Memorandum

To: MIDS Work Group

From: Barr Engineering Company

Subject: MIDS Subtask 2.1(1): Review Methods, Models and Spreadsheets Used to Track Runoff Reduction at Development Sites and Recommend Integrated System of MID Credits that Account for Both Runoff and Pollution Reduction

Date: Draft Memorandum: December 21, 2010; Final Memorandum: June 12, 2011

Project: 23621050.00 MIDS

The goal of MIDS Subtask 2.1(1) is to review existing credit methodology systems used to assess development runoff impacts, evaluate the credit methodology systems, and recommend a credit methodology system approach that will allow for the user to evaluate runoff impacts. For the purposes of this memorandum, a *credit methodology system* is defined as documented procedures that provide a calculation foundation for low-impact design (LID) techniques. LID, as defined per the MIDS legislation, is an approach to stormwater management that mimic's native soil and vegetation hydrology so that the rate and volume of the predeveloped stormwater reaching receiving waters is unchanged. For MIDS, predevelopment hydrology is based on native soil and vegetation.

A summary table listing all Barr-reviewed credit methodology systems, including those not included in this memorandum, can be found in the Appendix.

Introduction and Summary

Barr initially screened fifteen available credit methodology systems through goal assessment and criteria evaluation to determine their usefulness in achieving MIDS legislation. This screening process and results are discussed on Pages 2 through 6 of this memorandum. Based on the screening, six credit methodologies were selected for in-depth review. Barr's summary of six credit methodology system features (documentation, calculation foundations and performance standards) is discussed on Pages 6 through 8. Our review of the procedures and pros and cons of each of these six credit methodology systems is presented on Pages 9 through 13. Finally, our suggestions for a MIDS credit methodology system are provided on Pages 13 through 15.

Common Goals of Credit Methodology Systems

Barr looked at the goals of fifteen different credit methodology systems. The fifteen systems were chosen primarily due to the level of documentation provided for the system and applicability to most development sites. Five common goals of the credit methodology systems were:

Pollutant Loading- determines the pollutant loading rate to receiving waters.

Groundwater Recharge Volume- determines the infiltration volume required to provide groundwater recharge.

Water Quality Volume/Stormwater Runoff Volume- determines the runoff volume required to provide a specific amount of water quality treatment.

Channel Protection Volume- determines the bankful and sub-bankful volume required to control stream erosion.

Stormwater Runoff Rate- determines the peak flow rate to receiving waters.

Other calculation goals used a combination of the above goals to determine an ultimate calculation goal such as impervious area mitigation.

Table 1 summarizes the credit methodology system goals by entity.

Table 1. Credit Methodology System Goals by Entity

Criteria	Entity														
	City of Seattle	Georgia	Florida	Kitsap County, Washington	Maryland	Massachusetts	Minnesota	New Hampshire	New Jersey	Pennsylvania	Purdue University	Rhode Island	Stearns County, Minnesota	Ventura County, California	Virginia
Pollutant Loading			X					X		X	X	X	X		X
Groundwater Recharge Volume					X	X			X			X			
Water Quality Volume/Stormwater Runoff Volume		X		X	X	X	X			X	X	X		X	X
Channel Protection Volume					X		X					X			
Stormwater Runoff Rate				X										X	X
Other	X													X	

Credit Methodology System Comparison

Barr compared the credit methodology systems of the fifteen entities based on the extent to which the following seven criteria applicable to MIDS legislation were met.

Native Hydrology Mimicry- the methodology encourages rate and volume control to predevelopment conditions.

LID Promotion- the methodology encourages LID design, including natural area conservation, site reforestation, runoff routing to increase flow length and infiltration, and minimization of impervious area.

Pollutant Loading Estimation- the methodology provides pollutant loading output for use in TMDL and anti-degredation goal assessment.

Scientific Evaluation- the methodology is based on scientific research and principles.

User Friendliness- the methodology calculation tool is easy to use based on learning time, simplicity, input method, and level of effort required for iterative process design changes.

Input Standardization- the methodology ensures that inputs for calculation are consistent for BMP design and performance, which reduces subjectivity.

