RI Stormwater Design and Installation Standards Manual

Introduction to Revised Manual

Objectives of this Workshop

- Review key changes from May 2009 Public Review Draft Manual
- Obtain feedback
- Answer questions
- Last opportunity to substantially modify manual wording prior to formal process

Activities since May 2009 Draft

- Addressed written and oral comments: 283 in total
- Conducted workshop for municipal officials, planners, DPW directors, and NGOs
- Held 3 open work sessions with the Rhode Island Builders Association
- Held 2 work sessions with RIDOT officials
- Convened meeting with Statewide Planning Office
- Evaluated stormwater manual BMPs to a project pursuant to declaratory ruling request

Origin of Changes

- Response to comments
- Further analysis of policies and standards
- Completion of unfinished portions of manual
- Declaratory ruling request

Agenda

8:55 Overview of Changes from the 2009 Draft

Rich Claytor, Horsley Witten Group

9:30 Manual Review by Chapter with Q & A

- **Chapters 1 & 2 - Intro and Stormwater Impacts**

  Russ Chateauneuf, RIDEM

- **Chapter 3 – Standards and Performance Criteria**

Eric Beck, RIDEM

- **Chapter 4 – LID Site Planning and Design**

Scott Millar, RIDEM

10:15 Break

Agenda (cont'd)

10:30 Manual Review by Chapter with Q & A (cont'd)

- **Chapter 5 – Water Quality Treatment BMPs**

Rich Claytor, Horsley Witten Group

- **Chapter 6 & 7 – Pretreatment and Storage**

Russ Chateauneuf, RIDEM

- **Appendix A,** *Jim Boyd, CRMC*; **App. D,** *Rich Claytor*; **App. H,** *Russ Chateauneuf*

11:45 Summary, Next Steps, and Discussion

Russ Chateauneuf, RI DEM

12:00 Adjourn

RI Stormwater Design and Installation Standards Manual

Overview of Changes since the 2009 Public Review Draft

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Major Content Changes

Chapter 1

- Added the entire language from the "Cleaner Bay Act of 2007" to Chapter 1;
- Applicability section revised/clarified;
- 11 Stormwater Standards (Removed Standard 12 "Stormwater Management Plan" moved to "Overview" in Chapter 3);

Chapter 2

- No major changes

Major Content Changes

Chapter 3

- Presumption of compliance with Water Quality Standards stated (with exceptions);
- 1-year precipitation values updated;
- Recharge required within same subwatershed
- Water Quality Standard 3 language revised to clarify intent;
- Added reference to Appendix H: requirements for pollutant loading analysis;

Updated Precipitation Values

RI Region	24-hour (Type III) Rainfall Amount (inches)						
	1-Year*	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year
Northern: Providence County	**3.1** ***2.7***	**3.4** ***3.3***	**4.2** ***4.2***	**5.0** ***4.8***	**6.2** ***5.6***	**7.5** ***6.2***	**8.9** ***7.0***
Eastern: Newport & Bristol Counties	**3.2** ***2.7***	**3.4** ***3.4***	**4.3** ***4.3***	**5.1** ***4.9***	**6.3** ***5.7***	**7.6** ***6.3***	**9.1** ***7.1***
Southern: Kent & Washington Counties	**3.2** ***2.7***	**3.5** ***3.4***	**4.4** ***4.4***	**5.2** ***5.0***	**6.4** ***5.8***	**7.7** ***6.4***	**9.3** ***7.2***

Major Content Changes (continued)

- Water budget analysis required for projects proposing significant dewatering;
- Added "Infill" projects and definition to Standard 6, referenced in Std's 2 & 3;
- Added an option for redevelopment projects to achieved equivalent pollutant removal;
- Provided an option for sediment control trapping devices per the RI ESC Handbook;
- Clarification of water quality treatment requirements for pervious areas;

Major Content Changes
(continued)

- Clarified "green roofs" as a separate category of BMP;
- Clarified the method for computing peak flow rate for WQ_v;
- Clarified the method for computing CP_v (added the short-cut method);
- Modification to the hydrologic criteria for Q_p and clarification of limits for doing a Downstream Analysis;

Major Content Changes

Chapter 4

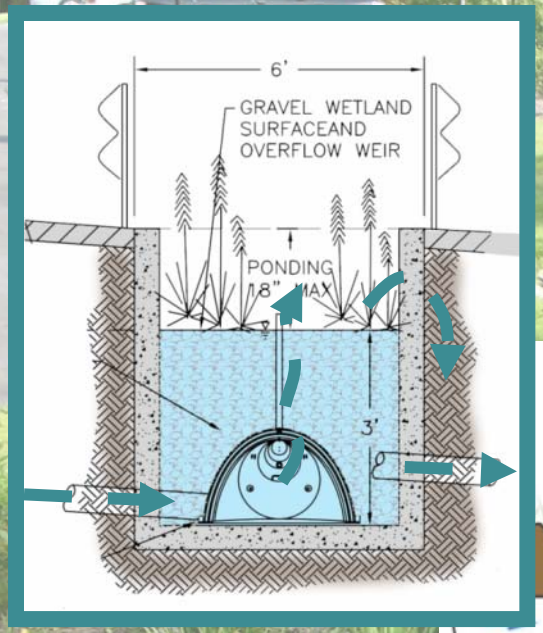
- Clarified the type of lawns as meeting qualifying pervious area requirement; and
- Clarification on the required professional credentials for soils evaluation.

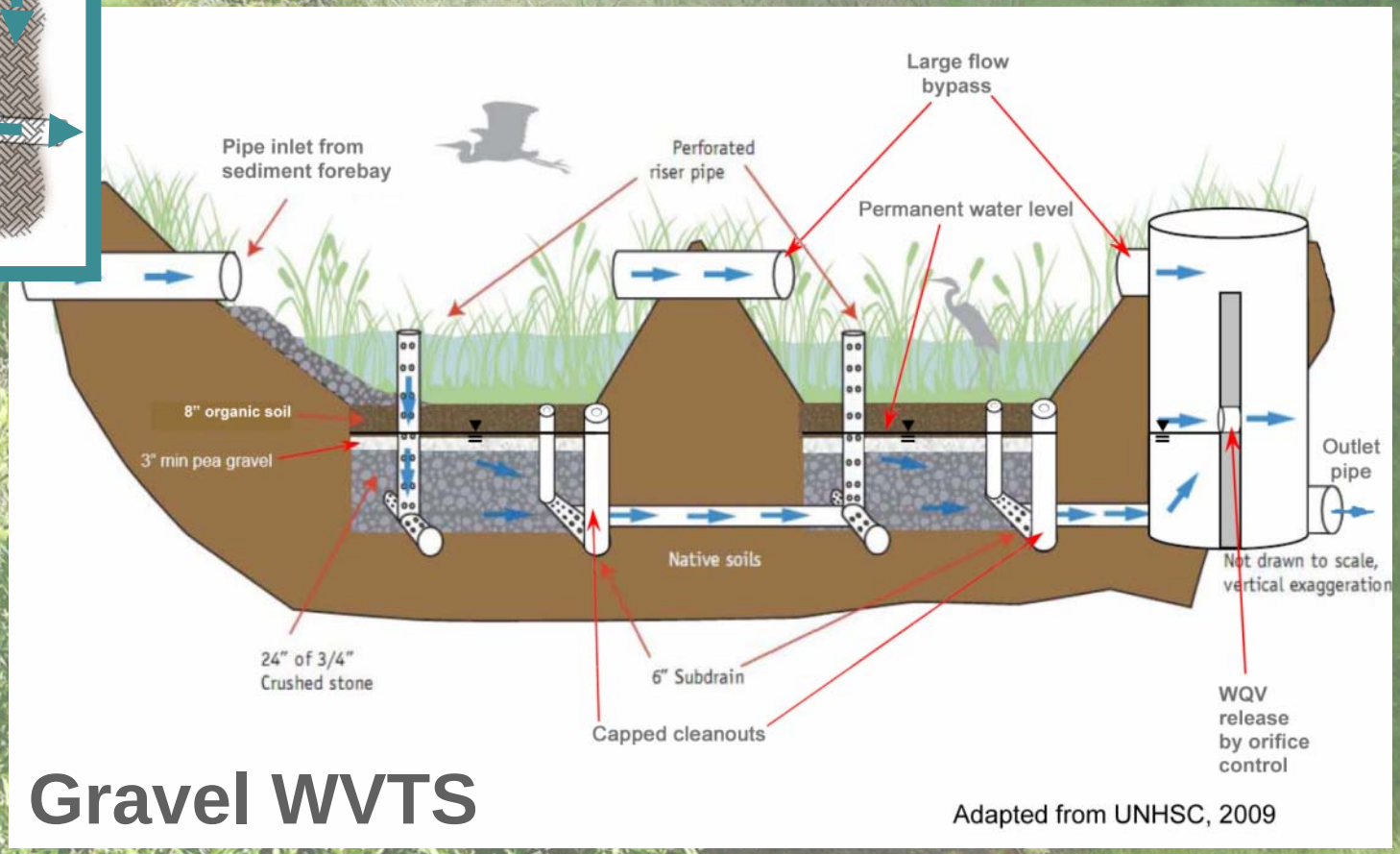
Major Content Changes

Chapter 5

Wet Vegetated Treatment Systems (WVTS)

