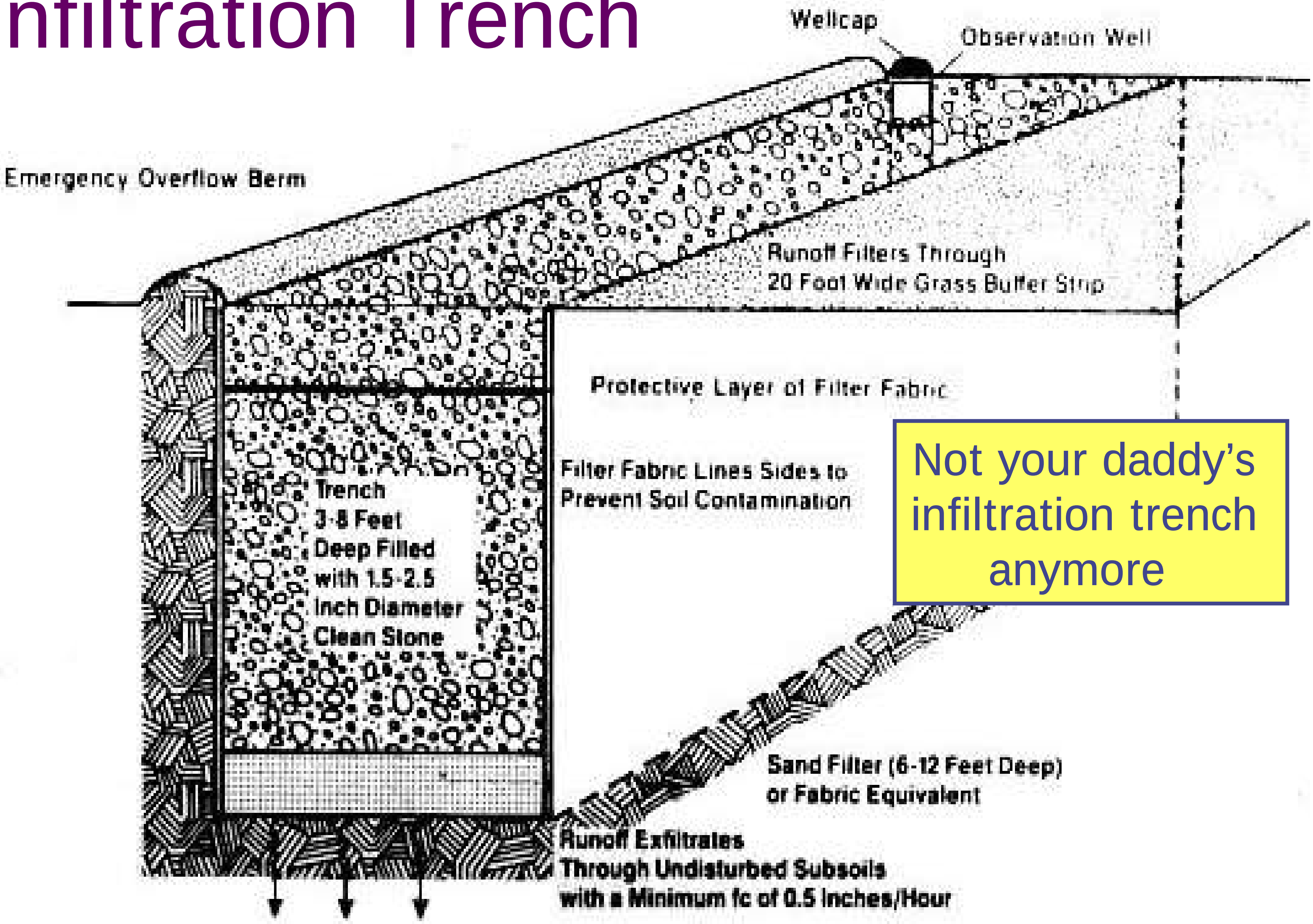
No Underdrain

Design Guidelines for Island Bioretention Practices

- Two size stone filter to protect underdrain
- Coral or pumice in lieu of mulch for top
- Two cell design - first pretreats sediment
- Shallow filter depth (2 to 3 feet OK)
- Media: 50% sand, 20% leaf compost, 30% parent soil
- Design variations based on annual rainfall
- Need good plant list for USVI
- Avoid invasive species

