Rhode Island Stormwater Design and Installations Standards Manual

Public Workshop
BMP Design - Critical Elements
March 22, 2011

Presentation Outline

• Water Quality
• Pretreatment
• Storage

Minimum Design Criteria

• Required Elements and Design Guidance
  - If required elements can't be met, select a different BMP
• Six Categories
  - Feasibility
  - Conveyance
  - Pretreatment
  - Treatment
  - Landscaping
  - Maintenance
Section 5.2: Wet Vegetated Treatment Systems

**WVTS: Design Notes**

- Shall not be located within jurisdictional waters, except may be allowed in previously developed upland buffers
- Restricted in cold-water fisheries watersheds
  - Discharges prohibited w/in 200 ft of jurisdictional waters
  - Beyond 200 ft, discharge up to the CP, through an underdrained gravel trench outlet
- LUHPPL runoff requires a 3-ft separation to gw, no separation distance required for non-LUHPPL runoff
- Permanent pool volumes shall not be included in storage calcs for peak flow management (CP/Qp)

**Approved WQ BMPs**

- Min flowpath of 2:1 (length to width)
- High surface area to volume ratio
  - Pretreatment (10% of WQv)
  - Deepwater zones (25% of WQv)
  - Remaining 65% WQv combination of shallow pool and ED
- Shallow depths over most of surface area
  - 35% 6 inches or less
  - 65% 18 inches or less
- Complex internal microtopography, including aquatic benches
- Plant with emergent vegetation
- Consumes most land of any BMP
  - 1.5% of DA
Example - Chepachet, RI

Horsley Witten Group, Inc.

**WET VEGETATED TREATMENT SYSTEM CALCULATIONS**

<table>
<thead>
<tr>
<th>REQUIRED</th>
<th>PROVIDED</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRAINAGE AREAS AND WATER QUALITY VOLUME</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL CONTRIBUTING DRAINAGE AREA (10 Ac. MIN.)</td>
<td>n/a</td>
<td>439,520 sf</td>
</tr>
<tr>
<td>n/a</td>
<td>10.1 acres</td>
<td></td>
</tr>
<tr>
<td>TOTAL IMPERVIOUS AREA (Chepachet MA)</td>
<td>n/a</td>
<td>95,300 sf</td>
</tr>
<tr>
<td>n/a</td>
<td>1.5 acres</td>
<td></td>
</tr>
<tr>
<td>TOTAL IMPERVIOUS AREA (RIDOT System Per Commonwealth)</td>
<td>n/a</td>
<td>190,800 sf</td>
</tr>
<tr>
<td>n/a</td>
<td>4.4 acres</td>
<td></td>
</tr>
<tr>
<td>TOTAL IMPERVIOUS AREA</td>
<td>n/a</td>
<td>256,100 sf</td>
</tr>
<tr>
<td>n/a</td>
<td>5.9 acres</td>
<td></td>
</tr>
<tr>
<td>RUNOFF DEPTH FOR WATER QUALITY VOLUME (WQv)</td>
<td>1.00</td>
<td>1.00 in</td>
</tr>
<tr>
<td>TREATMENT VOLUME REQUIRED (WQv)</td>
<td>0.93</td>
<td>ac-ft</td>
</tr>
<tr>
<td>21,342</td>
<td>ft</td>
<td></td>
</tr>
<tr>
<td>PRETREATMENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEDIMENT FOREBAY (10% OF WQv)</td>
<td>2,134</td>
<td>4,499 ft</td>
</tr>
<tr>
<td>0.05</td>
<td>0.10 ac-ft</td>
<td></td>
</tr>
</tbody>
</table>

**TREATMENT**

| MIN. SURFACE AREA OF WVTS (1.5% of Drainage area) | 6,583 | 5,870 sf |
| 0.15 | 0.20 acres |
| DEEPWATER ZONE VOLUME (25% of WQv) | 5,135 | 5,988 ft |
| 0.22 | 0.34 ac-ft |
| HIGH MARSH AREA - 0"-6" DEPTH (55% of total surface area) | 2,307 | 3,373 sf |
| 0.05 | 0.08 acres |
| TOTAL MARSH AREA - 0"-18" DEPTH (85% of Total Surface Area) | 4,285 | 6,097 sf |
| 0.10 | 0.14 acres |

