APPENDIX H REQUIREMENTS RELATED TO NITROGEN-IMPAIRED WATERS IN THE GREAT BAY ESTUARY AND CHLORIDE-IMPAIRED WATERS

Discharges to the Nitrogen-Impaired Waters of the Great Bay Watershed and Their Tributaries

Table H-1 lists the municipalities that have regulated MS4s that discharge to the nitrogen-impaired waterbodies in the Great Bay Estuary watershed or their tributaries. An operator of an MS4 listed in Table H-1 shall include the following BMPs in Water Quality Response Plans developed to address nitrogen discharges from its MS4s:

i. Part 2.3.2, Public education and outreach: topics addressed shall include impacts, proper use of and availability of slow release fertilizers, proper disposal of grass clippings and leaf litter and proper management of pet waste, unless the permittee determines that one or more of these issues is not a significant contributor of nitrogen to discharges from the MS4 and the permittee retains documentation of this finding in the SWMP;

ii. Part2.3.4.8, Illicit Discharge Detection and Elimination Program: the permittee shall track nitrogen reductions following the removal of an illicit connection. Tracking shall be done consistent with methods found in Attachment 1 to Appendix H and each annual report shall document the calculated nitrogen reduction[1] in addition to the reporting required by 2.3.4.8.f.

iii. Part 2.3.6, Stormwater Management in New Development and Redevelopment: the requirement for adoption/amendment of the permittee's ordinance or other regulatory mechanism shall include a requirement that new development and redevelopment stormwater management BMPs be optimized for nitrogen removal; retrofit inventory and priority ranking under 2.3.6.1.b shall include consideration of BMPs to reduce nitrogen discharges.

iv. Part 2.3.7, Good House Keeping and Pollution Prevention for Permittee Owned Operations: establish procedure for use of slow release fertilizers in addition to reducing and managing fertilizer use as provided in 2.3.7.1; establish program to properly manage grass cuttings and leaf litter on permittee property, including prohibiting blowing organic waste materials onto adjacent impervious surfaces; increased street sweeping frequency of all municipal owned streets and parking lots to a minimum of two (2) times per year, once in the spring (following winter activities such as sanding) and at least once in the fall (following leaf fall).

In addition, any structural BMPs listed in Table 4-3 of Attachment 1 to Appendix H installed in the regulated area within the Great Bay Estuary watershed by the permittee or its agents shall be tracked and the permittee shall estimate the nitrogen removal by the BMP consistent with Attachment 1 to Appendix H. The permittee shall document the BMP type, total area treated by the BMP, the design storage volume of the BMP and the estimated nitrogen removed per year by the BMP in each annual report[1].

[1] Note: The Draft Permit does not contain any quantifiable permittee specific annual nitrogen load reduction requirements.

Discharges to Chloride-Impaired Waters

Table H-2 lists the municipalities discharging to chloride-impaired waters for which a TMDL has not yet been approved. Permittees that operate regulated MS4s that discharge to the identified impaired waters must identify and implement BMPs designed to substantially reduce chloride discharges. For this purpose, the permittee shall develop a Salt Reduction Plan that includes specific actions designed to achieve salt reduction on municipal roads and facilities, and on private facilities that drain to the MS4. The Salt Reduction Plan shall be completed within three (3) years of the effective date of the permit and shall include:

For municipally maintained surfaces:

(i) Tracking of the amount of salt applied to all municipally owned and maintained surfaces and reporting of salt use beginning in the year 3 annual report;
(ii) Planned activities for salt reduction on municipally owned and maintained surfaces, which may include but are not limited to:

- Operational changes such as pre-wetting, pre-treating the salt stockpile, increasing plowing prior to de-icing, monitoring of road surface temperature, etc.;
- Implementation of new or modified equipment providing pre-wetting capability, better calibration rates, or other capability for minimizing salt use;
- Training for municipal staff and/or contractors engaged in winter maintenance activities;
- Adoption of guidelines for application rates for roads and parking lots (see NHDES, Chloride *Reduction Implementation Plan for Dinsmore Brook, App. J and K* (February 2011), http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-11-13.pdf ;: *Winter Parking Lot and Sidewalk Maintenance Manual (Revised edition June 2008)* http://www.pca.state.mn.us/publications/parkinglotmanual.pdf; and the application guidelines on page 17 of *Minnesota Snow and Ice Control: Field Handbook for Snow Operators (September 2012)* http://www.mnltap.umn.edu/publications/handbooks/documents/snowice.pdf for examples);
- Regular calibration of spreading equipment;
- Designation of no-salt and/or low salt zones;
- Public education regarding impacts of salt use, methods to reduce salt use on private property, modifications to driving behavior in winter weather, etc.; and
- Measures to prevent exposure of salt stockpiles (if any) to precipitation and runoff; and

(iii) An estimate of the total tonnage of salt reduction expected by each activity; and
(iv) A schedule for implementation of planned activities including immediate implementation of operational and training measures, continued annual progress on other measures, and full implementation of the Plan by the end of the permit term.

For privately maintained facilities that drain to the MS4:

(i) Identification of private parking lots with 10 or more parking spaces draining to the MS4;
(ii) Requirements for private parking lot owners and operators and private street owners and operators (1) that any commercial salt applicators used for applications of salt to their parking lots or streets be trained and certified, and (2) to report annual salt usage within the municipal boundaries (either townwide, or within the area draining to the MS4).