Small Infiltration Practices

Infiltration Trench



Not your daddy's infiltration trench anymore

Groundwater Concerns

- Soluble pollutants will not be treated by infiltration practices and will enter groundwater
- So will spills and leaks
- *Preventative approach:* Restrict infiltration near groundwater supply areas (wells) and restrict infiltration at hotspot land uses

Longevity and Maintenance

- Terrible track record in the past
- Failure rates of 50% or more in 1980s
- New soil testing and pretreatment has sharply reduced failures when applied at small sites
- Infiltration is true post-construction practice– will fail if installed prior to full site stabilization
- Works well in many regions with porous soils

Key Island Design Issues

- Measure soil infiltration rate on-site
- Surface pretreatment prior to infiltration (25 to 50% of WQv)
- WQv a function of annual rainfall
- Stabilize site prior to installation
- Keep overhead vegetation away

More on Soil Infiltration Rates

- The real infiltration rate is what the practice actually does several years after construction – research indicates it should be reduced in half
- Trees and shrubs promote infiltration through macropores
- Try not to force a lot of infiltration depth over a small surface area

Truly Bad Infiltration Practices

Vote for your favorite practices that are born to fail or look ugly

Nominee No. 1: Engineer’s no karma version of Japanese Rock Garden

Nominee No. 2: The infiltration trench that couldn't

Nominee No. 3: The right practice in the wrong spot

Really Cool Designs

- Despite the past failures, infiltration is still the most ideal practice when conditions are right and it is installed properly
- Consider the following cool designs:

