Structural Storm Water Best Management Practices (BMPs)

What Are BMPs?

“BMPs are measures or practices used to reduce the amount of pollution entering surface waters, air, land or ground waters. They may take the form of a process, activity or physical structure. Some BMPs are simple and can be put into place immediately, while others are more complicated and require extensive planning.” Source: US EPA
How Are They Used?

- As temporary & permanent measures to remove pollutants from stormwater
- For compliance with construction & post-construction ordinances

What Are They Used For?

- To clean runoff before it reaches our nation’s waterways
- To control erosion, promote ground water infiltration & capture contaminants present in stormwater
- To comply with national, state, and local laws

How Are They Evaluated?

- Intended use
- Function
- Longevity
- Cost
- Flow capacity
- Maintenance requirements
- Pollutant removal efficiency
What Does NPDES Phase II Say About BMPs?

- "...implementation at small construction sites will also result in a significant reduction in pollution discharges and an improvement in surface water quality."
- "State program [general permit] submittals must identify BMPs..."
- "...MS4 is required to submit...the BMPs to be implemented..."
- "...permit requirements...will require implementation of BMPs."

Vegetation Stabilization

Vegetation removes pollutants from storm water through filtration

Seeding

- Purpose
  - Quick revegetation of disturbed site soil areas
  - Select appropriate seed mix
  - Evaluate soil's nutritional value and amend (if necessary)
- Traditional Solution
  - Seeding alone
- Improved Solution
  - Erosion control blankets (ECBs) reduce raindrop impact & hold seed in place
- Est. Cost: $2.00/SY

NAHB Reference: Pages 2-4
### Mulching

- **Purpose**
  - Provide seeds with optimum growth environment

- **Traditional Solution**
  - Blown straw or wood fiber mulch

- **Improved Solution**
  - ECBs retain heat & moisture to accelerate the growth of vegetation
  - Straw and/or coconut fibers degrade by the time vegetation is established

- Est. Cost: $2.00/SY

NAHB Reference: Pages 7-8

### Structural Controls

Intercept and convey storm water during or after construction

### Silt Fence

- **Purpose**
  - Slows down runoff & encourages settlement of suspended solids
  - Prevents storm water from transporting sediment off-site

- **Traditional Solution**
  - Hay bales

- **Current Solution**
  - Silt fence fabric attached to posts in factory or on-site
  - Wooden posts typically placed 6-10 feet apart

- **Improved Solution**
  - Since proper installation is critical, a machine-trenched process is preferred

- Est. Cost: $6.00/linear foot

NAHB Reference: Pages 16-17
Silt Dike

- **Purpose**
  - Reduces stormwater velocity in grassed swales
  - Functions very similar to a stone filter berm
  - Removes sediment & maintains laminar flow
- **Traditional Solution**
  - Hay bales or silt fence
- **Improved Solution**
  - Manufactured triangular silt dike with woven monofilament geotextile filter
- **Est. Cost:** $6.00/linear foot

Sediment Trap

- **Purpose**
  - A small, excavated pond in a low area on a site
  - Retains runoff long enough for sediment to settle out
- **Traditional Solution**
  - Woven monofilament geotextile filter beneath rock riprap
- **Improved Solution**
  - Fabricated geotextile filter bag
- **Est. Cost:** Varies

Sediment Basin

- **Purpose**
  - Functions as a small settling pond for sediment produced by construction activities
  - Receives & releases site runoff through grassed swales as quantities exceed capacity
- **Traditional Solution**
  - Pond lined with rock riprap
- **Improved Solution**
  - Basin slopes are seeded & protected with EGBs
- **Est. Costs:** $3,500/acre developed
Earth Dike/Diversions

- Purpose
  - Used to protect construction work areas from upslope runoff & diverts sediment-laden runoff to traps or outlets
- Traditional Solution
  - Rock riprap or concrete-lined channel
- Improved Solution
  - Compacted soil, seed mix and a turf reinforcement mat
- Est. Cost: $5-$15/SY

What Are Turf Reinforcement Mats (TRMs)

- Aesthetically pleasing, strong, stable matrix designed to hold seed & soil
- Permanently anchors grass system
- Comparable performance to rock riprap yet typically half the cost
- Extends the performance limits of vegetation
- Reduces sediment transport to enhance storm water quality

What the EPA Says about TRMs...