BMPs Treatment Train Inclusion- the methodology includes credit for BMPs in series or parallel.

Table 2 summarizes the criteria achievement for the fifteen credit methodology systems.

Table 2. Credit Methodology System Comparison by Entity

Criteria	Entity														
	City of Seattle	Georgia	**Florida**	**Kitsap County, Washington**	Maryland	Massachusetts	Minnesota	New Hampshire	New Jersey	**Pennsylvania**	**Purdue University**	Rhode Island	**Stearns County, Minnesota**	Ventura County, California	**Virginia**
Native Hydrology Mimicry	●	○	◑	●	◑	◑	○	◑	◑	●	◑	◑	◑	◑	◑
LID Promotion	●	●	●	●	●	●	●	●	○	●	●	●	○	●	●
Pollutant Loading Estimation	○	○	●	○	○	◑	○	●	○	●	●	◑	●	○	●
Scientific Evaluation	●	○	●	●	●	●	○	●	●	●	●	●	●	●	●
User Friendliness	●	◑	◑	●	◑	◑	◑	○	○	◑	◑	○	●	○	●
Input Standardization	●	○	◑	●	●	◑	○	◑	●	◑	●	●	●	◑	●
BMP Treatment Train Inclusion	○	○	●	○	○	○	○	◑	○	◑	○	◑	○	○	●

Key:

○ = Does Not Meet Criteria

◑ = Moderately Meets Criteria

● = Significantly Meets Criteria

Entities listed in bold = Entities with Credit Methodology Systems selected for further evaluation

Based on Table 2, the six entities selected for further analysis included Florida, Kitsap County, Pennsylvania, Purdue, Stearns County, and Virginia. The names of the selected entities are in bold in Table 2. The City of Seattle and Kitsap County have similar approaches, but Kitsap County's credit goals of stormwater runoff rate and water quality volume are more directly oriented to MIDS goals than the City of Seattle's goal of impervious area mitigation.

Credit Methodology System Features

To meet credit methodology system goals, entities had varying documentation and calculation foundations. These are described in detail for each of the entities in this section. A review of the system is then provided summarizing the methodology procedures and identifying the pros and cons of each system.

Documentation

The primary credit methodology system documents used by the various entities to assess goal fulfillment are shown in Table 3 with an evaluation of the content as fair, good or excellent based on readability, completeness and/or ease of use. The entities that were found to be the most user-friendly tended to include well-written instructions and a simple calculator.

Table 3. Credit Methodology System Documents

Entity	Name of Tool	Methodology Procedure Guidance	Methodology Calculator Instructions	Spreadsheet Calculator	Online Calculator
Florida	Stormwater Quality Applicant's Handbook	Fair	None	None	None
Kitsap County	Kitsap County BMP Sizing Calculator	Excellent	Excellent	Excellent	None
Pennsylvania	Stormwater Calculation Process	Good	None	None	None
Purdue	Long Term Hydrologic Impact Analysis (L-THIA) Low Impact Development Spreadsheet	Excellent	Excellent	Excellent	Good
Stearns County	Stearns County Pollutant Loading Model	Good	None	Good	None
Virginia	Runoff Reduction Method	Good	Good	Excellent	None

Calculation Foundations and Performance Standards

Table 4 summarizes the calculation foundations and the performance standards for the credit methodology system goals. The goals for the entities selected for further analysis only included three of the five common goals previously listed: Pollutant Loading, Water Quality Volume/Stormwater Runoff Volume, and Stormwater Runoff Rate. The other two common goals, Groundwater Recharge Volume and Channel Protection Volume, are not directly calculated by the methodology but are often ultimately included as a result of the performance standards.