**GEOMETRY**

| LENGTH | 185 ft |
| WIDTH (average) | 45 ft |
| WIDTH (maximum) | 80 ft |
| RATIO (average) | 2 to 1 |
| RATIO (maximum) | 2 to 1 |

**CHANNEL PROTECTION VOLUME (CPV)**

| RUNOFF VOLUME FROM 1-YR, 24-HR, TYPE II STORM (Vr) | 11,609 | 13,565 ft |
| CPV (Vr x W) | 11,609 | 13,565 ft |
| LENGTH OF UNDERDRAINED GRAVEL TRENCH | 36 ft |
Gravel WVTS: Design Notes

- Min. length-to-width ratio 1:1, min. flowpath (L) of 15 ft
- Pretreatment: 10% WQv
- Remaining 90%, a combination of one or more basins/chambers filled with gravel and open ED
- Outlet invert just below gravel surface
- Surface area must be minimum 0.35% of DA
- May use organic soil
- Plant with emergent vegetation

Section 5.3: Infiltration

- Field verification of soil permeability/texture essential
- Pretreatment essential - minimum 25% of WQv
- Bottom of infiltration facility cannot be located in fill*, must have 3’ separation from gw and bedrock*
- Size based on design infiltration rates (Table 5-3)
- Guidance: Keep drainage areas to each practice small, may reduce some potential problems
- Reduced requirements for residential areas (2’)

Table 5-3: Design Infiltration Rates for Different Soil Textures (Rawls et al., 1982)

<table>
<thead>
<tr>
<th>USDA Soil Texture</th>
<th>Design Infiltration Rate (I) (in/day)</th>
<th>Design Infiltration Rate (I) (in/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sand</td>
<td>8.27</td>
<td>0.0115</td>
</tr>
<tr>
<td>Loamy Sands</td>
<td>3.41</td>
<td>0.0053</td>
</tr>
<tr>
<td>Sandy Loam</td>
<td>1.02</td>
<td>0.0014</td>
</tr>
<tr>
<td>Loam</td>
<td>0.52</td>
<td>0.0007</td>
</tr>
<tr>
<td>Silt Loam</td>
<td>0.27</td>
<td>0.0004</td>
</tr>
</tbody>
</table>
Design Notes (cont’d)

- Cannot be used if contributing drainage is a LUHPPL
- Higher maintenance burden
- Stabilize site prior to installation
- Must meet variety of setbacks* (Table 5-2)
- May be used for larger storm events if infiltration rate > 8.3 in/hr**, mounding analysis may be required

- Reduced requirements for small-scale BMPs in residential (res.) areas

** 100% WQv treatment required by separate BMP in these areas

Sample Calculations

The Sunshine Market is a hypothetical commercial development consisting of a fish and produce market. It is located in Charlestown, RI and discharges to Green Hill Pond. On-site soils are Windsor loamy sand (HSG “A”).

Total Disturbed Area = 3.0 ac
Impervious Area = 1.56 ac

1. Compute required Re based on A soils and Sect 3.3.2
   \[ Re = \left( \frac{1''}{F} \right) I ] / 12 \]
   \[ Re = \left( \frac{1''}{0.6''} \right) (1.56 \text{ ac}) (1 \text{ ft}/12 \text{ in}) \]
   \[ = 0.08 \text{ ac-ft} = ~3,500 \text{ cf} \]

2. Compute WQv
   \[ WQv = \left( \frac{1''}{I} \right) \]
   \[ WQv = \left( \frac{1''}{1.56 \text{ ac}} \right) (1 \text{ ft}/12 \text{ in}) \]
   \[ = 0.13 \text{ ac-ft} = ~5,700 \text{ cf} \]

3. Required Volume Calculations
   \[ \text{Min. WQ} = \left( \frac{0.2''}{DA} \right) / 12 \]
   \[ \text{Min. WQ} = \left( \frac{0.2''}{3.0 \text{ ac}} \right) (1 \text{ ft}/12 \text{ in}) \]
   \[ = 0.05 \text{ ac-ft} = ~2,200 \text{ cf} \]