- **The gravel WVTS detail and text was revised to clarify the stormwater flowpath;**
- **Clarification on a number of criteria related to forebay size, use of liners, storage allocation, setbacks, among others;**
- **Inspection and maintenance frequency and provisions refined.**





Gravel WVTS

Adapted from UNHSC, 2009

Major Content Changes

Infiltration Practices

- Maximum rate allowed to be used for WQ_v treatment revised: no more than 8.3”/hour;
- Separation distance to groundwater variable based on land use (3 ft vs. 2 ft);
- Testing requirements variable based on land use;
- Prohibition for placement in fill variable with land use;

Major Content Changes

Infiltration Practices (continued)

- Horizontal setback distances refined;
- Design infiltration rates specified for Rhode Island soils;
- Infiltration through sidewalls prohibited with one exception;
- Inspection and maintenance frequency and provisions refined.

Major Content Changes

Permeable Paving

- Summary sheet added;
- Type of perm. material clarified (i.e., porous pavement/concrete or permeable paver blocks);
- Groundwater separation distance, horizontal setbacks, testing requirements, fill soil prohibition, etc. identical to infiltration practices;
- CNs provided for larger storms.

Major Content Changes

Filtering Practices

- Separation distance to groundwater clarified (3 feet from top of filter, bottom above gw);
- Storage allocations and sizing methods clarified;
- Modeling and sizing procedures/methods clarified;
- Qualified professional referenced for design of plantings; and
- Inspection and maintenance frequency and provisions refined.

Major Content Changes

Green Roofs

- Summary sheet added; and
- CNs added for larger storms.

Major Content Changes

Open Channel Systems

- Max drainage area clarified;
- Max longitudinal slope without check dams raised to 4%;
- Modeling and sizing procedures/methods clarified;
- Wet swales excavated into groundwater may trigger water budget analysis (i.e., dewatering potential);
- Inspection and maintenance frequency and provisions refined.

Major Content Changes

Practice Selection Criteria

- Clarified purpose of selection matrices as “guidance”;
- Revised tables to reflect changes in criteria (e.g., cold-water fisheries limitations); and
- Moved “Pollutant Removal” table to Appendix H.

Major Content Changes

Chapter 6

Pretreatment Practices

- Clarified deep sump catch basin use and limitations;
- Clarified proprietary practice use, limitations and pollutant removal capabilities (e.g., TSS removal requirements, design flows, and req'd. storage);

Major Content Changes

Chapter 7

Storage Practices

- Clarified criteria where basins are used for water quality objectives (Table added for "Using Basins for Additional Pollutant Removal);
- Added infiltration practices used for "Recharge/Storage only".

Major Content Changes

Glossary

- **Added, deleted and/or revised key definitions:**
  - **Added: Areas Subject to Storm Flowage (ASSF)**
  - **Edited: Dry "extended" detention;**
  - **Added" Infill;**
  - **Edited: Max extent practicable;**
  - **Deleted:"Record Drawing" deleted;**
  - **Edited: Seasonal high groundwater table.**

Major Content Changes

Appendices

- Appendix A (SM Checklist):LID Site Planning and Design Checklist reformatted;
- Appendix B (Veg Planting Guidelines): Planting list slightly updated;
- Appendix C (Retrofitting): Proprietary practices added to retrofit options;
- Appendix D (Design Examples): Design Examples added/revised (Example #1 includes LID site planning and design components);

Major Content Changes

Appendices

- Appendix E (O&M Guidelines): No major changes; referenced as a guidance document, actual O&M requirements moved to Chapter 5;
- Appendix F (BMP Const Specs): Several changes to construction/material specifications;
- Appendix G (Pollution Prevention & Source Controls): Driveway & parking lot sealant info added;

Major Content Changes

Appendices

- Appendix H (Assorted Design Tools)
  - Revised testing guidelines for infiltration practices;
  - Clarified professional qualifications for soil testing;
  - Added pollutant loading analysis method and requirements, including BMP pollutant removal efficiency table;
  - Added short -cut method for Cp_v.

Major Content Changes

Appendices

- Appendix I (RI Stream Order): No major changes;
- Appendix J (Tech. Assessment Protocol): Several minor revisions; corrected pretreatment references; added bacteria, TN and TP methods; removed bulk sampling for total solids; clarified particle size distribution sampling; & clarified data review/reporting requirements.
- Appendix K (Modeling Guidance): Very minor revisions (e.g., reference “drainage area maps” vs. “subwatershed maps,” QPAs, etc).

Questions?

RI Stormwater Design and Installation Standards Manual

Chapters 1 and 2

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Changes in Chapters 1 and 2

- Smart Development Act Language verbatim (§1.1)
- MEP definition provided in footnote p.1-2
- Applicability derived from specific application rules or regulations (§1.2)
- Application by local permitting programs (MS4s)
- Responsibility for design (disclaimer)
- Minimum Standard 12 Stormwater Management Plan (submittal/site plan) eliminated

Questions?

RI Stormwater Design and Installation Standards Manual

Chapter 3

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3.1 Overview

- All of the minimum standards contribute to protecting the water and habitat quality of receiving waters from the negative impacts of stormwater runoff. This is achieved by using a combination of both structural controls and non-structural practices (such as LID) as part of an effective stormwater management system. In general, when a project's stormwater management system is designed, installed, and maintained in accordance with the requirements of this manual, its runoff impacts will be presumed to be in compliance with applicable state regulatory standards and requirements.

Table 3-1 Design Rainfall Amounts for Rhode Island

- Clarified Type III Event
- Amended the 1 Yr storm values, changed from 2.7 inches to 3.1 for Northern Region and to 3.2 for Southern and Eastern Regions

3.2.2 Minimum Standard 2: Groundwater Recharge

- Stormwater must be recharged **within the same subwatershed** to maintain baseflow at pre-development recharge levels to the maximum extent practicable.
- In addition, applicants may be required to provide a **water budget analysis** for proposed groundwater dewatering.
- Recharged roof runoff can be subtracted from WQv but not from larger storm calculations, unless applicant verifies that the drywells are sized for the 100-year, 24-hour (Type III) storm event.

3.2.3 Minimum Standard 3: Water Quality

- Excludes LID credits allowed under Section 4.6
- The WQv must be treated by at least one of the structural BMPs listed in Chapter Five at each location where a discharge of stormwater will occur.
- Minimum average pollutant removal efficiencies: 85% (was 90%) removal of total suspended solids (TSS), 60% (was 90%)removal of pathogens, 30% (was 40%)removal of total phosphorus (TP) for discharges to freshwater systems, and 30% removal of total nitrogen (TN) for discharges to saltwater or tidal systems.

3.2.3 Minimum Standard 3: Water Quality

- Note: Based upon results published in the scientific literature, the structural BMPs listed in Chapter Five can be assumed to meet these standards when properly designed, constructed, and maintained.
- In some cases, the permitting agencies may require that an applicant prepare and submit a pollutant loading analysis developed in accordance with the provisions of Appendix H.

3.3.3.2 Water Quality Flow (WQf)

- When using a hydraulic/hydrologic model for facility sizing and WQ_f determination, designers must use the adjusted CN (equation in Manual) for the drainage area to generate runoff equal to the WQ_v for the 1.2-inch precipitation event.

3.2.4 Minimum Standard 4: Conveyance and Natural Channel Protection

- *Peak flow from* the 10-year, 24-hour *(Type III)* design storm event.
- The Rational Method may be used for sizing the conveyance system.
- The required minimum CP_v shall be computed using the methodology developed in 1987 by Harrington (See Appendix H.4) or by calculating 65% of the direct runoff volume from the post-development 1-year, 24-hour (Type III) storm.
- The CP_v shall be released at roughly a uniform rate over a 24-hour duration

3.2.5 Minimum Standard 5: Overbank Flood Protection and 3.3.5 Overbank Flood Protection (Qp)

- Clarified Type III storm event
- The Qp criterion can be waived for sites that:
  - *Direct discharge* to a large river (i.e., 4th-order stream. See Appendix I for State-wide list and map of stream order), *bodies of water > 50.0 acres in surface area (i.e., lakes, ponds, reservoirs),* or tidal waters.