Nominee No. 1: Small scale infiltration works best

Nominee No. 2: Infiltration trench that could

Nominee No. 3: Nice landscaping and cool sign

Infiltration using permeable pavers

~20" of Gravel Storage Layer

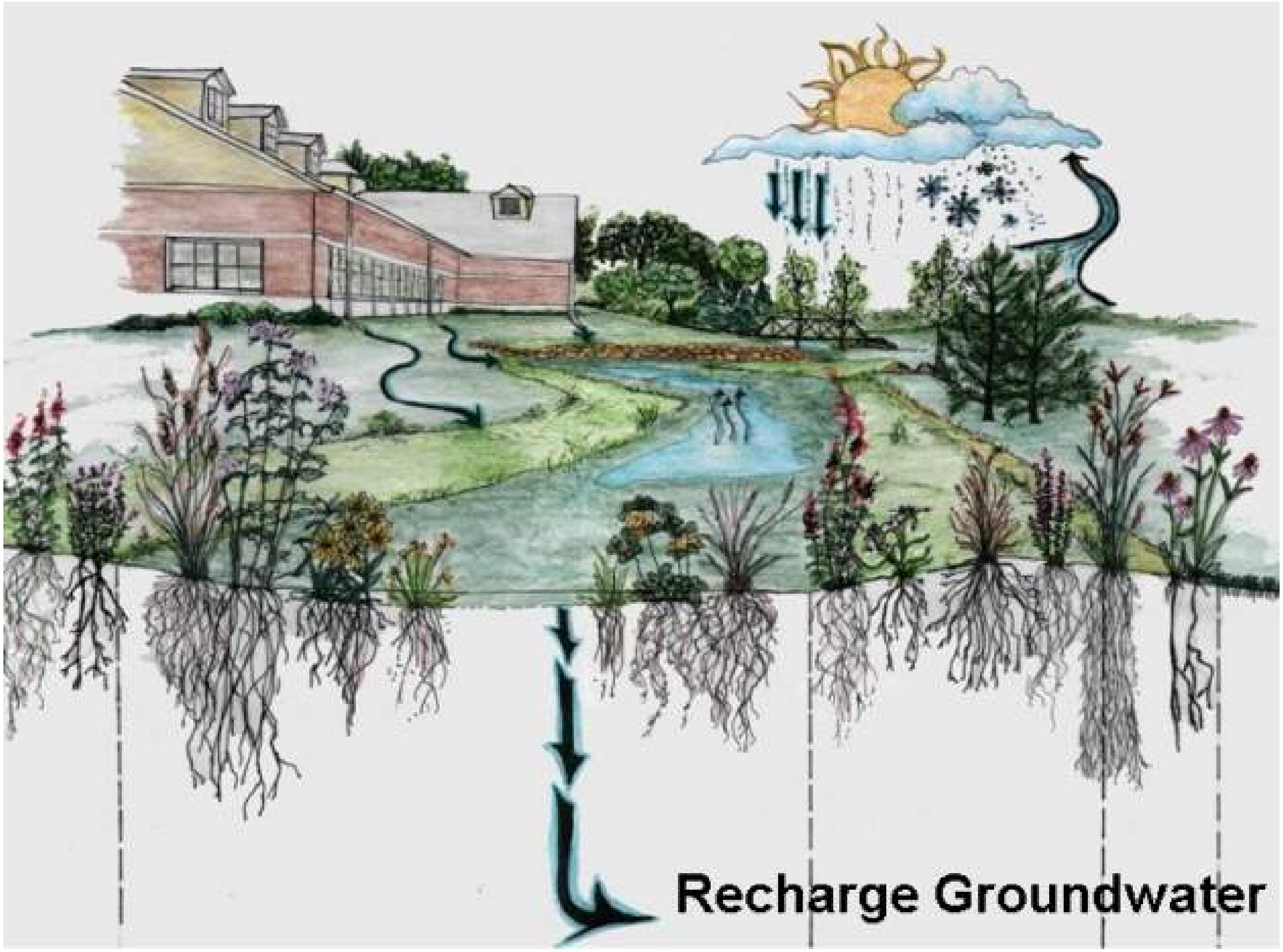
Typical Applications

Finding Island Sources of Permeable Pavers

Design Guidelines for Island Infiltration Practices

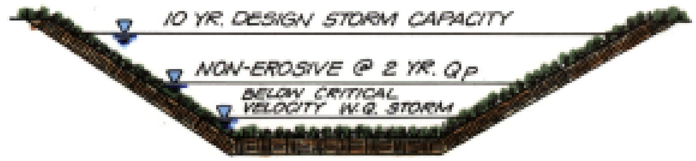
- Lose the bottom liner – bottom sand filter
- Be conservative in design infiltration rate
- Infiltrate shallow depths in small areas close to the source
- Understand the future use and management activity of the contributing land use
- Try to have a least two levels of pretreatment to keep sediment out