The permittee may rely on state programs in compliance with this requirement as follows:

- If the state of NH enacts a mandatory statewide training and certification requirement for commercial salt applicators, permittees shall not be required to establish local regulations, ordinances or other requirements to mandate use of certified operators, but may rely on the state program in compliance with this requirement;
- To the extent that the state of NH operates a voluntary training and certification program for commercial salt applicators, permittees may meet this permit condition by establishing local requirements for use of state-certified applicators. Should the state discontinue its existing training and certification program and not institute an equivalent program, the permittee shall identify an equivalent training or certification program and/or conduct its own training and certification program; and
- To the extent that the state of NH operates a salt usage reporting system for commercial salt applicators, the permittee may require reporting to the appropriate state entity in lieu of collecting salt usage data itself. Should the state discontinue its salt usage reporting system, the permittee shall collect data on salt usage from commercial salt applicators and report such data in its annual report, beginning in the year 3 annual report.

(iii) Requirements for new development and redevelopment to minimize salt usage, and to track and report amounts used to the municipality;

Table H-1. Municipalities With Regulated MS4s Within the Great Bay Estuary Watershed

1	Barrington
2	Brentwood
3	Candia
4	Chester
5	Danville
6	Derry
7	Dover
8	Durham
9	East Kingston
10	Epping
11	Exeter
12	Fremont
13	Greenland
14	Hampstead
15	Hampston Falls
16	Kensington
17	Kingston
18	Lee
19	Madbury
20	Milton
21	Newfields
22	Newington
23	North Hampton
24	Portsmouth
25	Raymond
26	Rochester
27	Rollinsford
28	Sandown
29	Somersworth
30	Stratham
31	Plus Nontraditional and Transportation MS4s located in urbanized areas within the above municipal boundaries

NH Small MS4 General Permit

Appendix H - Table H-2 Chloride Impaired Waters With out a TMDL

	Primary Town	Water Name
1	BEDFORD	MCQUADE BROOK
2	DOVER	BERRY BROOK
3	DOVER	INDIAN BROOK
4	DURHAM	COLLEGE BROOK
5	DURHAM	RESERVOIR BROOK
6	GOFFSTOWN	CATAMOUNT BROOK
7	LONDONDERRY	LITTLE COHAS BROOK, CWF
8	LONDONDERRY	SOUTH PERIMETER BROOK
9	MANCHESTER	BAKER BROOK
10	MANCHESTER	DORRS POND INLET BROOK
11	MANCHESTER	DORRS POND, MANCHESTER
12	MANCHESTER	NUTT POND, MANCHESTER
13	MANCHESTER	RAYS BROOK
14	MANCHESTER	STEVENS POND, MANCHESTER, WWF
15	NASHUA	NASHUA RIVER - MINE FALLS DAM POND
16	NEWINGTON	PAULS BROOK
17	PORTSMOUTH	BORTHWICK AVE BROOK
18	PORTSMOUTH	LOWER HODGSON BROOK
19	PORTSMOUTH	NEWFIELDS DITCH
20	PORTSMOUTH	PICKERING BROOK
21	PORTSMOUTH	SAGAMORE CREEK
22	PORTSMOUTH	UPPER HODGSON BROOK
23	RYE	EEL POND, RYE
24	SALEM	POLICY BROOK
25	SALEM	UNNAMED TRIB TO HARRIS BROOK
26	SEABROOK	CAINS BROOK - NOYES POND
27	STRATHAM	PARKMAN BROOK
28	Plus Non traditional and Transportation MS4 sdischarging to the waterbodies listed above	

ATTACHMENT 1

ATTACHMENT 1 TO APPENDIX H

The estimates of nitrogen load reductions resulting from BMP installation and illicit connection removal are intended for informational purposes only and there is no associated permittee specific required nitrogen load reduction specified by the Draft Permit. Nitrogen load reduction estimates calculated consistent with the methodologies below may be used by the permittee to comply with future permit conditions or future TMDL WLAs if the EPA and the state agency find the reductions consistent with future permit conditions or WLAs.

This attachment provides the method and an example to calculate the BMP Nitrogen load as well as methods to calculate nitrogen load reductions for structural BMPs, illicit removal in an impaired Watershed.

(1)Nitrogen Reduction Estimates for Elimination of Illicit Connections and Discharges

The permitee may estimate nitrogen reduction from eliminating illicit connections within the Watershed. Before estimating this reduction ($\text{Reduction}_{\text{illicit}}$), the permittee must provide documentation of how the discharge was disconnected and eliminated and keep such documentation in their SWMP. The $\text{Reduction}_{\text{illicit}}$ shall be determined by using Equation 4-2, detailed below. The discharge flow is estimated using metered household water use, or can be estimated based on the number of occupants and an average water use of 60 gallons/day. The permittee may select an area specific average occupant water use for use in calculating the nitrogen reduction if the permittee documents the basis for deviating from 60 gal/day in their SWMP.

$\text{Reduction}_{\text{illicit}}$ = (Discharge flow) x (Water use factor) x ($\text{TN}_{\text{illicit}}$) x (conversion factor)
(Equation 4-2)

Where:

$\text{Reduction}_{\text{illicit}}$	= Amount of nitrogen load reduction for elimination of illicit discharge (lbs/year)
Discharge Flow	= Estimate of discharge flow (gallons/day)
$\text{TN}_{\text{illicit}}$	= 40 mg/L (nitrogen concentration in sewerage[1])
Water use factor	=0.9 (assume 90% of water used goes to sanitary sewer)
Conversion factor	= 0.00304 (factor to convert to lbs/day

Example 2-5: Calculation for illicit disconnection ($\text{Reduction}_{\text{illicit}}$): A permittee identifies an illicit connection from a single family home in the Watershed Area and works with the offending discharger to eliminate the illicit connection. The household has an average daily water use of 150 gallons/day.