3.2.6 Minimum Standard 6: Redevelopment

- The permitting authority may take into consideration prior projects or multiphase projects in determining if the redevelopment threshold has been met.
- For redevelopment sites with >40% existing impervious surface coverage, only Stds 2 (recharge) and 3 (water quality) must be addressed. However, the permitting agency may require peak flow control on a case-by case basis within a watershed with history of flooding problems.
- For sites with >40% impervious, alternatives may be proposed that would achieve an equiv. pollutant reduction by using a combination of other BMPs and strategies, including treating 100% of the redevelopment area by BMPs with a lesser pollutant removal than stipulated in Std 3.

3.2.6 Minimum Standard 6: Infill Projects

- An infill project is a development site that meets all of the following: the site is currently predominately pervious (less than 10,000 sf of existing impervious cover); it is surrounded (on at least three sides) by existing development (not including roadways); the site is served by a network of existing infrastructure and does not require the extension of utility lines or new public road construction to serve the property; and the site is one (1) acre or less where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential.

3.2.6 Minimum Standard 6: Infill Projects

- For infill sites, the stormwater management requirements will be the same as for new development except that existing impervious area may be excluded from the stormwater management plan (unless subject to local approval or necessary for mitigation by regulation) and only Stds 2 and 3 need be applied. The applicant, however, can meet those requirements either on-site or at an approved off-site location within the same watershed, provided the applicant satisfactorily demonstrates that impervious area reduction, LID strategies, and/or structural BMPs have been implemented on-site to the maximum extent practicable.

3.2.6 Minimum Standard 6: Infill Projects

- An approved off-site location must be identified, the specific management measures identified, and an implementation schedule developed in accordance with local review and with DEM/CRMC concurrence as appropriate. The applicant must also demonstrate that there are no downstream drainage or flooding impacts as a result of not providing on-site management for large storm events
- The intent of this provision is to allow flexibility to meet the goals of improved recharge, water quality, and channel and flood protection to receiving waters while still promoting infill in urban and urban fringe areas.

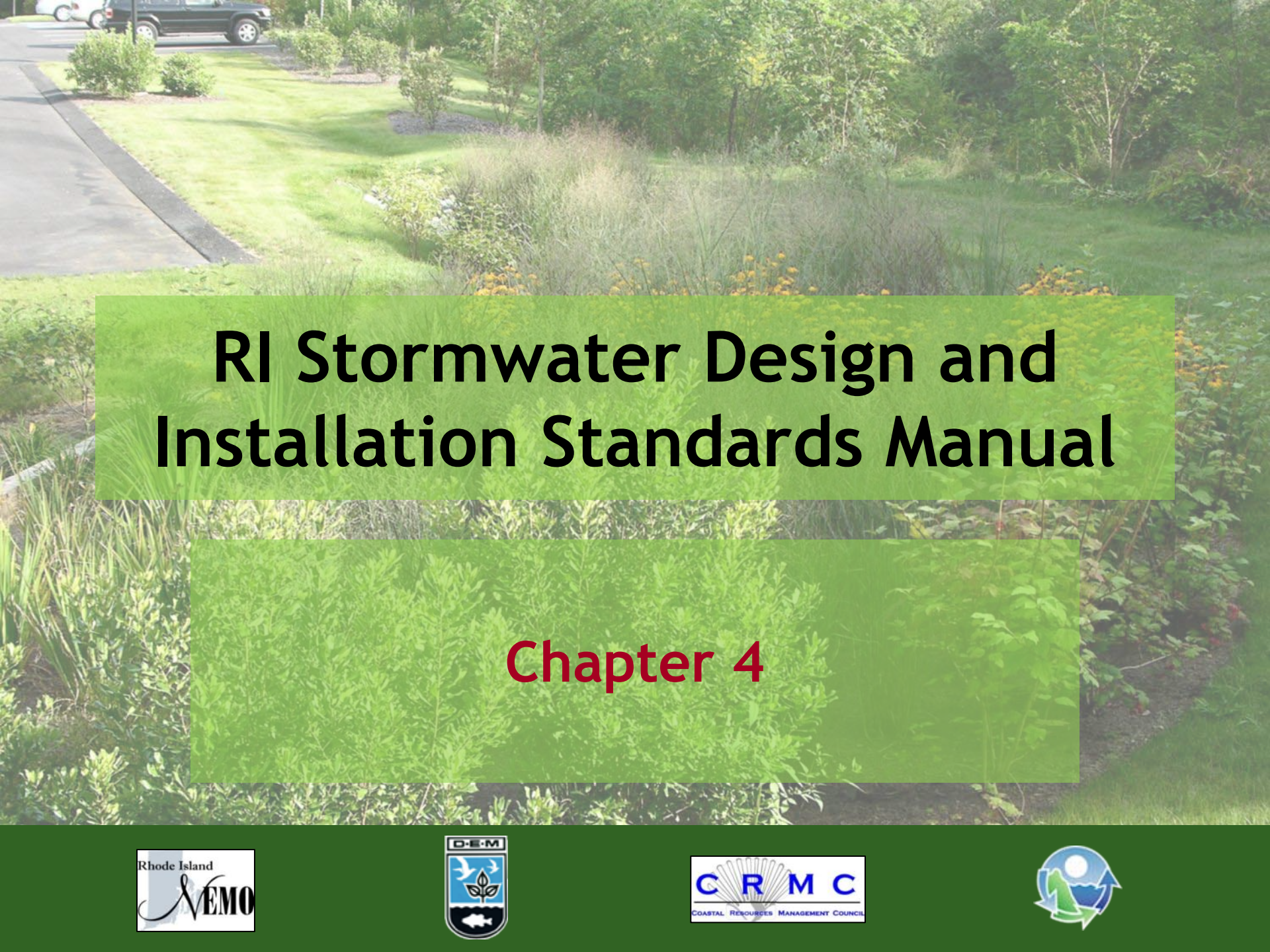
3.2.10 Minimum Standard 10: Construction Erosion and Sedimentation Control

- Temporary sediment trapping practices must be sized *to store* 1 inch of runoff, *from the contributing area or per the sediment volume method (Rhode Island Soil Erosion and Sediment Control Handbook),* whichever is greater; and temporary conveyance practices must be sized to handle the peak flow from the 10-year, 24-hour *(Type III)* design storm.

3.3.6 Downstream Analysis

- Modified Table 3-7: Projects for which a Downstream Analysis is required to clarify use of *Area of Disturbance*
- A typical downstream analysis will require a hydrologic investigation of the *disturbed* area draining to a proposed detention facility and of the contributory watershed to the location of the 10% rule for the 10- and 100-year, *24-hour (Type III) storms. The approving agency may also request analysis of the 1-year, 24-hour (Type III) storm on a case-by-case basis.*

Questions?



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Chapter 4

LID Site Planning and Design Strategies

1. Avoid the Impacts

2. Reduce the Impacts

3. Manage the Impacts

RI LID Site Planning and Design Guidance

- Conservation Development
- Buffer Standards
- Site Clearing and Grading
- Roadway Standards
- Parking Ratios
- Compact Growth
- LID Landscaping
- Special Use Ordinances

Questions?