Grass Channels and Dry Swales



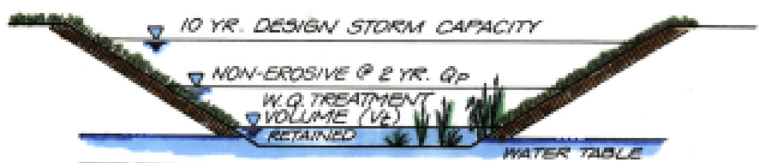
Does not include ditches

(a) DRAINAGE CHANNEL



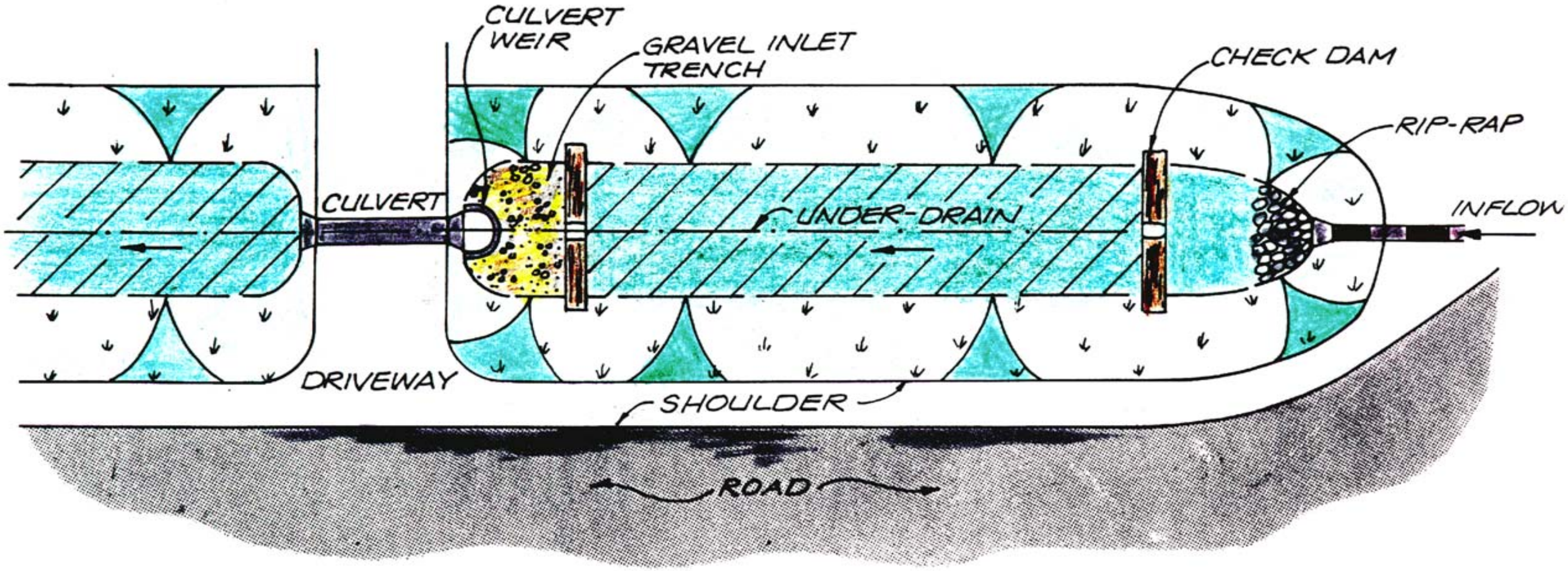
(b) GRASS CHANNEL

(c) DRY SWALE

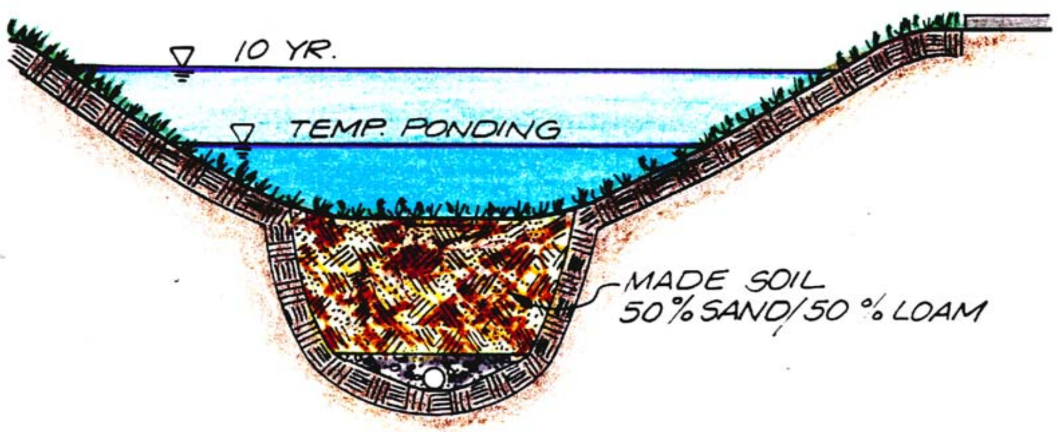


(d) WET SWALE

Dry Swale



PLAN



PROFILE

Dry Swale Performance

- Excellent research in recent years
- Significant reduce runoff volume (mean 40%)
- May be as high as 80% with trees/shrubs (ET) and less efficient underdrain collection
- Grass height/mowing regime does not appear to influence removal capability
- Removal drops sharply when vegetative cover in bioswale >80%