Substitution into equation 4-2 yields a $\text{Reduction}_{\text{illicit}}$ of 16.4 pounds of nitrogen removed per year:

$\text{Reduction}_{\text{illicit}}$ = (150 gal/day) x (0.9) x (40 mg/L) x (0.00304)
= **16.4 lbs/yr**

[1] Metcalf&Eddy, Wastewater Engineering,Treatment and Reuse. McGraw-Hill. 2003. Table 3-15.

Example continued:

Example 2-5a: Calculation for illicit disconnection when household water use is not known: A permittee identifies an illicit connection from a single family home in the Watershed Area and works with the offending discharger to eliminate the illicit connection. The household has 5 occupants.

Calculation of discharge flow:

Discharge Flow = (5 occupants) x (60 gallons per occupant/day)
= 300 gallons / day

Substitution into equation 4-2 yields a Reduction $_{\text{illicit}}$ of 32.8 pounds of nitrogen removed per year:

Reduction $_{\text{illicit}}$ = (300 gal/day) x (0.9) x (40 mg/L) x (0.00304) = **32.8 lbs/yr**

(2) Nitrogen Reduction Estimates from the installation of Structural Controls:

BMP N Load:

The **BMP N Load** is the annual nitrogen load from the drainage area to each proposed or existing BMP used by permittee. This measure is used to estimate the amount of annual nitrogen load that the BMP will receive or treat (BMP N Load).

To calculate the BMP N Load for a given BMP:

1) Determine the total drainage area to the BMP and sort the total drainage area into two categories: total impervious area (IA) and total pervious area (PA);

2) Calculate the nitrogen load associated with impervious area (N Load $_{IA}$) and the pervious area (N Load $_{PA}$) by multiplying the IA and PA by the appropriate land use-based nitrogen load export rate provided in Table 4-1; and

3) Determine the total nitrogen load to the BMP by summing the calculated impervious and pervious subarea nitrogen loads.

Example 4-1 to determine nitrogen load to a proposed BMP: A permittee is proposing a storm water infiltration system that will treat runoff from 8.23 impervious acres and 1.51 acres of landscaped pervious area (HSG C).

The **BMP N Load** = (N Load $_{IA}$) + (N Load $_{PA}$)

Where:

N Load $_{IA}$ = (IA) x (impervious cover nitrogen export loading rate (Table 4-1))
= 8.23 acre x 14.1 lbs/acre/year
= 116 lbs N/year

Example continued:

N Load $_{PA}$ = (PA) x (pervious cover nitrogen export loading rate, HSG A/B (Table 4-1))
= 1.51 acre x 2.7 lbs/acre/year
= 4.1 lbs N/year

BMP N Load = 116 lbs N/year + 4.1 lbs N/year
= **120.1 lbs N/year**

Table 4-1. Annual nitrogen load export rates

Nitrogen Source Category by Land Use	Land Surface Cover	Nitrogen Load Export Rate, lbs/ac/yr	Nitrogen Load Export Rate, kg/ha/yr
All Impervious Cover	Impervious	14.1	15.8
*Developed Land Pervious (DevPERV)- HSG A/B	Pervious	1.4	1.6
*Developed Land Pervious (DevPERV) – HSG C	Pervious	2.7	3.1
*Developed Land Pervious (DevPERV) - HSG D	Pervious	4.6	5.2
Notes: • For pervious areas, if the hydrologic soil group (HSG) is known, use the appropriate value from this table. If the HSG is not known, assume HSG D conditions for the nitrogen load export rate.			

Method to Calculate Nitrogen Load Reductions from Structural Storm Water Best Management Practices

Methods and examples are provided in this Attachment to calculate nitrogen load reductions for the structural BMPs presented in Table 4-3 for the following purposes:

1) To determine the nitrogen load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious;
2) To determine the nitrogen load reduction for a structural BMP with a known design volume when the contributing drainage area has impervious and pervious surfaces.

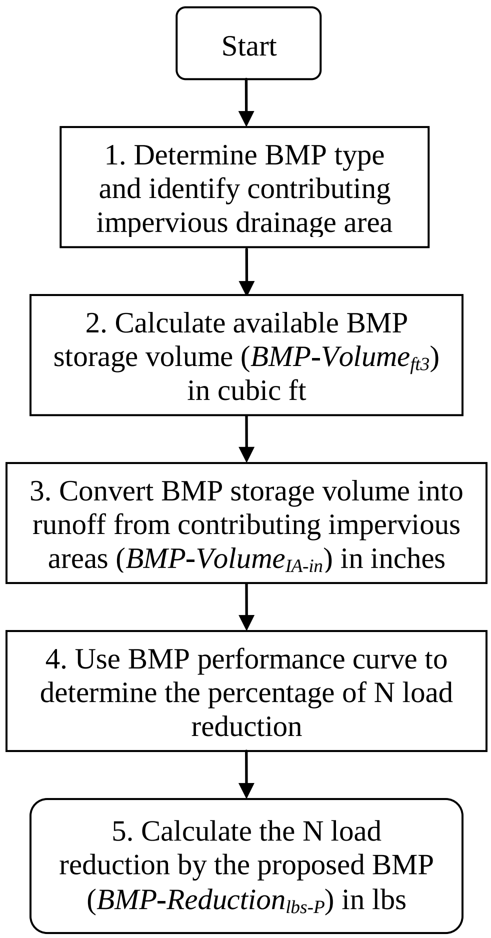
Table 4-3. Classification of BMP to Determine Nitrogen Reduction[1]

Structural BMP	Classification
Infiltration Trench	Runoff Reduction (RR)
Infiltration Basin or other surface infiltration practice	Runoff Reduction (RR)
Bioretention Practice	Runoff Reduction (RR)
Gravel Wetland System	Stormwater Treatment (ST)
Porous Pavement	Runoff Reduction (RR)
Wet Pond or wet detention basin	Stormwater Treatment (ST)
Dry Pond or detention basin	Runoff Reduction (RR)
Water Quality Swale	Runoff Reduction (RR)

[1]**Recommendations of the Expert Panel to Define Removal Rates for New State Stormwater Performance Standards** http://chesapeakestormwater.net/wp-content/plugins/download-monitor/download.php?id=25, Retrieved 12/14/2012

<u>Method to determine the nitrogen load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious:</u>

Flow Chart 1 illustrates the steps to determine the nitrogen load reduction for a structural BMP with a known design volume when the contributing drainage area is 100% impervious.