- "...combines vegetative growth & synthetic materials to form a high strength mat that helps prevent soil erosion in drainage areas..."
- "TRMs offer shear strength, resistance to ultraviolet (UV) degradation, and inertness to chemicals found in soils..."
- "TRMs enhance the natural ability of vegetation to permanently protect soil from erosion..."
- "By protecting the soil from scouring forces and enhancing vegetative growth, TRMs can raise the threshold of natural vegetation to withstand higher hydraulic forces..."
Storm Water Conveyance Channel

- **Purpose**
  - Convey storm water while resisting soil erosion
- **Traditional Solution**
  - Rock riprap or concrete paving
- **Improved Solution**
  - TRM and proper seed mix
  - Can handle short-term storm events up to 20 ft/sec
  - Removes suspended sediment from runoff
- **Est. Cost:** $5-$15/SY

NAHB Reference: Pages 26-27
Check Dams

- Purpose
  - Slow down runoff and remove suspended sediment during peak storm events
- Traditional Solution
  - Storm water flows through rock riprap or logs, depositing soil on the upstream face
  - Woven monofilament geotextile should be placed beneath riprap
- Improved Solution
  - Manufactured triangular silt dike with woven monofilament geotextile filter
  - Est. Cost: $6.00/linear foot

Standard Inlet Protection

- Purpose
  - Removes sediment from runoff before reaching storm drain system
- Traditional Solution
  - Silt fence barriers
  - Straw bale inlet barriers
  - Block/gravel drop inlet filters
- Improved Solution
  - Geotextile filter set inside the inlet
  - Est. Cost: $150/inlet

Curb Inlet Protection

- Purpose
  - Removes sediment from runoff before reaching storm drain system
- Traditional Solution
  - Block/gravel drop inlet curb filters
- Improved Solution
  - Formed around or across the curb inlet
  - Made from recycled, synthetic fibers that filter out sediment and debris
  - Built-in over flows drain water more quickly during an extreme event to prevent ponding
  - Est. Cost: $100/inlet

NAHB Reference: Pages 28-29
Outlet Protection
- **Purpose**
  - Provide smooth transition from pipe to open channel
  - Protect against undermining of structure
- **Traditional Solution**
  - Rock riprap or concrete pipe collars
- **Improved Solution**
  - Polymeric transition mat for energy dissipation and TRM for grass reinforcement
- **Est. Cost:** Up to $2,000/outlet

Subsurface Drain
- **Purpose**
  - Used to drain areas by lowering the ground water
- **Traditional Solution**
  - Perforated plastic pipe and drainage stone
- **Improved Solution**
  - Nonwoven geotextile filter, which prevents fine soils from clogging the drain, or
  - Panel-shaped, prefabricated drainage systems have geotextiles already attached
- **Est. Cost:** $2.00/linear foot

Reinforced Soil Retaining Systems
- **Purpose**
  - Holds soil permanently in place to allow for immediate grade changes on-site
- **Traditional Solution**
  - Cast-in place concrete
- **Improved Solution**
  - Interlocking masonry units & internal soil reinforcement
  - High strength woven geotextiles are the most cost-effective soil reinforcement available
- **Est. Cost:** $15.00/SF
Storm Water Permitting: Structural BMPs

Stabilized Construction Entrance

- **Purpose**
  - Funnels traffic to one entrance/exit
  - Gravel surface reduces soil tracked off-site
- **Traditional Solution**
  - Dumped stone
- **Improved Solution**
  - Geotextile placed beneath stone separates subgrade from expensive stone
  - Results in reduced site disturbance & increased roadway life
- **Est. Cost:** Up to $2,500/entrance

Porous Pavement

- **Purpose**
  - Promote groundwater recharge, reduce stormwater runoff & improve quality
- **Traditional Solution**
  - Porous concrete pavement
  - Polymeric cells or mats
- **Improved Solution**
  - Grassed, fiber-reinforced soil paving system, or
  - Grass shoulder stabilized with a high performance turf reinforcement mat for highway construction
- **Est. Cost:** $20.00/SY

Storm Water Management

Collect and/or convey storm water during or after construction

Presenter: Deron N. Austin, P.E.
Phone: 423-553-2728
Extended Detention (Dry) Pond

- **Purpose**
  - Used to collect stormwater during and/or after construction
  - Promotes groundwater recharge and settling of sediment
- **Traditional Solution**
  - Excavating or building an earthen berm around perimeter, lined with rock riprap or concrete
- **Improved Solution**
  - Slopes should be lined with a TRM and vegetation
- Est. Cost: $5-$15/SY