Table 4. Credit Methodology System Calculation Foundations and Performance Standards

Entity	Goal		
	Pollutant Loading	**Water Quality Volume/ Stormwater Runoff Volume**	**Stormwater Runoff Rate**
Florida	**Foundation:** Simple Method, BMP RR **Standard:** 85% reduction or pre = post load for TP, TN		
Kitsap County		**Foundation:** WWHM3, Runoff RR **Standard:** Infiltrate 91% of runoff volume for period modeled (annual or extended timeseries)	**Foundation:** WWHM3 **Standard:** Match peak flow rates and durations from ½ of 2-year to 50-year for predeveloped woods
Pennsylvania	**Foundation:** Simple Method, BMP RR **Standard:** Sites with ≤ 90% of site controlled by BMPs must show 85% TSS, TP reduction and 50% TN reduction	**Foundation:** User Design **Standard:** PRV= 1" X IA, EDV= 1" x IA	**Foundation:** User Modeled **Standard:** Match peak flow rates for 2-year to 100-yr, 24-hr event for predeveloped conditions
Purdue	**Foundation:** Simple Method, BMP RR **Standard:** N/A	**Foundation:** SCS Method **Standard:** N/A	
Stearns County	**Foundation:** P8 **Standard:** presettlement/15% IA = post load for TSS, TP		
Virginia	**Foundation:** Simple Method, BMP RR **Standard:** 0.28 lbs/acre/yr TP, 2.68 lbs/acre/yr TN	**Foundation:** Runoff RR **Standard:** Capture water quality event = 90th percentile rainfall depth (one inch)	**Foundation:** User Modeled with adjusted CN **Standard:** $Q_{post} \leq (V_{forested}/V_{post}) \times Qpeak_{forested}$ for design storm event

Key:
BMP RR- BMP Removal Rate
CN- Curve Number
EDV- Extended Detention Volume
IA- Impervious Area
P8- P8 Urban Catchment Model by William W. Walker, Jr.; performs continuous simulation modeling
PRV- Permanently Removed Volume
$Qpeak_{forested}$- Peak Flow Rate for Development in Forested Conditions
Q_{post}- Peak Flow Rate for Post Development Conditions
Runoff RR- Runoff Reduction Rate
SCS Method- Soil Conservation Service Runoff Curve Number (CN) Method
Simple Method- Simple Method by Tom Schueler; annual load= annual runoff x pollutant concentration x area
TSS- Total Suspended Solids
TP- Total Phosphorus
TN- Total Nitrogen
User Design- user determines the volume removed by the BMP
User Modeled- user models BMPs to determine rate control provided
WWHM3- Western Washington Hydrology Model, Professional Version 3; performs continuous simulation modeling

System Review

Table 5 describes the procedure, pros and cons of each credit methodology system.

Table 5. Credit Methodology Review

Entity	Procedure	Pros	Cons
Florida	**Summary:** User chooses BMPs to achieve pollutant load reduction and uses BMP sizing design criteria that are presumed to meet performance standards based on continuous simulation modeling and water quality literature review. **Calculation Documentation:** User completes written calculations **Calculation Procedure:** • Determine downstream water body and select performance standard • Calculate post-development loading without treatment using Event Mean Concentrations (EMCs)and annual runoff volume (using curve number [CN] based data) • Determine which BMPs will meet load reduction performance standard as determined by retention depth (using CN based data)	Standard inputs provided per meteorological zone include: • EMCs • Retention depth to meet 85% load removal • Mean annual runoff coefficients as a function of directly and non-directly connected impervious area • Mean annual load reduction efficiencies per retention depth as a function of directly and non-directly connected impervious area Equation and examples for treatment trains provided	Is still draft procedures with cumbersome instructions and examples User can still select CN values, which does not ensure consistency/is subjective Does not include rate control calculation

Entity	Procedure	Pros	Cons
Kitsap County	**Summary:** User chooses BMPs to achieve rate control and water quality volume reduction and uses BMP sizing design criteria that are presumed to meet performance standards based on continuous simulation modeling and runoff reduction literature review. **Calculation Documentation:** User enters information into spreadsheet calculator **Calculation Procedure:** *Flow Control Calculator:* • Enter mean annual precipitation, impervious area • Iteratively select BMP configuration until flow control standard is achieved *Water Quality Calculator:* • Enter mean annual precipitation, impervious area • Iteratively design bioretention cell until water quality standard is achieved	Sizing factors are based on a combination of mean annual precipitation, impervious area, and infiltration rates, and does not allow subjective CN values Good guidance documents and calculator instructions Easy-to-use spreadsheet calculator Includes many BMPs Includes rate control calculation in spreadsheet calculator Promotes LID by including credit for tree retention and planting and flow dispersion	Does not provide pollutant loading output Does not include treatment train calculation