   Cp, and Q, are waived since site discharges to coastal waters with tide effects

* Reduced requirements for small-scale BMPs in res. areas

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Approved WQ BMPs

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** 100% WQv treatment required by separate BMP in these areas

Approved WQ BMPs
### Site Data

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil</td>
<td>Loamy Sand</td>
</tr>
<tr>
<td>Ground Elevation at BMP</td>
<td>20'</td>
</tr>
<tr>
<td>Seasonal High Groundwater</td>
<td>9'</td>
</tr>
<tr>
<td>Soil slopes</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

### Infiltration Chambers Design

### Design Criteria for Infiltration Chambers

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infiltration rate ($f_c$) greater than or equal to 0.5 inches/hour.</td>
<td>Design infiltration rate is 2.41 inches/hour. OK.</td>
</tr>
<tr>
<td>Soils have a clay content of less than 20% and a silt/clay content of less than 60%.</td>
<td>Loamy sand meets both criteria.</td>
</tr>
<tr>
<td>Infiltration cannot be located in fill soils.</td>
<td>Not fill soils. OK.</td>
</tr>
<tr>
<td>Hotspot runoff shall not be infiltrated.</td>
<td>Not a hotspot land use. OK.</td>
</tr>
</tbody>
</table>
**Design Criteria, cont’d**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>The bottom of the infiltration facility must be separated by at least 3 feet vertically from the SHGT.</td>
<td>Elevation of seasonally high water table: 9’ Elevation of BMP location: 20’. The difference is 11’. Thus, the facility can be up to 8’ deep. OK.</td>
</tr>
<tr>
<td>Infiltration facilities must be located 50 feet horizontally from coastal features.</td>
<td>Chamber &gt;50’ from all coastal features. OK.</td>
</tr>
<tr>
<td>Maximum contributing area generally 5 acres or less.</td>
<td>Area draining to facility is &lt; 5 acres. OK.</td>
</tr>
<tr>
<td>Setback 25 feet down-gradient from structures.</td>
<td>Chamber edge &gt;25’ from all structures. OK.</td>
</tr>
</tbody>
</table>

**Cross-section Views of Chambers**

**Sizing Equation for Infiltration Chambers**

Infiltration chambers can generally be sized by the equation below:

\[ V = L \times \left[ (w \times d \times n) - (# \times A_c \times n) + (# \times A_c) + (w \times f_c \times T / 12) \right] \]

Where:
- \( V \) = design volume (e.g., WQv) (cf)
- \( L \) = Length of infiltration facility (ft)
- \( w \) = Width of infiltration facility (ft)
- \( d \) = Depth of infiltration facility (ft)
- \( n \) = Number of rows of chambers
- \( # \) = Number of chambers
- \( A_c \) = Cross-sectional area of chamber
- \( f_c \) = Design infiltration rate (in/hour)
- \( T \) = Fill time in hrs
Solve for Length of Facility

Assume that:

- \( n = 0.33 \)
- \( d = 4 \) feet
- \( f = 2.41 \) inch/hour (Table 5.2)
- \( T = 2 \) hours (use default value unless site-specific data exists)
- \( A_c = 3.5 \) sf (supplied by manufacturer)
- \( s = 15 \) ft / 3.25 ft (supplied by manufacturer) = 4.6, only 4 rows can fit

Solve for length given that we have 15' of width that we want to use at our site.

Therefore:

\[
L = \frac{5,700 \text{ ft}^3}{[(15*4 \times 0.33)−(4*3.5 \text{ ft}^2 \times 0.33)+(4*3.5 \text{ ft}^2)+(15*2.41 \text{ in/hr} \times 2 \text{ hr/12})]}
\]

\[
L = \frac{5,700 \text{ ft}^3}{[(19.8 \text{ ft}^2)−(4.6 \text{ ft}^2)+(14 \text{ ft}^2)+(6.0 \text{ ft}^2)]}
\]

\[
L = 162 \text{ ft}
\]

Final Sizing

Add one foot to each end to give room for a stone buffer (more or less depending on manufacturer's specifications).