Grass Channel Performance

- Changes in pollutant concentration are not always great as they pass through grass channel
- TSS, metals and nitrogen show some decline in concentration
- Phosphorus and fecal coliform levels often do not drop (in some cases, increase)
- **Runoff reduction** is the key to swale load reduction
- In nearly all cases, the bulk of pollutant removal occurs by infiltration rather than filtering

Longevity and Maintenance

- Engineered designs in the right settings experience few initial maintenance problems
- Field studies indicate that most grass swales did not achieve their hydraulic residence time
- Application on slopes greater than 2% is problematic w/o cells or checkdams
- Long-term vegetative management is major issue: to mow or not to mow?

Truly Bad Swale Designs

- A ditch is not a swale and a grass channel is not a dry swale
- Designers have been missing out on opportunities to treat most if not all runoff in the conveyance system
- Check these ones out:

Nominee No. 1: The high input swale with curb

Nominee No. 2: The 90 second swale

Nominee No. 3: Everyone likes to mow soggy grass swale

Really Cool Bioswale Designs

- Swales with real style and panache
- Some of these designs make revolutionary changes to street rights of way
- Vote for the swale of the year

Nominee No. 1: Bioswale with a ton of bio

Nominee No. 2: A pretty dry swale

Nominee No. 3: Best ever State Highway swale

Nominee No. 4: Swale in area with low rainfall

Nominee No. 5: What you don’t see is really impressive dry swale

Source: Martin Covington, P.E.

Nominee No. 6: The Swale of Century

Design Guidelines for Grass Channels

- Gentle grades and side slopes
- Select the most appropriate warm season grass for expected swale conditions
- Add some perennial rye to get rapid cover
- Erosion control fabric for steeper grades
- May need some topsoil, fertilization and liming to get grass started
- Design for at least 10 minutes contact time in swale for a one-inch storm (or)
- Add check dams to promote trapping and storage
- Ineffective on slopes > 10% or if not regularly cleaned out

Coir Fiber Log as a Check Dam

Design Guidelines for Dry Swales

- Lose the filter fabric (choker stone is enough)
- Utilize trees, shrubs and landscaping
- Shallow media (2 to 3 ft) and large (6 inch), inefficient underdrains
- Turf (and mowing) not always desirable
- Think through long-term vegetation management

Wet Ponds and Wetlands

Truly Bad Designs

- Sadly, so many to choose from!
- You must vote for one of the six nominees to enshrine in the Stormwater Hall of Shame

Nominee No. 1: Perfectly square wetland

Nominee No. 2: The McWetland - shortest distance from inlet to outlet

Nominee No. 3: Stormwater wetland that is really only a shallow wet pond (too deep for plants, too tiny to matter)