Entity	Procedure	Pros	Cons
Pennsylvania	**Summary:** User follows 13-step process to demonstrate compliance for non-structural BMP inclusion, water quality volume control (based on user-documented design), and pollutant loading reduction (based on water quality literature review values). **Calculation Documentation:** User completes worksheets **Calculation Procedure:** • Provide general site information • Identify sensitive areas • Identify and quantify benefits of non-structural BMPs • Calculate runoff capture volume (either a CN based guideline or impervious area based guideline) • Design BMPs and document volume stored for each BMP • Provide routing analysis to demonstrate peak rate control for 2-year through 100-year storm events • Calculate pollutant loading reduction for the site; calculations required vary depending on volume control provided and percentage of site controlled by BMPs	Standard inputs provided include: • Event Mean Concentrations • BMP removal efficiencies Simple process and worksheets Includes equations for removal efficiencies of BMPs in series and parallel	BMP removal efficiencies and design standards are independent in this process, which does not ensure consistency between users; a BMP can be designed with different configurations and will still be credited the same removal efficiency User can still select CN values, which does not ensure consistency/is subjective Must provide separate routing analysis for rate control

Entity	Procedure	Pros	Cons
Purdue	**Summary:** User enters development information and BMPs to screen to estimate runoff volume and pollutant loading for pre and post-development conditions based on SCS Methodology and water quality literature review. **Calculation Documentation:** User enters information into online or spreadsheet calculator **Calculation Procedure:** • Enter state and county, land use, lot size, soil type, land use change, and BMPs (either as basic LID screening or specific, lot-level BMPs)	Online calculator for easy accessibility and use CN inputs for pre and post-development are standardized per cover type Promotes LID by encouraging impervious area minimization	Hard to change inputs using online version; spreadsheet version allows for greater flexibility Does not include treatment train calculation Does not include rate control calculation
Stearns County	**Summary:** User enters lot information to estimate pollutant loading for presettlement, 15% impervious cover, and proposed conditions based on linear regression analysis for P8 model output. BMP evaluation identifies whether a typically sized infiltration BMP will maintain allowable loading thresholds. **Calculation Documentation:** User enters information into spreadsheet calculator **Calculation Procedure:** • Enter lot size, soil type, and cover information	CN inputs for pre and post-development are standardized per cover type Easy-to-use spreadsheet calculators for target post-development loading to equal either presettlement or 15% impervious thresholds	Limited to 0.25 to 2.0 acres lot size and impervious area of 5% to 50% of lot area BMP evaluation limited to bioretention, infiltration trench, and buffer strip Does not directly promote LID by encouraging conservation and imperious area minimization Does not include treatment train calculation Does not include rate control calculation

Entity	Procedure	Pros	Cons
Virginia	**Summary:** User follows 3-step process which includes non-structural BMP inclusion, water quality storm event volume control (based on runoff reduction literature review), and pollutant loading reduction (based on water quality literature review). **Calculation Documentation:** User enters information into spreadsheet calculator **Calculation Procedure:** *Non-Structural BMPs (Site Data)* • Enter land cover information for forest, managed turf, and impervious *Water Quality Compliance* • Iteratively enter, for each drainage area, area to be treated by given BMP, and, If applicable, select downstream BMPs to be employed until target load reduction is achieved *Channel and Flood Protection* • Enter rainfall depths for 1, 2, and 10-year, 24-hour events • Use adjusted CN provided for each drainage area to calculate peak discharges for the 1,2, and 10-year, 24-hour events	Runoff coefficient inputs for post-development are standardized per cover type Easy-to-use spreadsheet calculator Includes many BMPS Includes treatment train calculation in spreadsheet calculator	Many documents to sift through to understand process Must provide separate routing analysis for rate control Stormwater management regulations for Virginia are not finalized

MIDS Work Group Directions and Goals for Tracking System

The preceding draft memorandum was presented to the MIDS Work Group and Barr asked for the group's input.