RI Stormwater Design and Installation Standards Manual

Chapter 5

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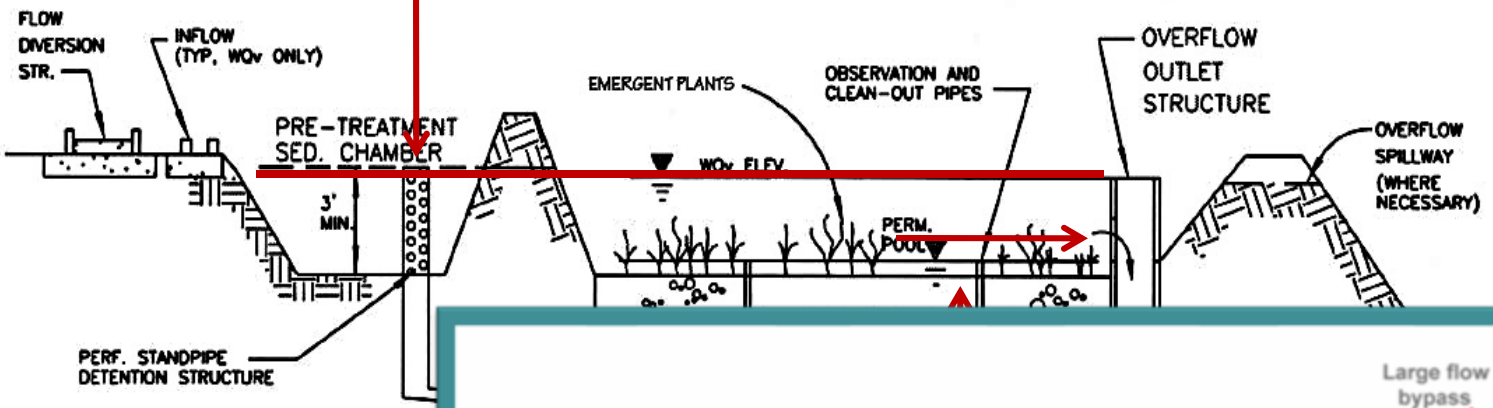
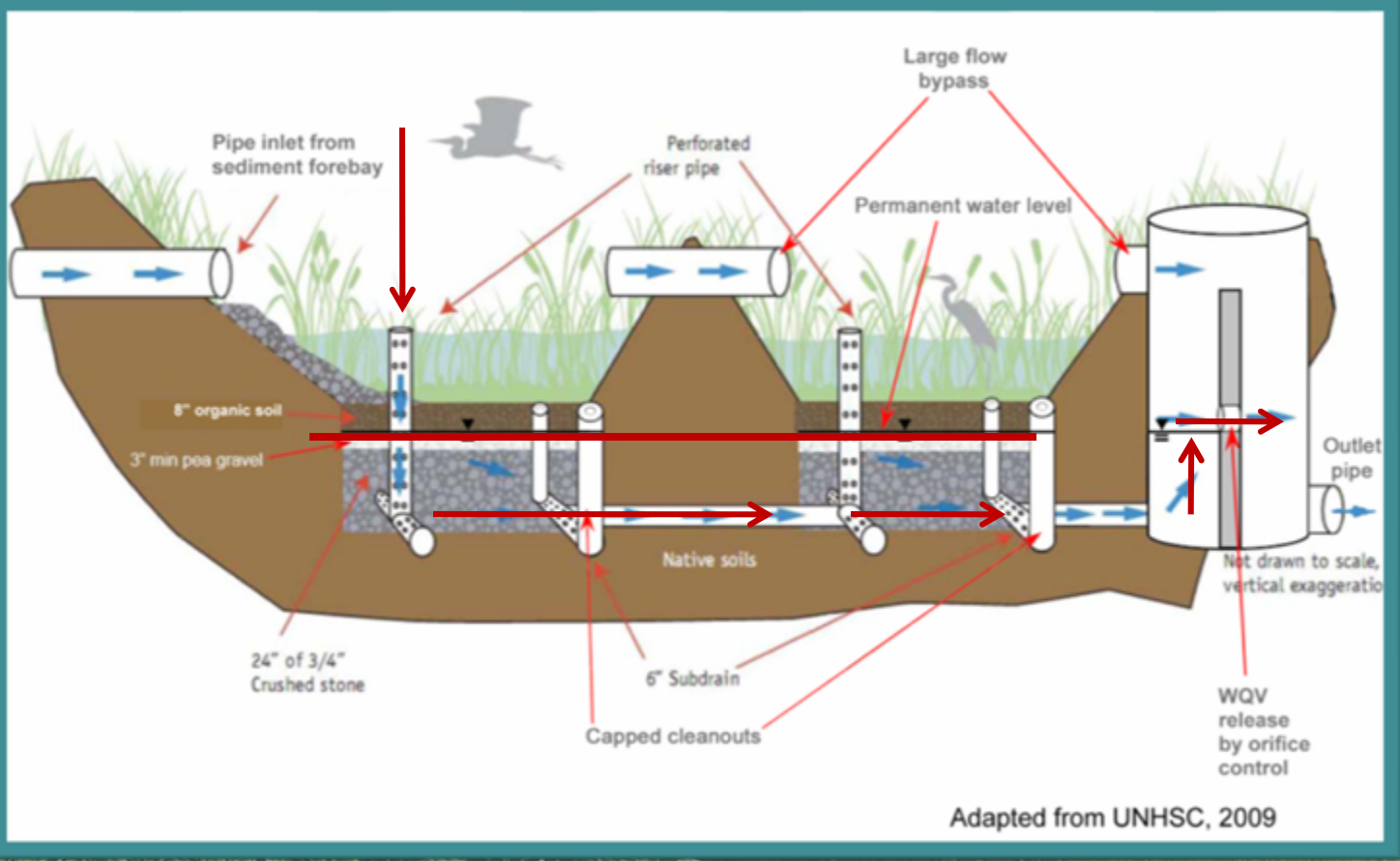
Chapter 5

Wet Vegetated Treatment Systems (WVTS)

- **The gravel WVTS detail and text was revised to clarify the stormwater flowpath:**
  - **Clarified saturated substrate**
  - **When liners are needed**
- **Clarified criteria related to:**
  - **forebay size (at each inlet>10% of design flow)**
  - **storage allocation (forebay counts as part of WQ_v, min gravel bed depth of 24”)**
  - **Setbacks (per DEM’s OWTS Rules)**
  - **Minimum drainage area unless in gw (10 ac or 5 ac)**


FLOW DIVERSION STR.
INFLOW (TYP. WQv ONLY)
PRE-TREATMENT SED. CHAMBER
3' MIN.
EMERGENT PLANTS
OBSERVATION AND CLEAN-OUT PIPES
WQv ELEV.
PERM. POOL
OVERFLOW OUTLET STRUCTURE
OVERFLOW SPILLWAY (WHERE NECESSARY)
PERF. STANDPIPE DETENTION STRUCTURE


Large flow bypass
Pipe inlet from sediment forebay
Perforated riser pipe
Permanent water level
8" organic soil
3" min pea gravel
Outlet pipe
Native soils
Not drawn to scale, vertical exaggeratio
24" of 3/4" Crushed stone
6" Subdrain
Capped cleanouts
WQV release by orifice control
Adapted from UNHSC, 2009

Gravel Wetland Examples

Infiltration Practices

- Maximum rate allowed to meet WQ_v treatment rqmts revised: no more than 8.3”/hour
  - Deleted multiple pretreatment requirements for rates less than above
- Separation distance to groundwater variable based on land use:
  - 3 feet except for strictly residential uses (2 ft).
- Testing:
  - 1 test pit per 5,000 sq ft (residential - 1 test per 5 lots with uniform soils)

Infiltration Practices(continued)

- Cannot be placed in fill, except:
  - Strictly residential land uses up to 2 ft max
  - Non-resid. land uses may use filtering practices
- Mounding analysis required for:
  - Practices designed for ≥10 yr storm & ≤ 4 ft separation to gw
- Clarified pretreatment methods/options

Infiltration Practices (continued)

- Horizontal setback distances refined/clarified;
- Design infiltration rates specified for Rhode Island soils;
- Infiltration through sidewalls prohibited;
  - Exception where the depth is greater than the square root of the bottom surface area.
- Several misc. changes: (e.g., porosity for stone changed from 0.4 to 0.33,

Small scale infiltration

Permeable Paving

- Summary sheet added;
- Type of perm. material clarified (i.e., porous pavement/concrete or permeable paver blocks);
- Groundwater separation distance, horizontal setbacks, testing requirements, fill soil prohibition, etc. identical to infiltration practices; and
- CNs provided for larger storms.

Curve Numbers for Infiltrating Permeable Pavements

Subbase (inches)	Hydrologic Soil Group			
	A	B	C	D
6	76	84	93	-
9	62	65	77	-
≥12	40	55	70	-

Infiltration using permeable pavers

Typical Applications

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Filtering Practices

- Clarified separation distance to groundwater:
  - 3 feet from top of filter
  - bottom must be above seasonal high groundwater
- Storage allocations and sizing methods clarified;
  - Total system must hold 75% of WQ_v
  - Bioretention planting bed depth defined (2-4 ft, with an exception for 12” in high gw situations)
  - Porosity value revised from 0.4 to 0.33
  - Minimum required filter bed surface area defined by modified Darcy’s Law equation

Filtering Practices (continued)

- Modeling:
  - Clarified procedures for using computer model (such as TR-55-based models) for design rate to document 75% storage volume of WQ_v
- Clarified qualified professional referenced for design of plantings
- Inspection and maintenance frequency and provisions refined

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Green Roofs

- Summary sheet added;
- CNs added for larger storms.

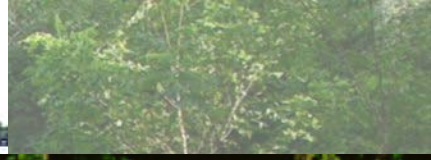
Open Channel Systems

- Clarified maximum drainage area
  - 5 acres draining to any one inlet location
- Max longitudinal slope without check dams raised to 4%
  - Wet swales *typically need* ≤1% longitudinal slope
- Wet swales excavated into groundwater may trigger water budget analysis (i.e., dewatering potential)
- Inspection and maintenance frequency and provisions refined

Open Channel Systems (cont'd)

- Dry swale sizing method clarified
  - Bioretention soil bed depth defined as minimum 30";
  - Minimum bottom width revised to 2'; and
  - Minimum required filter bed surface area defined by modified Darcy's Law equation.