Facility dimensions will be 15' x 164'.

Check to ensure that there is sufficient room for the infiltration chamber facility alongside proposed parking lot. The proposed parking lot is 200 ft long, Ok.

Section 5.3: Permeable Paving

Two main categories:

- Porous asphalt and pervious concrete
- Pavers
  1. Permeable solid blocks (min. void ratio 15%) or reinforced turf
  2. Solid blocks with open-cell joints > 15% of surface
  3. Solid blocks with open-cell joints < 15% of surface with 1” surface storage
Permeable Pavements - Design Notes

• May be used as infiltration and/or detention system
• For infiltrating practices:
  - Field verification of soil permeability/texture essential
  - Bottom of facility cannot be located in fill and must have 3' separation from gw and bedrock*
  - Size based on design infiltration rates (Table 5-3)
  - Cannot be used if contributing drainage is a LUMPPL
  - Must meet variety of setbacks (Table 5-4)
• Frequent maintenance necessary to retain permeability (vacuum)
• Use on low traffic/speed areas with gentle slopes (<5%)
• Generally not designed to accept runoff from other areas
* Reduced requirements for resid. areas

Approved WQ BMPs

Section 5.5: Filtering Practices

• Sand/organic filters
• Bioretention areas/Tree filters

Filter Sizing Equation

\[ A_f = \frac{(WQ_v) (d_f)}{[(k) (h_f + d_f) (t_f)]} \]

- \( A_f \): surface area of filter bed (ft^2)
- \( d_f \): filter bed depth (ft)
- \( k \): coef of permeability of filter media (ft/day)
- \( h_f \): average height of water above filter bed (ft)
- \( t_f \): design filter bed drain time (days) (2 days is recommended)
Sand/Organic Filter: Design Notes

- Pretreatment essential (25% WQv)
- Sized for temporarily holding at least 75% of WQv, including pretreatment
- Minimum depth of 18" (12" allowed in some instances)
- Use conservative permeability coeff. (3.5 ft/day for sand, 2 ft/day for peat, and 8.7 ft/day for leaf compost)
- Need maintenance access to filter bed
- Useful to treat LUHPPL runoff

Bioretention: Design Notes

- Pretreatment essential (25% WQv)
- Sized for temporarily holding at least 75% of WQv, including pretreatment
- 6"-9" ponding above surface
- Typically, 2'-4' planting soil bed (12" allowed in some instances)
- Specific engineered soil media
- Use a conservative permeability coefficient
- Detailed landscape plan

Bio Planting Soil and Mulch

- Loamy Sand to a Sandy Loam
  - 85-88 % sand
  - 8-12 % silt
  - 0-2 % clay
  - 3 to 5 % organic matter
- Add well-aged, well-aerated leaf compost (20% by volume) for bios with shallow media depths (<2')
- Layer of well-aged, shredded hardwood mulch
Capitol Beach Shopping Center is a hypothetical proposed development with a restaurant and bank. It is located in downtown Providence and discharges to the Providence River.

Bio - Sample Calculations

Total Drainage Area (A) = 0.5 ac
Impervious Area = 0.44 ac

Site Specific Data:
- Site discharges to a large river (i.e., 4th-order or larger stream);
- On-site soils are “Paxton-Urban land Complex” (HSG C);
- Existing low point elevation at practice location is 10.0 ft; and
- Soil boring observations show seasonal high groundwater table at 2.0 ft.
Required Volume Calculations

- Compute required Re_v based on C Soils and Sect. 3.3.2
  \[ Re_v = \frac{(1\text{"})(F)(I)}{12} \]
  \[ = \frac{(0.25\text{"})(0.44\text{ ac}) (1\text{ft/12in})}{12} \]
  \[ = 0.009\text{ ac-ft} = 390\text{ cf} \]

- Compute WQ_v
  \[ WQ_v = \frac{(1\text{"})(I)}{12} \]
  \[ = \frac{(1\text{"})(0.44\text{ ac}) (1\text{ft/12in})}{12} \]
  \[ = 0.037\text{ ac-ft} = 1,610\text{ cf} \]

- Cp_v and Q_v are waived since site discharges to a large river
- Bioretention will be designed without an impermeable liner to allow for infiltration.