Based upon review of available credit methodologies, the MIDS legislation, expected primary and secondary calculator users, and demonstrations of the Virginia calculator and the Capitol Region

Watershed District/Ramsey-Washington Metro Watershed District calculator, the MIDS Work Group determined that the credit tracking system/calculator should:

- provide an incentive for incorporating low impact development (LID) techniques onto a site
- determine the stormwater volume control required on the site
- determine TP and TSS removal
- provide volume and pollutant removal credit for BMPs in parallel and in series
- focus on pollutant removals for sites with Hydrologic Soil Group D soils
- not replace existing models, such as HydroCAD, for calculating and showing conformance to stormwater peak runoff rate requirements

The Virginia credit tracking calculator performs most of these functions and was adapted to Minnesota's needs in the creation of a draft beta version MIDS calculator. The foundation for defining the actual MIDS credits for some BMPs is based on the Barr modeling that had already been completed for other MIDS subtasks. Defining MIDS credits for other BMPs is based on literature review of runoff reduction amounts and pollutant removal efficiencies. Barr and the MPCA suggested that a Credit Council be formed to define and redefine MIDS credits in the future.

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Appendix

Credit Methodology Summary

Included in Memo	Entity	Division	Basis of Calculation	Name of Tool
	CRWD	N/A	Volume Requirement= Runoff Generated From 1" of Rainfall	Capitol Region Watershed District Volume Control Worksheet
	CNT	N/A	SCS Method (Volume), Rational Method (Rate)	Green Values Calculator
X	City of Seattle	Public Utilities, Planning and Development	Pre-designed BMPs	City of Seattle Green Stormwater Infrastructure Calculator
	Dane County, Wisconsin		Base Fee + Disturbed Area + Impervious Area	N/A
X	Florida (DRAFT)	Environmental Protection	Simple Method (Pollutants)	Stormwater Quality Applicant's Handbook
X	Georgia	Natural Resources- Environmental Protection	WQV Credit	Site Design Stormwater Credits
X	Kitsap County, Washington	Community Development- Development Engineering	Pre-designed BMPs	Kitsap County BMP Sizing Calculator for Flow Control; Kitsap County BMP Sizing Calculator for Water Quality
	Knox County, Tennessee	N/A	WQV Credit	Water Quality Volume (WQv) Credits
X	Maryland	Environment	GRV, WQV, & CPV Credit	Environmental Site Design
X	Massachusetts	Environmental Protection	GRV & WQV Credit	Low Impact Site Design Credit; TSS Removal Calculation Worksheet
X	Minnesota	MPCA	WQV & CPV Credit	Stormwater Credits and Development
X	New Hampshire	Environmental Services	Simple Method (Pollutants)	Guidance for Estimating Pre- and Post-Development Stormwater Pollutant Loads
X	New Jersey	Environmental Protection	GRV Credit	New Jersey Groundwater Recharge Spreadsheet
X	Pennsylvania	Environmental Protection	Simple Method (Pollutants), WQV Requirement= 2 inches x Impervious Area	Stormwater Calculation Process
X	Purdue University	College of Engineering	Simple Method (Pollutants), SCS Method (Volume)	Long Term Hydrologic Impact Analysis (L-THIA) Low Impact Development Spreadsheet
	RWMWD	N/A	Volume Requirement= Runoff Generated From 1" of Rainfall	RWMWD Watershed District Volume Control Worksheet
X	Rhode Island (DRAFT)	Environmental Management	Simple Method (Pollutants), WQV, GRV, & CPV Credit	Rhode Island Stormwater Design and Installation Standards Manual
	SEMCOG	N/A	WQV Credit	Design Calculation Process
X	Stearns County, Minnesota	Environmental Services	P8 (Pollutants)	Stearns County Pollutant Loading Model
	Town of Tolland, Connecticut	N/A	GRV, WQV, & CPV Credit	Storm Water Credits
X	Ventura County, California	Planning and Land Development Program	Effective Impervious Area (EIA), WQV = Runoff Generated from 0.75" Rainfall, Rational Method (Rate)	Ventura County Technical Guidance Manual for Stormwater Quality Control Measures
	VRJPO	N/A	WQV Credit	VRJPO Rules
	Vermont	Environmental Conservation	GRV & WQV Credit	Voluntary Stormwater Management Credits
X	Virginia	Conservation and Recreation	Simple Method (Pollutants), WQV Requirement= Runoff Generated from WQ Event, Simplified SCS Method (Rate)	Runoff Reduction Method; Development and Redevelopment Worksheets