(Dewatering)

- **Purpose**
  - Involves pumping sediment-laden water out of areas not otherwise drainable
- **Traditional Solution**
  - Retention pond
  - Time & space always challenging
- **Improved Solution**
  - Attach pump line to a geotextile tube, which accelerates dewatering, confines the discharge & allows for easy disposal of remaining soil
  - Typically, decanted water can flow back into water bodies without further treatment
- Est. Cost: $35-50/linear foot

(Infiltration Basins & Drain Fields)

- **Purpose**
  - Promote groundwater recharge & reduce stormwater runoff
  - Typically constructed in urban areas and can handle a large volume of stormwater
- **Traditional Solution**
  - Perforated pipe manifold, drainage stone & nonwoven geotextile filter
  - Percolation path removes contaminants from the storm water
- **Improved Solution**
  - Modular system for custom dimensions and efficient use of space

NAHB Reference: Pages 47-49

NAHB Reference: Pages 53-55
Vegetated Swale

- Purpose
  - Designed to remove storm water pollutants through filtration characteristics of vegetation
- Traditional Solution
  - Properly selected seed mix or sod can only handle up to 5-6 ft/sec velocity
- Improved Solution
  - Use of an ECB or TRM for faster vegetation establishment and extended performance
- Est. Cost: $5-$15/SY

Typical Pollutant Removal Efficiencies of Grassed Swales

- EPA sponsored studies have shown that grassed swales are most effective at removing particulate pollutants
- A conservative estimate is 25-50% removal, but 70-95% has been achieved on most sites

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<tr>
<th>Pollutant</th>
<th>Median % Removal</th>
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<tr>
<td>Total Suspended Solids</td>
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<tr>
<td>Copper-Containing Substances</td>
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<td>Arsenic</td>
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<td>Total Phosphorus</td>
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<td>Copper</td>
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<tr>
<td>Lead</td>
<td>67</td>
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<tr>
<td>All</td>
<td>71</td>
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</table>

Methods Used to Enhance Pollutant Removal

- Moderate bed slopes
- Permeable soils
- Dense vegetative cover
- Increased contact time (i.e. slower flow velocity)
  - Stone filter berms (i.e., rock "check dams")
- All methods reduce runoff and removes suspended sediment during peak storm events
- What would be the benefit of establishing vegetation faster?
Reinforced Grassed Swales Achieve Water Quality Performance Faster

- Less time to achieve full water quality performance.
- Sediment removal from unvegetated TRM.

Hydraulic Limits of Grassed Swales
- Consists of “unreinforced” vegetation and subsoil.
- Storm water discharges can erode vegetation and actually increase contaminant transport.
- Hydraulic performance limits of mature vegetation:
  - 5-6 ft/sec velocity
  - 1-2 psf shear stress
- Turf reinforcement mats allow vegetated swales to feature flow resistances of:
  - Up to 20 ft/sec velocity
  - Up to 12 psf shear stress

Features of Reinforced Grassed Swales
- Aesthetically pleasing and easy to install.
- An open, three-dimensional structure captures sediment before vegetation is established.
- The TRM works in conjunction with vegetation:
  - Provides a “mulching” effect that accelerates the establishment of vegetation.
  - Permanently anchors vegetation to extend its hydraulic performance limits.
- Comparable performance to rock riprap yet typically half the cost.

Cost Per Square Yard - In Place

- Turf Reinforcement Mat $5-$15
- Rip Rap $25-$60
- Concrete Lining $40-$80
Other Structural BMPs

- There are many other improved and innovative manufactured BMPs on the market including:
  - In-line hydrodynamic devices
  - Oil/water separators
  - Polycrylimides
  - Many others!

Conclusions

- The law states that all general stormwater permits & construction plans must describe the exact BMPs to be employed
- Vegetation improves aesthetics, pollutant removal rates, and reduces the costs of stormwater BMPs
- Rolled erosion control products and geotextiles increase the performance of vegetation, soil, and other materials used to construct structural BMPs

Additional Information: General

- Construction Industry Compliance Assistance, http://www.cicacenter.org/or-stormwater.html#bmp
- ACF Environmental, www.acfenvironmental.com
Additional Information:
Grassed Swales


Thank You for Your Time!