Flow Chart 1. Method to determine the nitrogen load reduction for a BMP with a known design volume when contributing drainage area is 100% impervious.

1) Identify the structural BMP type and contributing impervious drainage area (IA);

2) Document the available storage volume (ft^3) of the structural BMP (BMP-Volume $_{ft}{}^3$) using the BMP dimensions and design specifications (e.g., maximum storage depth, filter media porosity);

3) Convert BMP-Volume $_{ft}{}^3$ into inches of runoff from the contributing impervious area (BMP-Volume $_{IA\text{-}in}$) using equation 4-3:

BMP-Volume $_{IA\text{-}in}$ = BMP-Volume $_{ft^3}$/ IA (acre) x 12 in/ft x 1 acre/43560 ft^2 **(Equation 4-3)**

4) Determine the % nitrogen load reduction for the structural BMP (BMP Reduction $_{\%\text{-}N}$) using the appropriate BMP performance curve in Figure 4-1 (determined using Table 4-3) and the BMP-Volume $_{IA\text{-}in}$ calculated in step 3; and

5) Calculate the nitrogen load reduction in pounds of nitrogen for the structural BMP (BMP Reduction $_{lbs\text{-}N}$) using the BMP N Load as calculated from the procedure in above and the percent nitrogen load reduction (BMP Reduction $_{\%\text{-}N}$) determined in step 4 by using equation 4-4:

BMP Reduction $_{lbs\text{-}N}$ = BMP N Load x (BMP Reduction $_{\%\text{-}N}$/100) **(Equation 4-4)**

Example 4-3: Determine the nitrogen load reduction for a structural BMP with a known storage volume capacity when the contributing drainage area is 100% impervious:
A permittee is considering a bioretention system to treat runoff from 1.49 acres of impervious area. Site constraints would limit the bioretention system to have a surface area of 1200 ft^2 and the system would have to be located next to the impervious drainage area to be treated. The design parameters for the bioretention system are presented in Table Example 4-3. Biorention is considered a runoff reduction practice (Table 4-3).

Table Example 4-3. Design parameters for bioretention system for Example 4-3

Components of representation	Parameters	Value
Ponding	Maximum depth	6 in
	Surface area	1200 ft^2
	Vegetative parameter[a]	85-95%
Soil mix	Depth	30 in
	Porosity	40%
	Hydraulic conductivity	4 inches/hour
Gravel layer	Depth	8 in
	Porosity	40%
	Hydraulic conductivity	14 inches/hour
Orifice #1	Diameter	6 in

[a] Refers to the percentage of surface covered with vegetation

Determine the:

A) Percent nitrogen load reduction (BMP Reduction $_{\%\text{-}N}$) for the specified bioretention system and contributing impervious drainage area; and

B) Nitrogen reduction in pounds that would be accomplished by the bioretention system (BMP-Reduction $_{lbs\text{-}N}$)

<u>Solution:</u>

1) The BMP is a bioretention system that will treat runoff from 1.49 acres of impervious area (IA = 1.49 acre);

2) The available storage volume capacity (ft^3) of the bioretention system (BMP-Volume $_{BMP\text{-}ft^3}$) is determined using the surface area of the system, depth of ponding, and the porosity of the filter media:

Example Continued:

BMP-Volume $_{BMP\text{-}ft^3}$ = (surface area x pond maximum depth) + ((soil mix depth + gravel layer depth)/12 in/ft) x surface area x gravel layer porosity)
= (1,200 ft^2 x 0.5 ft) + ((38/12) x 1,200 ft^2 x 0.4)
= 2,120 ft^3

3) The available storage volume capacity of the bioretention system in inches of runoff from the contributing impervious area (BMP-Volume $_{IA\text{-}in}$) is calculated using equation 4-3:

BMP-Volume $_{IA\text{-}in}$ = (BMP-Volume $_{ft}{}^3$/ IA (acre) x 12 in/ft x 1 acre/43560 ft^2
BMP-Volume $_{IA\text{-}in}$ = (2120 ft^3/1.49 acre) x 12 in/ft x 1 acre/43560 ft^2
= 0.39 in

4) Using the RR performance curve shown in Figure 4-1 for a bioretention practice (Table 4-3), a **40%** nitrogen load reduction (BMP Reduction %-N) is determined for a bioretention system sized for 0.39 in of runoff from 1.49 acres of impervious area; and

5) Calculate the nitrogen load reduction in pounds of nitrogen for the bioretention system (BMP Reduction $_{lbs\text{-}N}$) using the BMP Load as calculated above in Example 4-1 and the BMP Reduction $_{\%\text{-}N}$ determined in step 4 by using equation 4-4.