Credit Methodology Summary

Included in Memo	Entity	*Calculation Goal*									*Primary Calculation Tool Type*			Pollutants Loads Calculated
		Pollutant Loading	Impervious Area Mitigation	Runoff Rate	Runoff Volume	GRV	WQV	CPV	Life Cycle Cost	Permit Fee	Written Procedure/Worksheets	Online Calculator	Spreadsheet	
	CRWD				X						X		X	N/A
	CNT			X	X				X			X		N/A
X	City of Seattle		X										X	N/A
	Dane County, Wisconsin									X	X			N/A
X	Florida (DRAFT)	X									X			TP, TN
X	Georgia						X				X			N/A
X	Kitsap County, Washington			X			X						X	N/A
	Knox County, Tennessee						X				X			N/A
X	Maryland					X	X	X			X			N/A
X	Massachusetts	X				X	X				X		X	TSS
X	Minnesota						X	X			X			N/A
X	New Hampshire	X											X	TSS, TP, TN
X	New Jersey					X							X	N/A
X	Pennsylvania	X			X						X			TSS, TP, TN
X	Purdue University	X			X							X		N, TP, TSS, Pb, Cu, Zn, Cd, Cr, Ni, BOD, COD, Oil & Grease, Fecal Coliform & Strep
	RWMWD				X						X		X	N/A
X	Rhode Island (DRAFT)	X				X	X	X			X			TSS, TP, TN
	SEMCOG						X				X			N/A
X	Stearns County, Minnesota	X											X	TSS, TP
	Town of Tolland, Connecticut					X	X	X			X			N/A
X	Ventura County, California		X	X			X				X			N/A
	VRJPO						X				X			N/A
	Vermont					X	X				X			N/A
X	Virginia	X		X			X	X					X	TP, TN

Credit Methodology Summary

Included in Memo	Entity	*Inputs Provided and Source*													*Submittal Information*	
		Retention Depths for Goal Load Removal	Mean Annual Mass Removal Efficiencies per Retention Depth	Runoff Coefficient as a Function of DCIA	Average Annual Precipitation	EMC	BMP Removal Efficiencies	BMP Curve Numbers	BMP Runoff Coefficient	BMP Sizing Factors/Area Credit	BMP Sizing Rainfall Targets	Impervious Runoff Coefficient	Pervious Runoff Coefficient	Infiltration Rates	Calculation Submittal Required?	Fee In Lieu of Impact Possible?
	CRWD											CRWD		MN SWM	Yes	Yes
	CNT							CNT	CNT						N/A	
X	City of Seattle									SEA					Yes	
	Dane County, Wisconsin														Yes	
X	Florida (DRAFT)	FDEP	FDEP	FDEP		FDEP										
X	Georgia														No	
X	Kitsap County, Washington									KSC					No	
	Knox County, Tennessee														No	
X	Maryland										MDE					
X	Massachusetts														Yes	
X	Minnesota														No	
X	New Hampshire				NOAA	NH SWM	NH SWM								Yes	
X	New Jersey														No	
X	Pennsylvania					MULTIPLE	MULTIPLE									
X	Purdue University					TNRCC									N/A	
	RWMWD											RWMWD		MN SWM	Yes	Yes
X	Rhode Island (DRAFT)					MULTIPLE	MULTIPLE									
	SEMCOG														No	
X	Stearns County, Minnesota														No	
	Town of Tolland, Connecticut														Unknown	
X	Ventura County, California											VC	VC		Yes	
	VRJPO													MULTIPLE	Yes	
	Vermont														No	
X	Virginia						VA RRM					MULTIPLE	MULTIPLE		No	Recommended