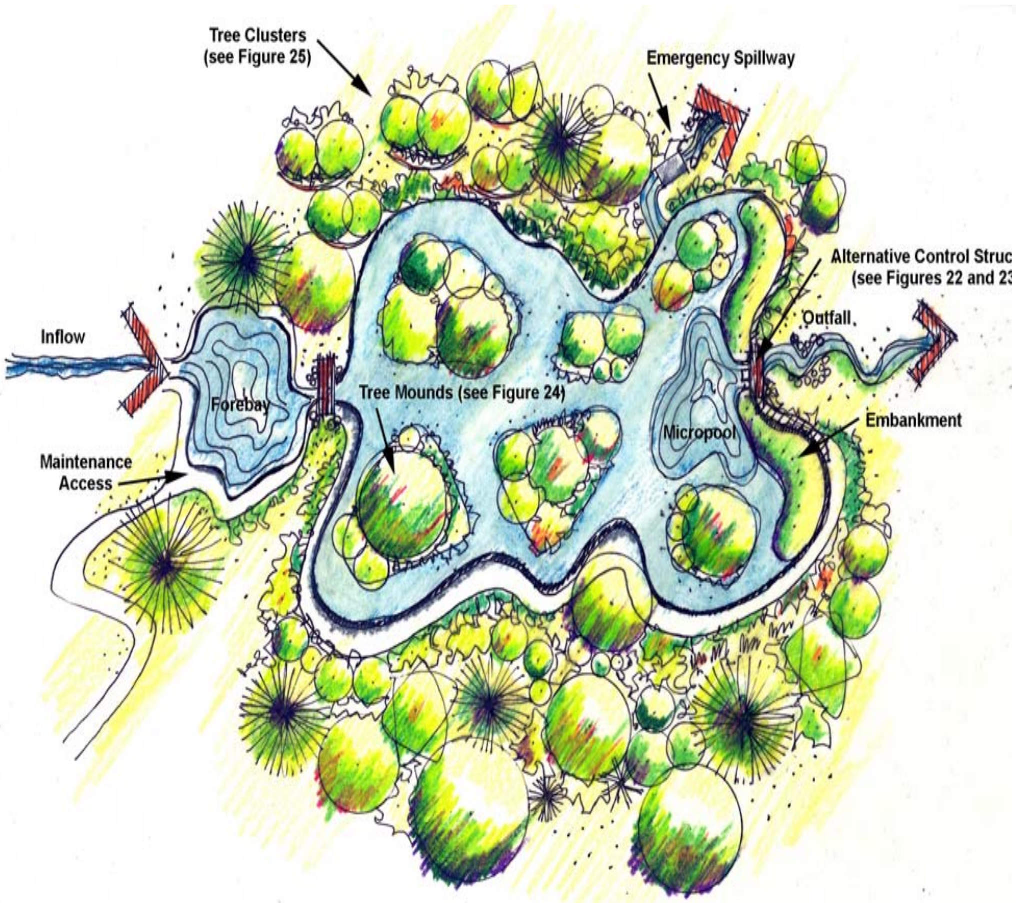
Really Cool Designs

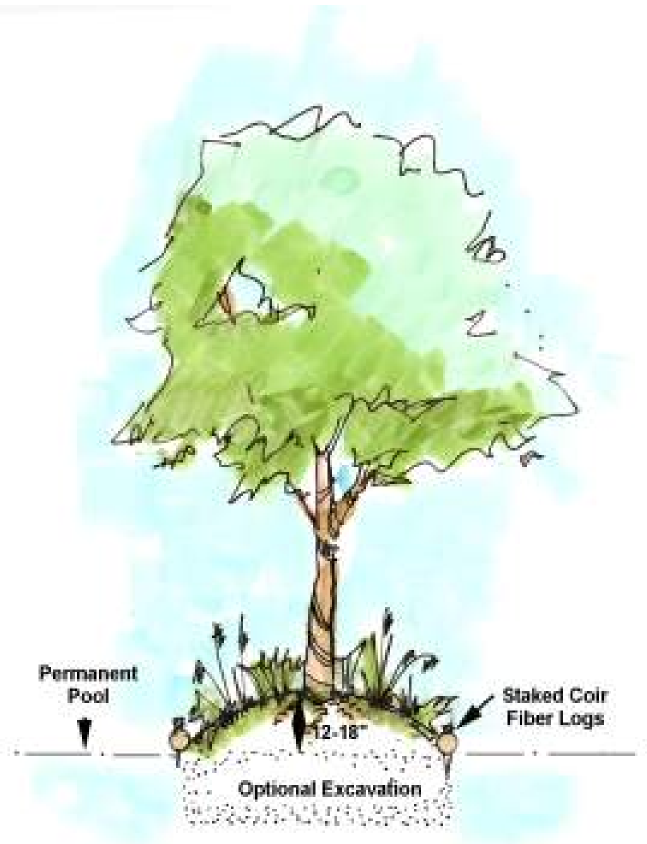
- Some designers have really worked to create effective and natural designs.
- Please vote for the nominee that really rates being termed a BEST management practice