Swales



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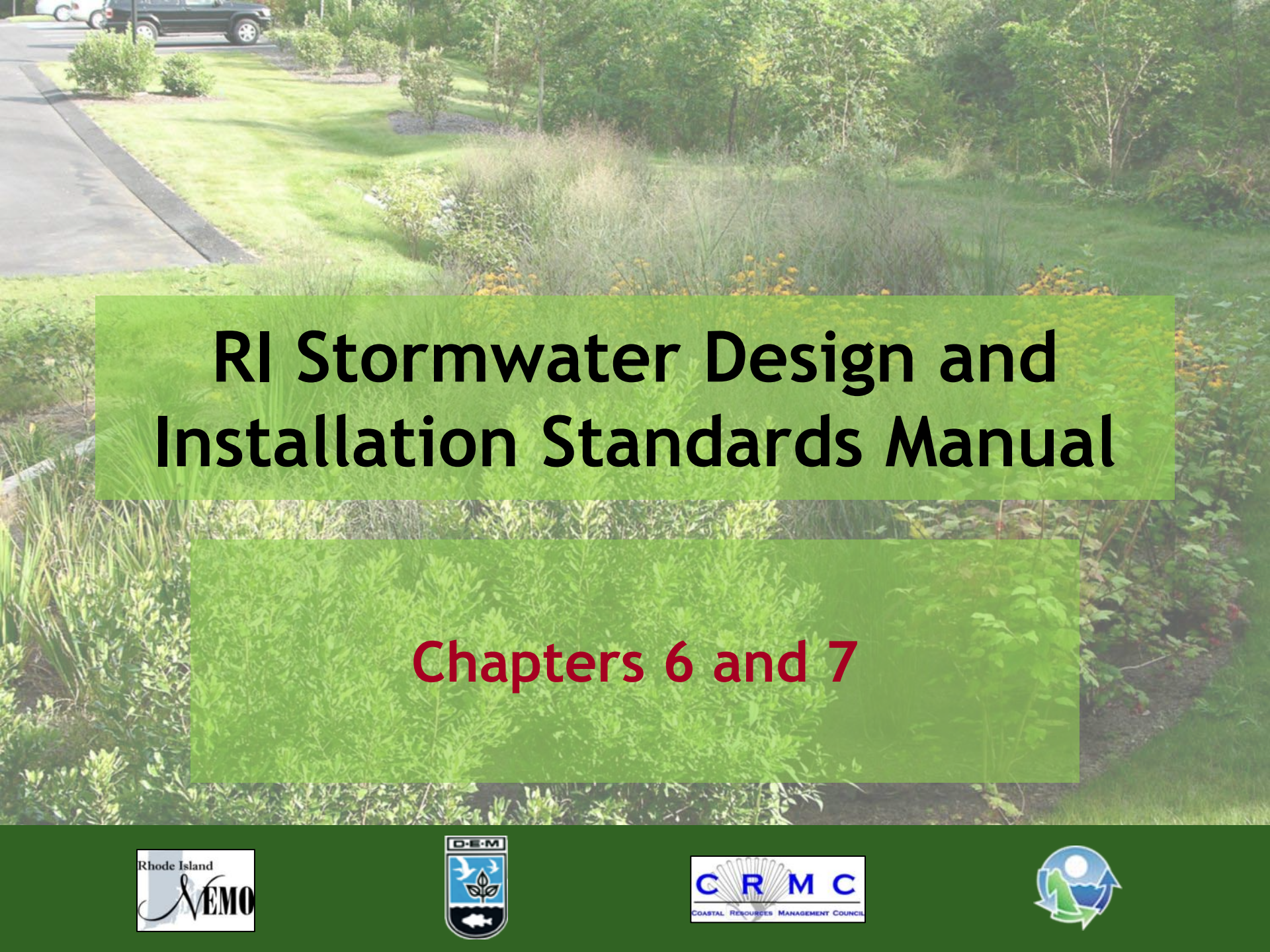
Practice Selection Criteria

- Clarified purpose of selection matrices as “guidance”;
- Revised tables to reflect changes in criteria (e.g., cold-water fisheries limitations); and
- Moved “Pollutant Removal” table to Appendix H.

Questions?



RI Stormwater Design and Installation Standards Manual

Chapters 6 and 7

Changes in Chapter 6

- Figures and photographs are schematic only (§6.1)
- Deep sump catch-basin to deep sump catch basin designs allowed but not counted toward WQv treatment
- CB inspection and cleaning frequency changed (§6.5.3)
- Inspect twice/yr; service annually or when ½ capacity filled
- Proprietary devices recognized for pretreatment

Changes in Chapter 7

- Wet Extended D-basins not limited to 25 acres provided groundwater intercepted (§7.2.1)
- Dry or Wet Extended d-basins accepted for some WQ benefit where add'l pollutant load reduction is needed
- Specific added requirements apply (e.g., separate routing of WQ_v and CP_v)(p. 7-4)
- Infiltration standards added for Re_v, CP_v, and Q_p(§7.4)
- 2-ft separation allowed for all non-LUHPPL flows
- Treatment of 100% WQv required prior to direct infiltration into > 8.3 in/hr soils

Using Basins for Additional Pollutant Loading Reduction

In order to use the removal rates for basins as listed in Appendix H.3 (Pollutant Loading Analyses) Table H-4, the following design criteria must be met.

Pretreatment

Required Elements

- Each basin shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall be sized to contain 10% of the water quality volume (WQ_v) sized per Chapter 6. The forebay storage volume counts toward the total WQ_v requirement.

Treatment

Required Elements

- The minimum detention time for the WQ_v shall be 24 hours.
- Storage for the channel protection volume (CP_v) and the WQ_v shall be computed and routed separately (i.e., the WQ_v cannot be met simply by providing CP_v storage for the one-year storm).
- Provide water quality treatment storage to capture the computed WQ_v from the contributing drainage area through a combination of permanent pool and extended detention, as outlined in Table 7-1.

Table 7-1. Minimum Required Storage Volumes for Basins Used for Enhanced Pollutant Removal

Design Variation	%WQ_v	
	Permanent Pool	Extended Detention
Dry Extended Detention Basin	20% min.	80% max.
Wet Extended Detention Basin	50% min.	50% max.

Design Guidance

- Water quality storage can be provided in multiple cells. Performance is enhanced when multiple treatment pathways are provided by using multiple cells, longer flowpaths, high surface area to volume ratios, complex microtopography, and/or redundant treatment methods (combinations of pool, extended detention, and shallow water).

Minimum Basin Geometry

Required Elements

- The minimum length to width ratio for a basin shall be 1.5:1 (i.e., length relative to width).
- Provide a minimum Drainage Area: Surface Area Ratio of 75:1.
- Incorporate an aquatic bench that extends up to 15 feet inward from the normal edge of water, has an irregular configuration, and a maximum depth of 18 inches below the normal pool water surface elevation (see Figure 5-5).

Design Guidance

- To the greatest extent possible, maximize flow path through the system, and design basins with irregular shapes.

Questions?

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Appendix A

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Stormwater Management Checklist

- Checklist to demonstrate application compliance with the 11 stormwater management standards and to guide the regulatory review
- Most significant format change is Section A.1.3 to help applicants incorporate LID site planning and design strategies

May 2009 vs. April 2010

LID Strategies and Associated Methods	Method incorporated? (check one)			If no or N/A, you must document why the method is not feasible or not applicable at your site and include a description of proposed alternatives.
	Yes	No	N/A[1]	
Avoid the Impacts **Preservation of Undisturbed Areas** Limits of disturbance that protect areas to be preserved are clearly indicated on all construction plans.				
Mapped soils by Hydrologic Soil Group (HSG).				
Delineated building envelopes that avoid steep slopes, forest stands, riparian corridors, HSG D soils, and floodplains.				
New lots, to the extent possible, have been kept out of freshwater and coastal wetland jurisdictional areas.				
Important natural site features such as undisturbed forest, riparian corridors, and wetlands that have been identified and protected by a permanent conservation easement. The calculation of the percent of natural open space is provided.				
Preservation of Buffers and Floodplains Applicable vegetated buffers of coastal and freshwater wetlands and perennial and intermittent streams have been preserved.				
Limits of disturbance have been delineated on all construction plans that protect applicable buffers of wetlands, perennial, and intermittent streams.				

[1] N/A refers to "not applicable." If N/A is marked, applicants must describe why a certain method is not applicable at their site. For example, preserving wetland buffers may be not applicable for sites that are not located within buffers to any jurisdictional wetlands.