Credit Methodology Summary

Included in Memo	Entity	*Documents*			Comments
		Tool Documentation	Pages	Interactive Tool	
	CRWD	Rules	14-17	Spreadsheet	Worksheet calculations for infiltration basins, raingardens, and subsurface storage only. Hand calculations required for other BMPs.
	CNT	Methodology	All	Online Calculator	Residential/homeowner application
X	City of Seattle	Manual	4-36 - 4-111	Spreadsheet	
	Dane County, Wisconsin				Permit fees based on disturbed and impervious area, thus incentive for minimization
X	Florida (DRAFT)	Handbook	2 (Treatment Train), 6-20, 29-145 (BMPs), 146-151 (LID), 172-203 (Examples)	N/A	Different performance standards for Outstanding Florida Waters (OFW), Impaired, and Adopted TDMLs (either 85% Load Reduction or Post=Pre); credit for BMP treatment trains, addresses karst (pages 204-208); page 5-17 of the Research Report explains evaluation methodology, contnuous simulation modeling used for volume
X	Georgia	Manual	1.4-39 - 1.4-45	N/A	Chapter 3 has structural BMPs- page 3.1-7 BMP Removal Efficiencies, 3.1-30 Treatment Trains- these are just guidance (not used in a calulation)
X	Kitsap County, Washington	Guidance Document	All	Spreadsheet	Rate and volume control based on continuous simulation modeling- WWHM3
	Knox County, Tennessee	Manual	All	N/A	
X	Maryland	Manual	All	N/A	Revised chapter 5 in 2009
X	Massachusetts	Guidance Document	All	Spreadsheet	TSS calculation spreadsheet available
X	Minnesota	Manual	284-311	N/A	
X	New Hampshire	Guidance	All	Spreadsheet	
X	New Jersey	Manual	All	Spreadsheet	
X	Pennsylvania	Manual	All	N/A	Page 14- 16 is process, BMP Removal Efficiencies in Appendix A
X	Purdue University	Documentation	N/A	Online Calculator	Screening level tool
	RWMWD	Rules	13-16	Spreadsheet	Worksheet calculations for infiltration basins, raingardens, and subsurface storage only. Hand calculations required for other BMPs.
X	Rhode Island (DRAFT)	Manual	All	N/A	Page 1-7 - 1-12 is process, WQV- Chapter 4, GRV- Chapter 5, CPV- Chapter 5 and 7, rate- Chapter 5 and 7, Appendix H has pollutant loading analysis procedures (taken from Massachusetts)- page H-19 is treatment train
	SEMCOG	Manual	370-384	N/A	
X	Stearns County, Minnesota	Methodology	All	Spreadsheet	Screening level tool
	Town of Tolland, Connecticut	Manual	33-38	N/A	
X	Ventura County, California	Manual	2-11 - 2-12, 2-26 - 2-28		
	VRJPO	Rules	26-31	N/A	
	Vermont	Manual	3-1 - 3-16	N/A	
X	Virginia	Instructions	All	Spreadsheet	

Abbreviations

CNT	Center for Neighborhood Technology
CPV	Channel Protection Volume
CRWD	Capitol Region Watershed District
DCIA	Directly Connected Impervious Area
EMC	Event Mean Concentration
FDEP	Florida Department of Environmental Protection
GRV	Groundwater Recharge Volume
KSC	Kitsap County
MDE	Maryland Department of the Environment
MN SWM	Minnesota Stormwater Manual
MULTIPLE	Multiple Sources Referenced
NH SWM	New Hampshire Stormwater Manual
NOAA	National Oceanic and Atmospheric Administration
RWMWD	Ramsey-Washington Metro Watershed District
SEA	City of Seattle
SEMCOG	SE Michigan Council of Governments
TNRCC	Texas Natural Resource Conservation Commission
VA RRM	Virginia Runoff Reduction Method
VC	Ventura County
VRJPO	Vermillion River Joint Powers Organization
WQV	Water Quality Volume