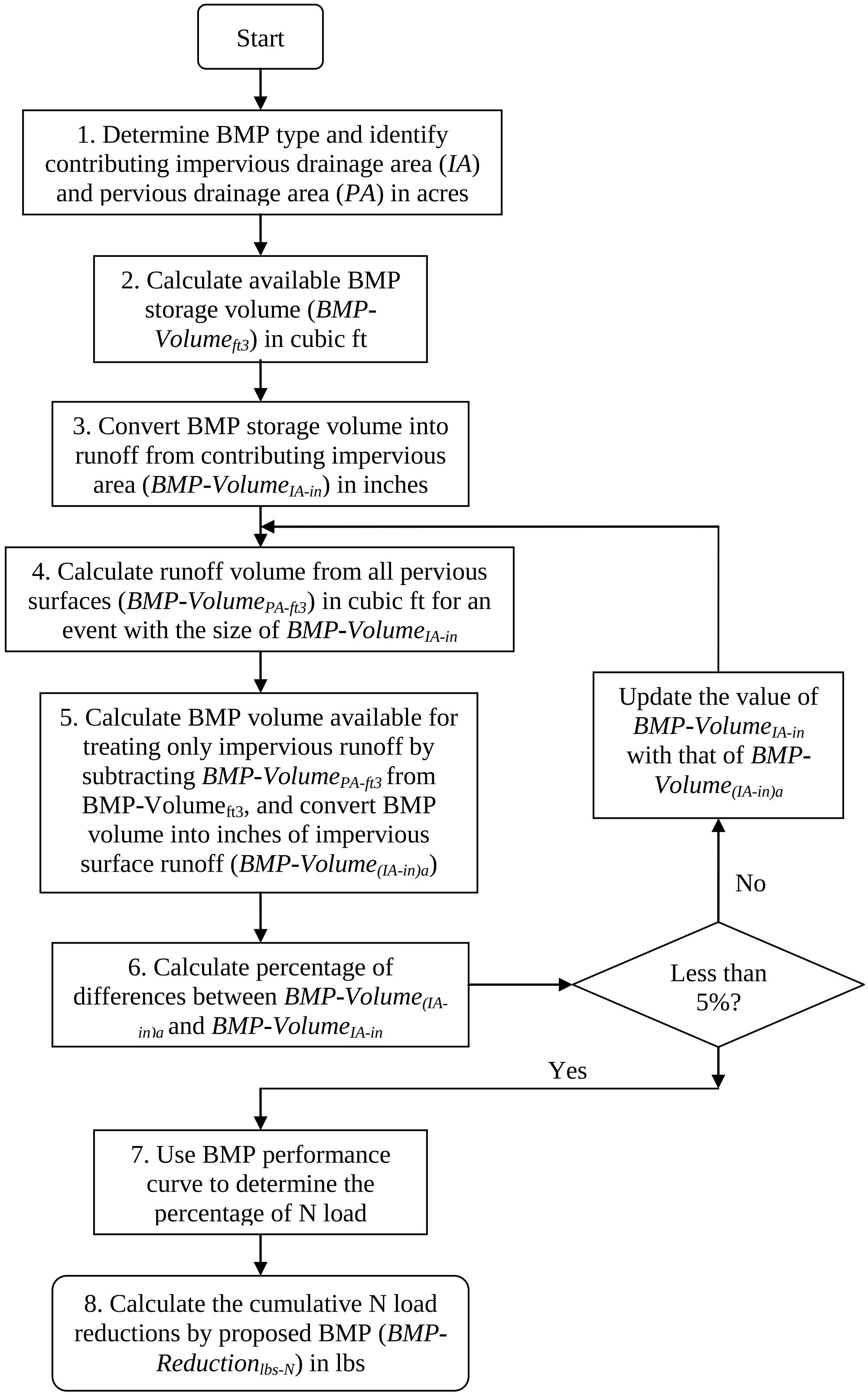
First, the BMP Load is determined as specified in Example 4-1:

BMP Load = IA (acre) x 14.1 lb/ac/yr
= 1.49 acres x 14.1 lbs/acre/yr
= 21 lbs/yr

BMP Reduction $_{lbs\text{-}N}$ = BMP Load x (BMP Reduction $_{\%\text{-}N}$/100)
BMP Reduction $_{lbs\text{-}N}$ = 21 lbs/yr x (40/100)
= **8.4 lbs/yr**

Method to determine the nitrogen load reduction for a structural BMP with a known storage volume when the contributing drainage area has impervious and pervious surfaces:

Flow Chart 2 illustrates the steps to determine the nitrogen load reduction for a structural BMP with a known storage volume when the contributing drainage area has impervious and pervious surfaces.



Flow Chart 2. Method to determine the nitrogen load reduction for a BMP with known storage volume when both pervious and impervious drainage areas are present.

1) Identify the type of structural BMP and characterize the contributing drainage area to the structural BMP by identifying the following information for the impervious and pervious surfaces:

Impervious area (IA) – Area (acre) and export rate (Table 4-1)

Pervious area (PA) – Area (acre) and runoff depth based on hydrologic soil group (HSG) and size of rainfall event. Table 4-4 provides values of runoff depth for various rainfall depths and HSGs. Soils are assigned to an HSG based on their permeability. HSG categories for pervious areas in the Watershed shall be estimated by consulting local soil surveys prepared by the National Resource Conservation Service (NRCS) or by a storm water professional evaluating soil testing results from the Watershed. If the HSG condition is not known, a HSG D soil condition should be assumed.