Bioretention Sizing Equation

Use sizing equation and values provided in Section 5.5.4:

\[ A_f = \frac{(WQ_v)(d_f)}{[(k)(h_f + d_f)(t_f)]} \]

- \( A_f \) = surface area of filter bed (ft²)
- \( d_f \) = filter bed depth (ft) (2-4 ft, depending on site constraints)
- \( k \) = coef of permeability of filter media (1 ft/day)
- \( h_f \) = ave. ht of water above filter bed (ft) (1/2 of ponding depth)
- \( t_f \) = design filter bed drain time (days) (2 days recom.)

\[ A_f = \frac{(1,610\text{ ft}^3)(4')}{[(1'/\text{day})(0.25' + 4')(2\text{ days})]} \]

(With \( d_f = 4' \), \( k = 1.0'/\text{day}, h_f = 0.25', t_f = 2\text{ days} \))

\[ A_f = 760\text{ sq ft} \]
**Final Sizing**

- Use width = 10’.
- Given a surface area requirement of 760 sq ft

Facility dimensions will be **10’ x 76’**.

- Check to ensure that there is sufficient room for the bioretention inside parking lot island. The proposed island is 115 ft long, **Ok**.

**Cross-section of Bioretention**

Set top of facility at 10’, with the top of berm at 11’. The facility is 5’ deep from rim to bottom of planting area, which will allow 3’ of clearance above the SHGT.

**Section 5.6: Green Roofs**

**Design Notes**

- Designed to manage WQv without bypass
- Safely convey runoff from larger storm events to a downstream drainage system
- No pretreatment required
Section 5.7: Open Channels

- Pretreatment: 10% WQv
- Use filter sizing equation
- \(2 \text{ ft} \leq \text{Bottom Width} \leq 8 \text{ ft}\)
- Minimum 30" engineered bio soil (12" allowed in some instances)
- Maximum 12" deep average surface ponding depth
- Select the most appropriate native seed mix for expected swale conditions (Appendix B)
- Do not use on slopes greater than 4% w/o cells or checkdams
- Erosion control fabric for steeper grades
- May need some topsoil, fertilization, and irrigation to get grass established

Dry Swale: Design Notes

- Approved WQ BMPs
Wet Swale: Design Notes

- Constructed in groundwater
- Pretreatment: 10% WQv
- Permanent pool may be included in WQv calculations
- 2 ft ≤ Bottom Width ≤ 8 ft
- Generally, <1% slope
- Planted with emergent vegetation (Appendix B)

Practices Approved for Other Criteria

- Pretreatment Practices
  - Chapter 6
    - Grass Channel
    - Filter Strips
    - Sediment Forebay
    - Deep Sump Catch Basins
    - Proprietary Devices

- Storage Practices - Chapter 7
  - Stormwater Basins
  - Underground Storage Devices
  - Infil. for Recharge/Storage

Ch 3
- Pretreatment Standards

Ch 5
- Approved BMPs for WQ Treatment
  - WWTS, Infiltration, filters, green roofs, channels
    - Design requirements
    - Recommended design guidance

Ch 6
- Pretreatment Practices
  - Cannot be used alone to meet WQ
  - Grass channels, filter strips, sediment forebay, deep sump catch basins, proprietary devices
Stormwater Standards

Standard 3

“...Pretreatment is required for water quality treatment practices where specified in the design guidelines within Chapter Five...”