LID Site Planning and Design Checklist

The applicant must document specific LID site planning and design strategies applied for the project (see Manual Chapter Four and the *RI Community LID Guidance Manual* for more details regarding each strategy). If a particular strategy was not used, a justification and description of proposed alternatives must be provided. If a strategy is not applicable (N/A), applicants must describe why a certain method is not applicable at their site. For example, preserving wetland buffers may be not applicable for sites located outside any jurisdictional wetland buffers. In communities where conservation development or other low-impact development site planning and design processes exist, following the local community conservation development option may help a project achieve this standard.

1. Strategies to Avoid the Impacts

A. Preservation of Undisturbed Areas

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following list:

- ☐ Limits of disturbance clearly marked on all construction plans.
- ☐ Mapped soils by Hydrologic Soil Group (HSG).
- ☐ Building envelopes avoid steep slopes, forest stands, riparian corridors, HSG D soils, and floodplains.
- ☐ New lots, to the extent practicable, have been kept out of freshwater and coastal wetland jurisdictional areas.
- ☐ Important natural areas (i.e., undisturbed forest, riparian corridors, and wetlands) identified and protected with permanent conservation easement.
- ☐ Percent of natural open space calculation is provided.
- ☐ Other (describe):

Explain constraints when a strategy is applied and/or proposed alternatives in space below:

B. Preservation of Buffers and Floodplains

☐ Not Applied or N/A. *Use space below to explain why:*

Select from the following:

- ☐ Applicable vegetated buffers of coastal and freshwater wetlands and perennial and intermittent streams have been preserved, where possible.
- ☐ Limits of disturbance included on all construction plans that protect applicable buffers
- ☐ Other (describe):

Explain constraints and/or proposed alternatives in space below:

RI Stormwater Design and Installation Standards Manual

Appendix D

Rhode Island NEMO

D·E·M

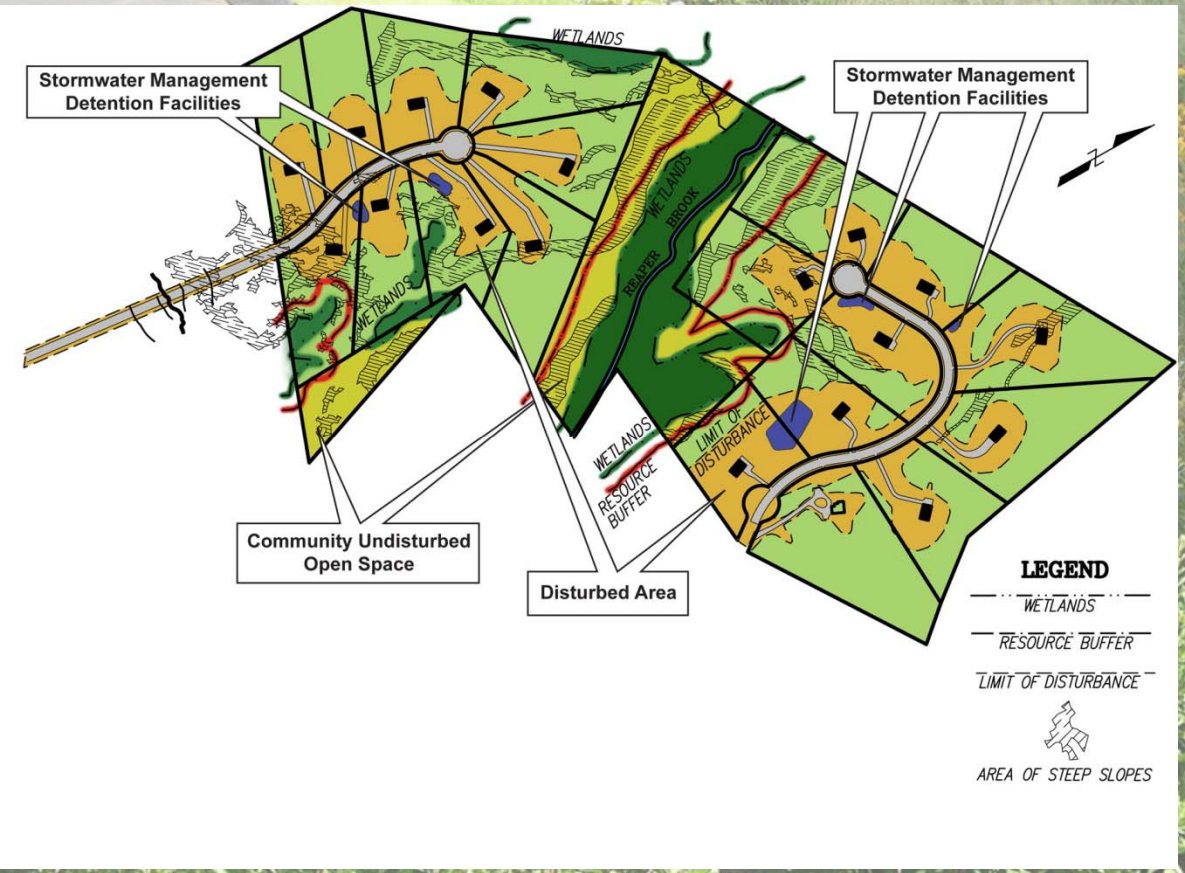
C R M C
Coastal Resources Management Council

Appendix D

Design Example #1 Reaper Brook Estates

- Hypothetical Location: Smithfield, RI, discharge to Reaper Brook (1st-order stream) near the Stillwater River, a Warm Water fishery;
- Total site area, (A) = 80.5 acres; two study points at two outfalls;
- Site Soils Type: 100% "B"; Recharge Factor, F = 0.35. Loamy-sand soils with average depth to groundwater ~ 10.0 feet.

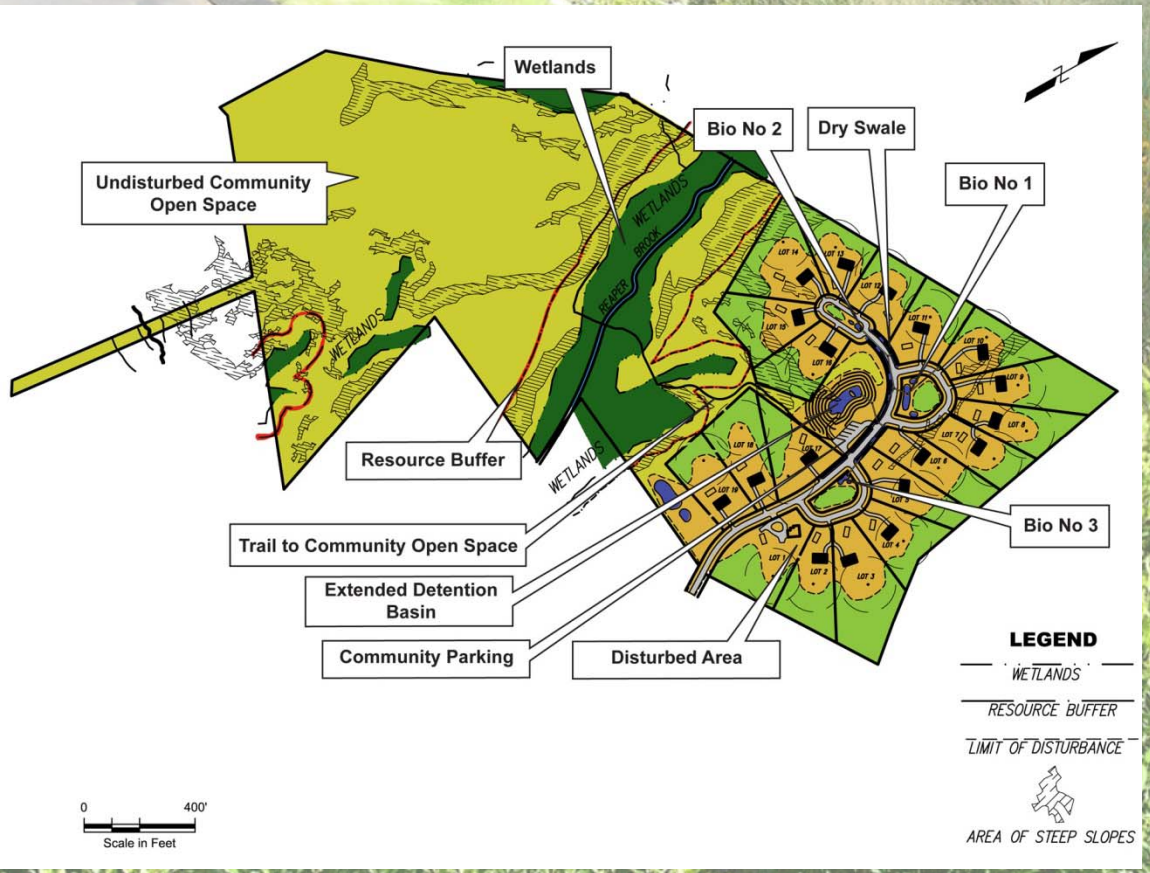
Yield Plan



The Yield Plan results:

- 19 single-family lots (min lots size = 2.75 ac, avg lot size = 3.32 ac);
- 28.0 acres of disturbed area;
- 15.38 acres of open space (outside of lot areas);
- 3,200 linear feet of street;
- 5.51 acres of impervious cover (roads, houses, and driveways).