Table 4-4. Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups (HSGs)

Rainfall Depth, Inches	Runoff Depth, inches		
	Pervious HSG A/B	Pervious HSG C	Pervious HSG D
0.10	0.00	0.00	0.00
0.20	0.00	0.01	0.02
0.40	0.00	0.03	0.06
0.50	0.00	0.05	0.09
0.60	0.01	0.06	0.11
0.80	0.02	0.09	0.16
1.00	0.03	0.12	0.21
1.20	0.04	0.14	0.39
1.50	0.11	0.39	0.72
2.00	0.24	0.69	1.08

Notes: Runoff depths derived from combination of volumetric runoff coefficients from Table 5 of *Small Storm Hydrology and Why it is Important for the Design of Stormwater Control Practices*, Pitt, 1999 and using the Stormwater Management Model (SWMM) in continuous model mode for hourly precipitation data for Boston, MA, 1998-2002.

2) Determine the available storage volume (ft^3) of the structural BMP (BMP-Volume $_{ft^3}$) using the BMP dimensions and design specifications (e.g., maximum storage depth, filter media porosity);

3) To estimate the nitrogen load reduction of a BMP with a known storage volume capacity, it is first necessary to determine the portion of available BMP storage capacity (BMP-Volume $_{ft^3}$) that would treat the runoff volume generated from the contributing impervious area (IA) for a rainfall event with a depth of *i* inches (in). This will require knowing the corresponding amount of runoff volume that would be generated from the contributing pervious area (PA) for the same rainfall event (depth of *i* inches). Using equation 4-5a below, solve for the BMP capacity that would be available to treat runoff from the contributing imperious area for the unknown rainfall depth of *i* inches (see equation 4-5b):

BMP-Volume $_{ft^3}$ = BMP-Volume $_{(IA\text{-}ft^3)i}$ + BMP-Volume $_{(PA\text{-}ft^3)i}$ **(Equation 4-5a)**

Where:

BMP-Volume $_{ft^3}$	= the available storage volume of the BMP
BMP-Volume $_{(IA\text{-}ft^3)i}$	= the available storage volume of the BMP that would fully treat runoff generated from the contributing impervious area for a rainfall event of size *i* inches
BMP-Volume $_{(PA\text{-}ft^3)i}$	= the available storage volume of the BMP that would fully treat runoff generated from the contributing pervious area for a rainfall event of size *i* inches

Solving for BMP-Volume $_{(IA\text{-}ft^3)i}$:
BMP-Volume $_{(IA\text{-}ft^3)i}$ = BMP-Volume $_{ft^3}$ - BMP-Volume $_{(PA\text{-}ft^3)i}$ **(Equation 4-5b)**

To determine BMP-Volume $_{(IA\text{-}ft^3)i}$, requires performing an iterative process of refining estimates of the rainfall depth used to calculate runoff volumes until the rainfall depth used results in the sum of runoff volumes from the contributing IA and PA equaling the available BMP storage capacity (BMP-Volume $_{ft^3}$). For the purpose of estimating BMP performance, it will be considered adequate when the IA runoff depth (in) is within 5% IA runoff depth used in the previous iteration.

For the first iteration (1), convert the BMP-Volume $_{ft^3}$ determined in step 2 into inches of runoff from the contributing impervious area (BMP Volume $_{(IA\text{-}in)1}$) using equation 4-6a.

BMP-Volume $_{(IA\text{-}in)1}$ = (BMP-Volume$_{ft^3}$/ IA (acre)) x (12 in/ft /43,560 ft^2/acre)
(Equation 4-6a);

For iterations 2 through n (2…n), convert the BMP Volume $_{(IA\text{-}ft^3)2...n}$, determined in step 5a below, into inches of runoff from the contributing impervious area
(BMP Volume $_{(IA\text{-}in)2…n}$) using equation 4-6b.

BMP-Volume $_{(IA\text{-}in)2...n}$ = (BMP-Volume $_{(IA\text{-}ft^3)2...n}$ / IA (acre)) x (12 in/ft /43,560 ft^2/acre)
(Equation 4-6b);

4) For 1 to n iterations, use the pervious runoff depth information from Table 4-4 and equation 4-7 to determine the total volume of runoff (ft^3) from the contributing PA (BMP Volume $_{PA\text{-}ft^3}$) for a rainfall size equal to the sum of BMP-Volume $_{(IA\text{-}in)1}$, determined in step 3. The runoff volume for each distinct pervious area must be determined.

BMP Volume $_{(PA\text{-}ft^3)1...n}$ = ∑ ((PA x (runoff depth)$_{(PA1,\ PA2..PAn)}$ x (3,630 ft^3/acre-in)
(Equation 4-7)

5) For iteration 1, estimate the portion of BMP Volume that is available to treat runoff from only the IA by subtracting BMP-Volume $_{PA\text{-}ft^3}$, determined in step 4, from BMP-Volume

$_{ft^3}$, determined in step 2, and convert to inches of runoff from IA (see equations 4-8a and 4-8b):

BMP-Volume $_{(IA\text{-}ft^3)2}$ = ((BMP-Volume$_{ft^3}$- BMP Volume $_{(PA\text{-}ft^3)1}$) **(Equation 4-8a)**

BMP-Volume $_{(IA\text{-}in)2}$ = (BMP-Volume $_{(IA\text{-}ft^3)2}$/IA (acre)) x (12 in/ft x 1 acre/43,560 ft^2) **(Equation 4-8b)**

If additional iterations (i.e., 2 through n) are needed, estimate the portion of BMP volume that is available to treat runoff from only the IA (BMP-Volume $_{(IA\text{-}in)3..n+1}$) by subtracting BMP Volume $_{(PA\text{-}ft^3)2..n}$, determined in step 4, from BMP Volume $_{(IA\text{-}ft^3)3..n+1}$, determined in step 5, and by converting to inches of runoff from IA using equation 4-8b):

6) For iteration A (an iteration between 1 and n+1), compare BMP Volume $_{(IA\text{-}in)a}$ to BMP Volume $_{(IA\text{-}in)a\text{-}1}$ determined from the previous iteration (a-1). If the difference in these values is greater than 5% of BMP Volume $_{(IA\text{-}in)a}$ then repeat steps 4 and 5, using BMP Volume $_{(IA\text{-}in)a}$ as the new starting value for the next iteration (a+1). If the difference is less than or equal to 5 % of BMP Volume $_{(IA\text{-}in)a}$ then the permittee may proceed to step 7.