Nominee No. 1: Longest flow path in pond ever seen

Nominee No. 2: Nice natural system

Nominee No. 3:
Freshwater emergent marsh

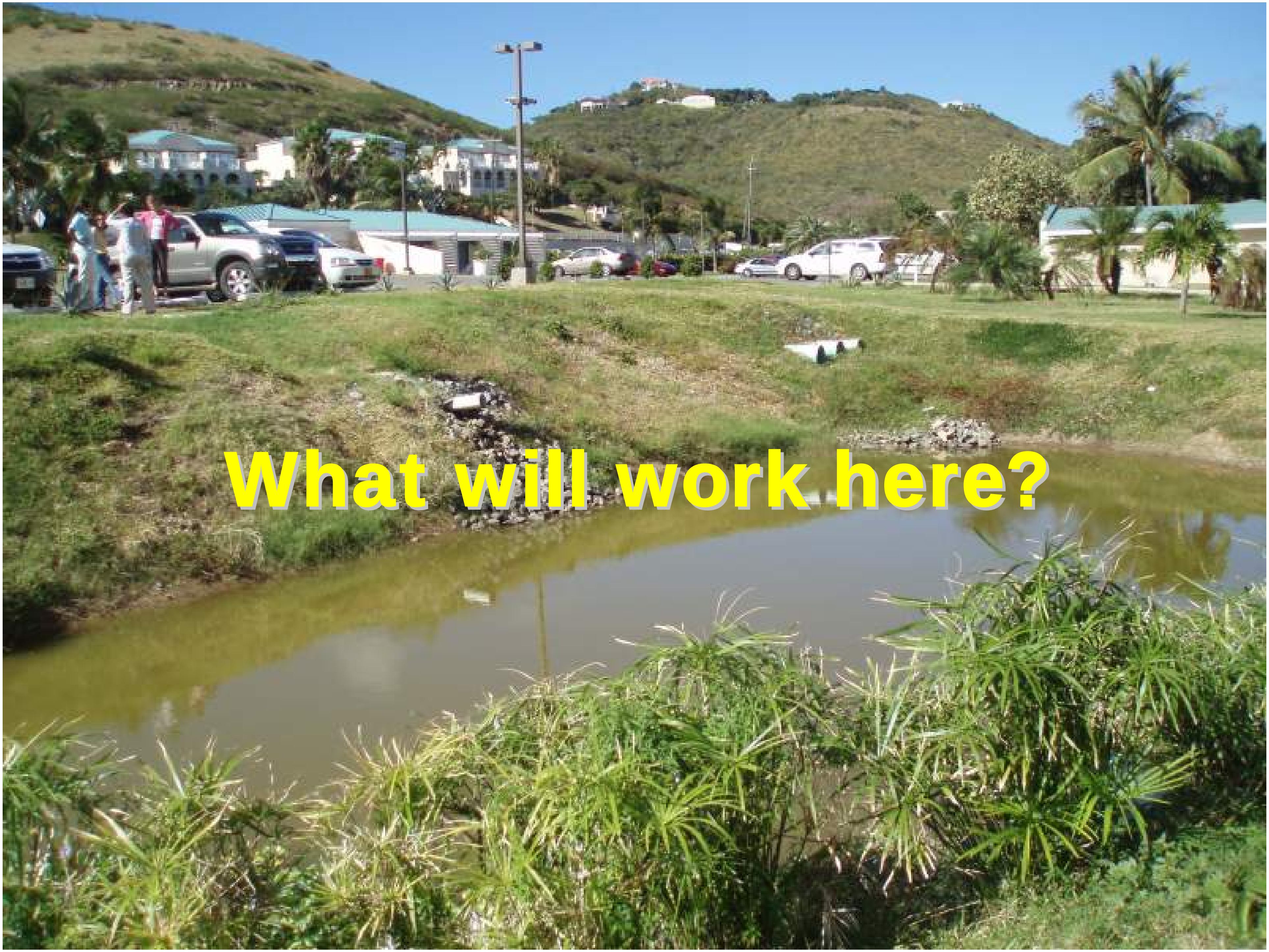




Wooded Wetland

Design Guidelines for Island Wetland Practices

- The forested wetland concept
- Greater range of depth zones above and below normal pool
- Don’t worry so much about startup planting – its just an initial framework
- Match pre-and post-project hydrology & groundwater at proposed site to plant types


What will work here?