Conservation Subdivision Design Plan



- 19 single family lots (min lots size = 1.1 ac and ag lot size =1.37 acres);
- 20.3 acres of disturbed area;
- 51.7 acres of open space (outside of lot areas);
- 2,500 linear feet of street;
- 3.83 acres of impervious cover (road, houses, driveways, and community parking lot).

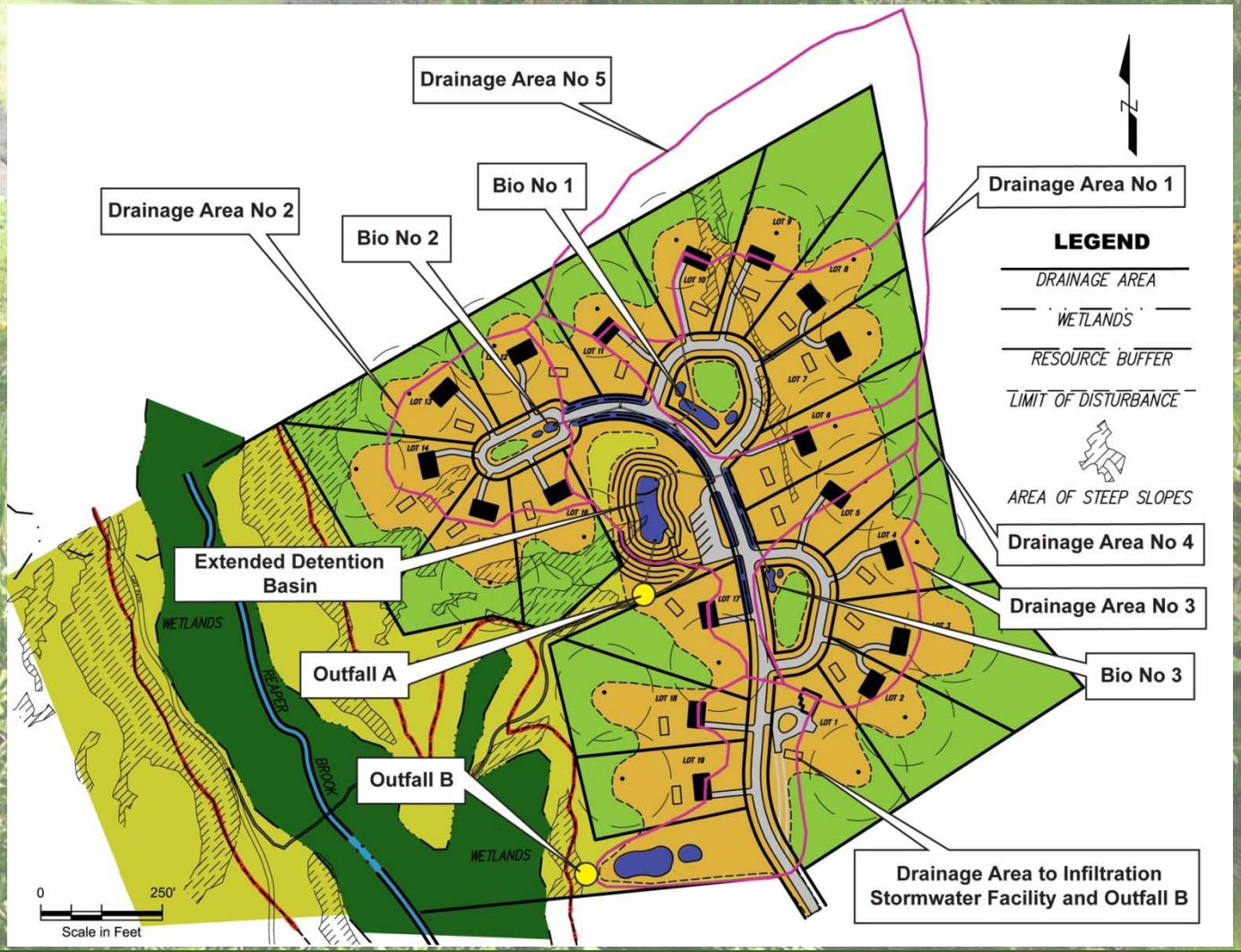
Stormwater Design Components

- LID Site Planning and Design;
- Required Design Criteria;
  - Recharge (Re_v);
  - Water Quality (WQ_v);
  - Channel Protection (Cp_v);
  - Overbank Control (Q_p) - 10 and 100 Yr Storms;
- Warm water fishery, no downstream hazards;
- Bioretention and dry swales for Re_v & WQ_v;
- Detention pond for Cp_v & Q_p;
- Downstream analysis not required ((20.3 acres and < 50% impervious)

Design Example Elements

- Specific sizing calculations for:
  - Bioretention facility (Re_v & WQ_v);
  - Dry swale (Re_v & WQ_v);
  - Detention Pond (Cp_v & Q_p);
- Illustrates both “hand” calculations and computer model (HydroCAD);

Drainage Area Map



Example HydroCAD Printout

Summary for Pond 2P: Bio2

Inflow Area = 2.420 ac, 21.90% Impervious, Inflow Depth = 0.52" for 1YR event
Inflow = 1.19 cfs @ 12.10 hrs, Volume= 0.104 af
Outflow = 0.68 cfs @ 12.30 hrs, Volume= 0.104 af, Atten= 43%, Lag= 12.4 min
Discarded = 0.07 cfs @ 12.30 hrs, Volume= 0.068 af
Primary = 0.62 cfs @ 12.30 hrs, Volume= 0.036 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.03 hrs
Peak Elev= 447.83' @ 12.30 hrs Surf.Area= 1,172 sf Storage= 839 cf

Plug-Flow detention time= 103.2 min calculated for 0.104 af (100% of inflow)
Center-of-Mass det. time= 103.2 min (996.5 - 893.3)

Volume	Invert	Avail.Storage	Storage Description
#1	447.00'	2,516 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
447.00	850	0	0
447.75	1,135	744	744
449.00	1,700	1,772	2,516

Device	Routing	Invert	Outlet Devices
#1	Discarded	447.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Device 3	447.75'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	443.00'	**18.0" Round Culvert** L= 260.0' RCP, square edge headwall, Ke= 0.500 Outlet Invert= 439.00' S= 0.0154 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Discarded OutFlow Max=0.07 cfs @ 12.30 hrs HW=447.83' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.61 cfs @ 12.30 hrs HW=447.83' (Free Discharge)
└**3=Culvert** (Passes 0.61 cfs of 15.35 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 0.61 cfs @ 0.94 fps)

Bioretention, Dry Swales and Detention Pond

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Appendix H

Rhode Island NEMO

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C R M C
Coastal Resources Management Council

Appendix H.1 – Soil Testing

- RI Registered PE allowed to determine SHWT and soil infiltration properties

Appendix H.3 - Pollution Loading Analyses

Simple Method

- New equation for bacteria
- Updated Event Mean Concentration (EMC) values
- Pollutant removal efficiency rating values for BMPs
- Pollutant removal ratings for BMPs in series (Georgia Method)
  - >80% succeeding BMP = 50%
  - <80% succeeding BMP = 75%
- Updated Average Annual Precipitation values RI

Table H-3 Pollutant Removal Efficiency Rating Values for Water Quality BMPs

Water Quality BMPs (those meeting Min. Std 3)		Median Pollutant Removal Efficiency (%)			
		TSS	TP	TN	Bacteria
WVTS	Shallow WVTS	85%[2]	48%[3]	30%[2]	60%[2]
	Gravel WVTS	86%[3]	53%[1]	55%[3]	85%[2]
Infiltration Practices	Infiltration Basin	90%[2]	65%[3]	65%[2]	95%[2]
	Infiltration Trench	90%[2]	65%[3]	65%[2]	95%[2]
	Subsurface Chambers	90%[2]	55%[2]	40%[2]	90%[2]
	Dry Well	90%[2]	55%[2]	40%[2]	90%[2]
	Porous Pavement	90%[1]	40%[1]	40%[2]	95%[2]
Filters	Sand Filter	86%[3]	59%[3]	32%[3]	70%[2]
	Organic Filter	90%[2]	65%[2]	50%[2]	70%[2]
	Bioretention	90%[1]	30%[2]	55%[2]	70%[2]
	Tree Filter	90%[1]	30%[2]	55%[2]	70%[2]
	Green Roof	90%[4]	30%[4]	55%[4]	70%[4]
Open Channels	Dry Swale	90%[1]	30%[2]	55%[2]	70%[2,6]
	Wet Swale	85%[3]	48%[3]	30%[2]	60%[2]