7) Determine the % nitrogen load reduction for the structural BMP (BMP Reduction $_{\%\text{-}N}$) using the appropriate BMP curve on Figure 4-1 and the BMP-Volume $_{(IA\text{-}in)n}$ calculated in the final iteration of step 5; and

8) Calculate the nitrogen load reduction in pounds of nitrogen for the structural BMP (BMP Reduction $_{lbs\text{-}N}$) using the BMP Load as calculated above in Example 4-1 and the percent nitrogen load reduction (BMP Reduction $_{\%\text{-}N}$) determined in step 7 by using equation 4.4:

BMP Reduction $_{lbs\text{-}N}$ = BMP Load x (BMP Reduction $_{\%\text{-}N}$/100) **(Equation 4.4)**

Example 4-4: Determine the nitrogen load reduction for a structural BMP with a known design volume when the contributing drainage area has impervious and pervious surfaces

A permittee is considering an infiltration basin to capture and treat runoff from a portion of the Watershed draining to the impaired waterbody. The contributing drainage area is 16.55 acres and is 71% impervious. The pervious drainage area (PA) is 80% HSG D and 20% HSG C. An infiltration basin with the following specifications can be placed at the down-gradient end of the contributing drainage area where soil testing results indicates an infiltration rate (IR) of 0.28 in/hr:

Structure	Bottom area (acre)	Top surface area (acre)	Maximum pond depth (ft)	Design storage volume (ft^3)	Infiltration Rate (in/hr)
Infiltration basin	0.65	0.69	1.65	48,155	0.28

Example continued:

Determine the:

A) Percent nitrogen load reduction (BMP Reduction $_{\%-N}$) for the specified infiltration basin and the contributing impervious and pervious drainage area; and

B) Nitrogen reduction in pounds that would be accomplished by the BMP (BMP-Reduction $_{lbs-N}$)

Solution:

1) A surface infiltration basin is being considered. Information for the contributing impervious (IA) and pervious (PA) areas are summarized in Tables Example 4-4-A and Example 4-4-B, respectively.

Table Example 4-4-A Impervious area characteristics

ID	% Impervious	Area (acre)
IA1	100	11.75

Table Example 4-4-B Pervious area characteristics

ID	Area (acre)	Hydrologic Soil Group (HSG)
PA1	3.84	D
PA2	0.96	C

2) The available storage volume (ft^3) of the infiltration basin (BMP-Volume $_{ft}{}^3$) is determined from the design details and basin dimensions; BMP-Volume $_{ft}{}^3$ = 48,155 ft^3.

3) To determine what the BMP design storage volume is in terms of runoff depth (in) from IA, an iterative process is undertaken:

Solution Iteration 1

For the first iteration (1), the BMP-Volume$_{ft}{}^3$ is converted into inches of runoff from the contributing impervious area (BMP Volume $_{(IA-in)1}$) using equation 4-6a.

BMP Volume $_{(IA-in)1}$ = (48,155 ft^2/ 11.75 acre) x (12 in/ft /43,560 ft^2/acre)
= 1.13 in

4-1) The total volume of runoff (ft^3) from the contributing PA (BMP Volume $_{PA-ft}{}^3$) for a rainfall size equal to the sum of BMP Volume $_{(IA-in)1}$ determined in step 3 is determined for each distinct pervious area identified in Table Example 4-4-B using the information from Table 4-3 and equation 4-7. Interpolation was used to determine runoff depths.

BMP Volume $_{(PA-ft}{}^3{}_{)1}$ = ((3.84 acre x (0.33 in) + (0.96 acre x (0.13 in)) x 3,630 ft^3/acre-in
= 5052 ft^3

5-1) For iteration 1, the portion of BMP Volume that is available to treat runoff from only the IA is estimated by subtracting the BMP Volume $_{(PA-ft}{}^3{}_{)1}$, determined in step 4-1, from BMP Volume$_{ft}{}^3$, determined in step 2, and converted to inches of runoff from IA:

Solution continued:

BMP Volume $_{(IA\text{-}ft^3)\,2}$ = 48,155 ft^3 – 5052 ft^3
= 43,103 ft^3

BMP Volume $_{(IA\text{-}in)\,2}$ = (43,103 ft^3/11.75 acre) x (12 in/ft x 1 acre/43,560 ft^2)
= 1.01 in

6-1) The % difference between BMP Volume $_{(IA\text{-}in)\,2}$, 1.01 in, and BMP Volume $_{(IA\text{-}in)1}$, 1.13 in is determined and found to be significantly greater than 5%:

% Difference = ((1.13 in – 1.01 in)/1.01 in) x 100
= 12%

Therefore, steps 4 through 6 are repeated starting with BMP Volume $_{(IA\text{-}in)\,2}$ = 1.01 in.

Solution Iteration 2

4-2) BMP-Volume $_{(PA\text{-}ft^3)2}$ = ((3.84 acre x 0.21 in) + (0.96 acre x 0.12 in)) x 3,630 ft^3/acre-in
= 3,358 ft^3

5-2) BMP-Volume $_{(IA\text{-}ft^3)\,3}$ = 48,155 ft^3 – 3,358 ft^3
= 44,797 ft^3

BMP-Volume $_{(IA\text{-}in)\,3}$ = (44,797 ft^3/11.75 acre) x (12 in/ft x 1 acre/43,560 ft^2)
= 1.05 in

6-2) % Difference = ((1.05 in – 1.01 in)/1.05 in) x 100
= 4%

The difference of 4% is acceptable.