BMP Pretreatment Requirements

<table>
<thead>
<tr>
<th>BMP Group</th>
<th>Required SWQ</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>WVTS</td>
<td>10%</td>
<td>Provided at each inlet, unless inlet provides &lt;10% of inflow</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Grass channel, filter strip, sediment forebay, proprietary device</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Deep sump catch basin combined with one of the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Upper sand layer; or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Washed pea gravel (1/8” to 3/8”)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not required for permeable pavements (unless there is “run-on”) or</td>
</tr>
<tr>
<td></td>
<td></td>
<td>drywells</td>
</tr>
<tr>
<td>Infiltration</td>
<td>25%</td>
<td>• Deep sump catch basins may not be used as sole pretreatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Grass channel, filter strip, sediment forebay, proprietary device</td>
</tr>
<tr>
<td></td>
<td></td>
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</tr>
<tr>
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<tr>
<td></td>
<td></td>
<td>drywells</td>
</tr>
<tr>
<td>Filtering</td>
<td>25%</td>
<td>• Deep sump catch basins may not be used as sole pretreatment.</td>
</tr>
<tr>
<td>Practices</td>
<td></td>
<td>• Deep sump catch basins may not be used as sole pretreatment.</td>
</tr>
<tr>
<td>Green Roofs</td>
<td>Not Applicable</td>
<td>No pretreatment required for direct rainfall.</td>
</tr>
<tr>
<td>Open Channels</td>
<td>10%</td>
<td>• Forebays/checkdams at pipe inlets and/or driveway crossings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Filter strip</td>
</tr>
</tbody>
</table>

Grass Channels

* Gentle side slopes and dense vegetation can increase pretreatment
**Filter Strip**

*Must be catch-basin-to-manhole configuration to count as pretreatment*

**Table 6-1 Guidelines for Filter Strip Pretreatment Sizing**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Impervious Parking Lots</th>
<th>Residential Lawns</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Inflow Approach Length (ft)</td>
<td>35 75 75 150</td>
<td></td>
</tr>
<tr>
<td>Filter Strip Slope (%)</td>
<td>&lt;2 &lt;2 &lt;2 &lt;2</td>
<td>&lt;2 &lt;2 &lt;2 &lt;2</td>
</tr>
<tr>
<td>Filter Strip Minimum Length (ft)</td>
<td>10 15 20 25</td>
<td>10 12 16 18</td>
</tr>
</tbody>
</table>

---

**Sediment Forebay**

---

**Deep Sump Catch Basin**

---
Proprietary Devices

- Must have third-party verified 25% TSS removal rate
- Flow-thru devices must be designed to handle entire WQ
- Must be designed as off-line (or have internal bypass) to allow large flows to bypass system
- Oil/grit separators great for LUHPPLs

WVTS: Shallow WVTS

Figure 5-1 Shallow WVTS

WVTS: Gravel WVTS

Figure 5-2 Gravel WVTS – Alternative 1
Filters: Bioretention

Open Channels

No pretreatment required

- Filters: Green roofs
- Infiltration: Permeable Pavers (unless there is "run-on")
- Infiltration: Dry Wells

Approved WQ BMPs
**Storage**

**Ch 3**

- Quantity Standards

**Ch 7**

- Storage Practices
  - Cannot be used alone to meet WQ
  - Stormwater basins, underground storage facilities, and high-rate infiltration for recharge/storage only

---

**Stormwater Basins**

- Min. DA of 25 acres for wet basins, unless in gw
- Permanent pool not included in storage calcs
- Cold-water fishery restrictions

---

**Enhanced Treatment**

- To use basins for additional pollutant loading reduction, must design according to info on pg. 7-4
**Underground Storage Devices**

- Max. DA generally 25 acres
- Sufficient access points shall be provided
- No cold-water fishery restrictions

---

**Infiltration (Recharge/Storage Only)**

- Sites with infiltration rates >8.3 in/hr
- Mounding analysis may be required
- May be constructed in suitable fill

---

**Mounding Analysis**

- When is it required?
  - Infiltration of stormwater (except for residential rooftops ≤ 1,000sf) AND
  - Separation to SHGT < 4' AND
  - On-line practice accepting runoff from the 10-year storm event and greater
- What does it tell us?
  - Feasibility of proposed BMP
  - Effect on nearby structures, OWTs, etc.
- How is it done?
  - Hantush Method or equivalent
Storage BMPs

Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basins

Scientific Investigations Report 2010–5102

Figure 6. Schematic diagram showing relative shape of groundwater mounding in aquifers of higher and lower soil permeability.

Questions?