Table H-4 BMP Pollutant Removal Rating Values for Other BMPs

Other BMPs		Median Pollutant Removal Efficiency (%)			
		TSS	TP	TN	Bacteria
Pretreatment BMPs	Grass Channel	70%[1,2]	24%[3]	40%[2]	NT
	Sediment Forebay	25%[4]	8%[5]	3%[5]	12%[5]
	Filter Strip	25%[4]	ND	ND	ND
	Deep Sump Catch Basin	25%[4]	NT	NT	NT
	Hydrodynamic Device	25%[1]	NT	NT	NT
	Oil and Grit Separator	25%[4]	NT	NT	NT
Storage BMPs	Dry Extended Detention Basin	50%[2]	20%[2]	25%[2]	35%[2]
	Wet Extended Detention Basin	80%[3]	52%[3]	31%[3]	70%[3]
	Underground Storage Vault[2]	20%[2]	15%[2]	5%[2]	25%[2]

"ND" Specifies No Data
"NT" Specifies No Treatment

References

1 (UNHSC, 2007b)
2 (CWP, 2007)
3 (Fraley-McNeal, et al., 2007)
4 (prescribed value based on general literature values and/or policy decision)
5 (50% of reported values of low end for extended detention basins)
6 Presumed equivalent to bioretention; will require diligent pollutant source control to manage pet wastes in residential areas

Appendix H.3 - Pollution Loading Analyses

Simple Method

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  - <80% succeeding BMP = 75%
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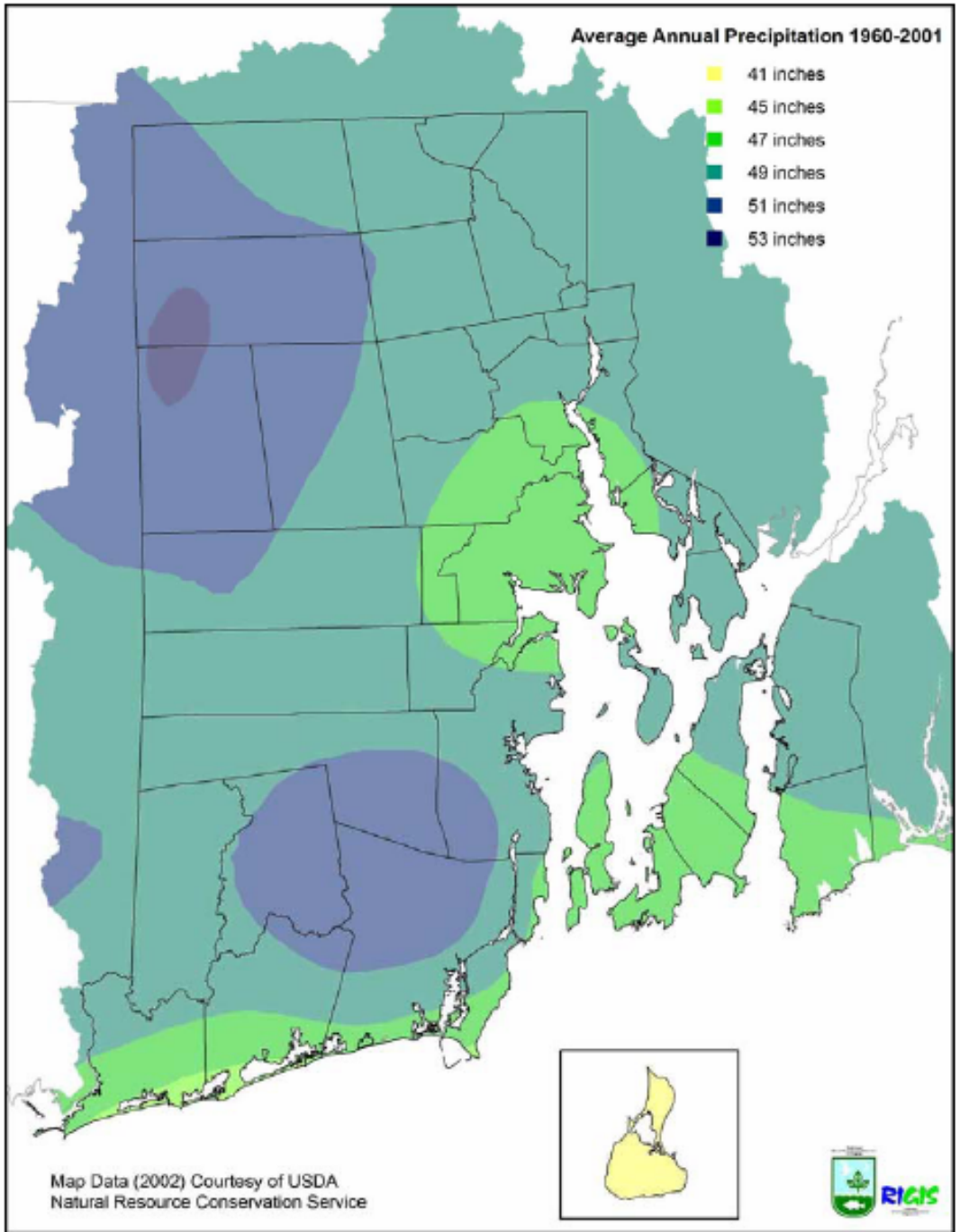
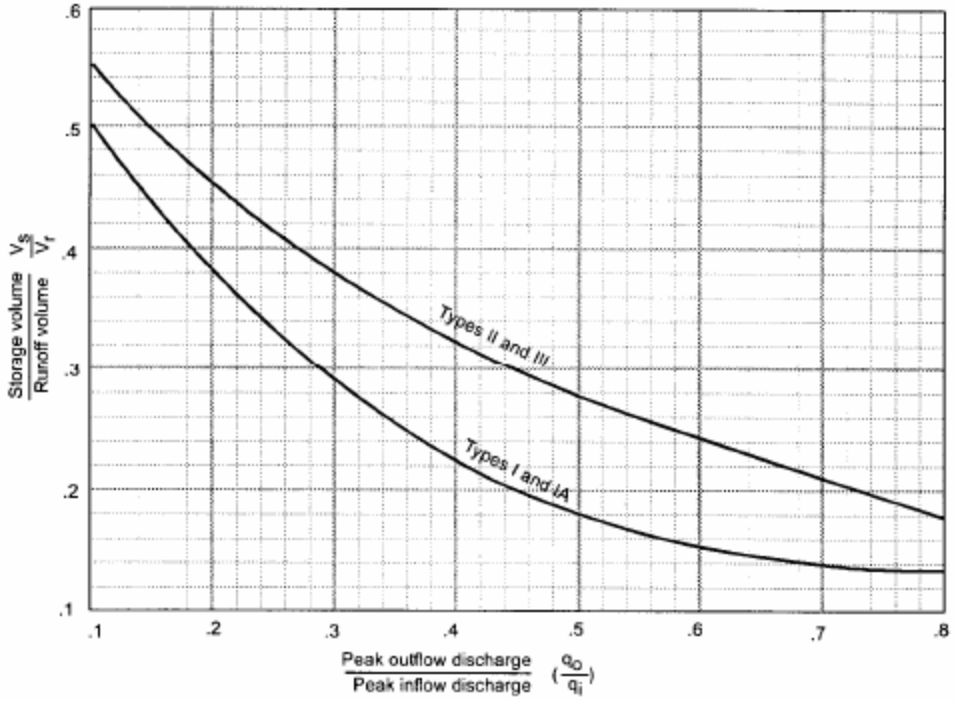
Figure H-8 Average Annual Precipitation Values for Rhode Island



Appendix H.4 “Short-cut” Sizing

Figure H-10 Approximate Detention Basin Routing For Rainfall Types I, IA, II, and III. (Source: TR-55, 1986)



Questions?

RI Stormwater Design and Installation Standards Manual

Next Steps & Estimated Schedule

Next Steps & Estimated Schedule

- 2nd workshop — June 2, 2010
- Written comments by — June 4, 2010

Formal Adoption Process Begins

- Public Notice — June 25, 2010
- Public Hearing — July 27, 2010
- Close Comment Period — July 30, 2010
- File Regulations — Mid-Aug, 2010

Implementation

- Effective Date: Sept 2010 ????
- Designer/Preparer Training: Sept 2010
- Lid Guidance Manual Completed-Fall 2010
- LID Training - Fall 2010
- Organize Stormwater Stakeholder Standing Committee
- Publicize Point of Contact at DEM\CRMC
- Plan on Errata Provisions