7) The % nitrogen load reduction for the infiltration basin (BMP Reduction $_{\%\text{-}N}$) is determined by using the RR treatment curve in Figure 4-1 and the treatment volume (BMP-Volume $_{Net\ IA\text{-}in}$ = 1.05 in) calculated in step 5-2 and is **BMP Reduction $_{\%\text{-}N}$ = 56%**.

8) The nitrogen load reduction in pounds of nitrogen (BMP-Reduction $_{lbs\text{-}N}$) for the proposed infiltration basin is calculated by using equation 4-4 with the BMP Load (as determined by the procedure in Example 4-1) and the N $_{target}$ of 56%.

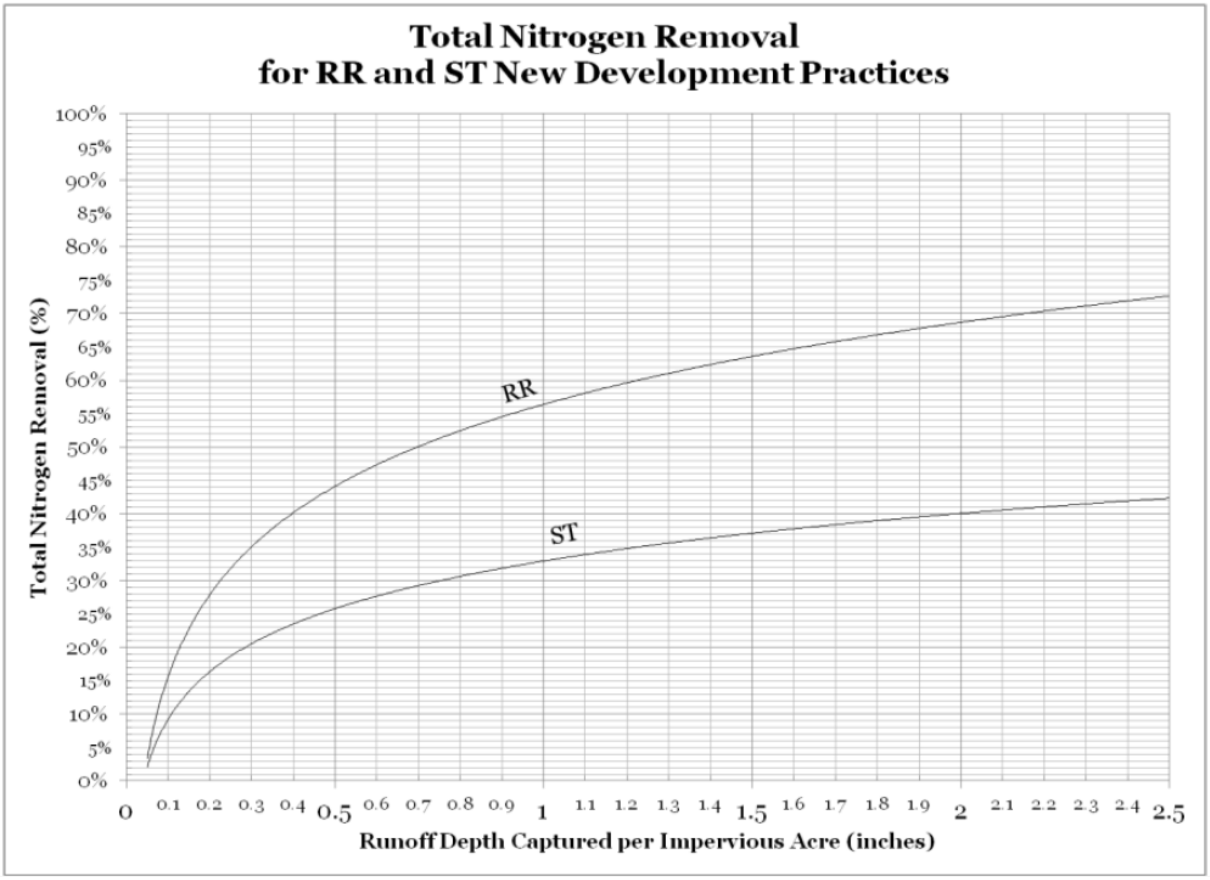
BMP-Reduction $_{lbs\text{-}N}$ = BMP N Load x (N $_{target}$ /100) **(Equation 4.4)**

Following example 4-1, the BMP load is calculated:

BMP N Load = (IA x impervious cover nitrogen export loading rate)
+ (PA$_{HSG\ D}$ x pervious cover nitrogen export loading rate, HSG D
+ (PA$_{HSG\ C}$ x pervious cover nitrogen export loading rate, HSG C)
= (16.55 acre x 15.4 lbs/acre/yr) + (3.84 acre x 4.6 lbs/acre/yr) + (0.96 acre x 2.7 lbs/acre/yr)
= 275.13 lbs/yr

BMP-Reduction $_{lbs\text{-}N}$ = 275.13 lbs/yr x 56/100 = **154.1 lbs/yr**

Figure 4-1. Total Nitrogen Removal for RR and ST Practices



Adopted from: Final CBP Approved Expert Panel Report on Stormwater Retrofits
http://chesapeakestormwater.net/wp-content/plugins/download-monitor/download.php?id=25, Retrieved 12/14/2012