North Carolina Department of Environment and Natural Resources

Pat McCrory
Governor

John E. Skvarla, III
Secretary

November 24, 2014

MEMORANDUM

TO: ENVIRONMENTAL REVIEW COMMISSION
The Honorable Mike Hager, Co-Chair
The Honorable Ruth Samuelson, Co-Chair
The Honorable Brent Jackson, Co-Chair

FROM: Neal Robbins, Director of Legislative Affairs

SUBJECT: Minimum Design Criteria for Stormwater Management Report

DATE: November 24, 2014

Pursuant to S.L. 2014-120 section 50, the Department shall submit interim reports on its progress in developing the Minimum Design Criteria to the Environmental Review Commission no later than September 1, 2014, and December 1, 2014. Please consider the attached as the formal submission this report.

If you have any questions or need additional information, please contact me by phone at (919) 707-8618 or via e-mail at neal.robbins@ncdenr.gov.

cc: Mitch Gillespie, Assistant Secretary for Environment, NCDENR
Tracy Davis, Director of Energy, Mineral, and Land Resources, NCDENR

1601 Mail Service Center, Raleigh, North Carolina 27699-1601
Phone: 919-707-8600 \ Internet: www.ncdenr.gov

NC Department of Environment and Natural Resources

Division of Energy, Mineral, and Land Resources

Progress Report on the Development of Minimum Design Criteria for Stormwater Management Pursuant to the Requirements of S.L. 2013-82 and S.L 2014-120

December 1, 2014

Since March 2014, the Minimum Design Criteria (MDC) Team has worked diligently to meet the regulatory requirements associated with Session Law 2013-82 (House Bill 480). This law requires DENR to convene a stakeholder team that includes industry experts, engineers, environmental consultants, faculty from the University of North Carolina and other stakeholders to develop MDC for stormwater management.

In summary, the Session Law 2013-82 tasks the MDC Team with the following:

1. To consult with DENR in developing MDCs that encompass all requirements for siting, design, construction and maintenance of stormwater BMPs. The MDCs shall be developed with the goal of generating state stormwater permits that comply with state water quality standards. DENR shall submit its recommendations to the Environmental Review Commission by September 1, 2014. (Session Law 2014-120 extended this deadline to February 1, 2015 with progress reports due to the ERC by September 1, 2014 and December 1, 2014)

2. To consult with the N.C. Environmental Management Commission (EMC) in developing a fast-track permitting process for issuing state stormwater permits without a technical review when all best management practices comply with all MDCs and the permit application is prepared by a qualified individual. The EMC shall adopt a fast-track permitting rule no later than July 1, 2016.

The MDC stakeholder team is comprised of 25 members who represent environmental consultants, the construction industry, local governments, university faculty, environmental groups, soil scientists, landscape architects, DOT and DENR. (See Appendix A for a list of team members.) The team has met for three to five hours once a month since March 2014 and has invested time between each meeting reading and preparing comments.

Despite the broad composition of the team, team members have been successful in reaching consensus and it has been a great opportunity to review and update stormwater design standards with a diverse and knowledgeable group of experts. In many cases, the work products of the MDC Team remove outdated design standards that are no longer believed to protect water quality. The efforts of the MDC Team are documented on the MDC Team web site at: http://portal.ncdenr.org/web/lr/state-stormwater/mdc-team.

Achievements of the MDC Team to Date

The first achievement of the MDC Team was the approval of a charter to establish procedures and protocols. The second was to define "Minimum Design Criteria" (MDC) and several other terms that clarify the role that a design practice might have in addressing water quality standards:

- *Minimum Design Criteria (MDC):* Design standards that must be met to ensure that a stormwater treatment system functions in perpetuity to protect water quality standards and achieves the pollutant removal rates associated with the system. The MDC apply to stormwater treatment systems regardless of the geographical location of the system, the stormwater program requirements to which it is subject or whether the system is being reviewed under the fast-track or regular review process. Additional supplemental design standards (described below) may also be implemented to address watershed-specific concerns. The design standards to be adhered by are to be based on state statute or NC Administrative Code.
- *Recommendation:* Design standards that the MDC Team considers to be a good idea but are not required by statute or rule to obtain a stormwater plan approval. Recommendations do not play any part in permitting decisions; they are just suggestions for designers to consider and use or discard as they deem appropriate.
- *Nutrient Design Criteria:* Supplemental design standards in addition to the MDC to increase the Total Nitrogen (TN) and Total Phosphorus (TP) pollutant removal rates associated with the device. Each nutrient design criteria will have an associated increase in TN and TP reduction for the device.
- *Bacteria Design Recommendation:* Supplemental design recommendations in addition to the MDC to optimize the device's effectiveness in reducing bacteria concentrations in stormwater. (Note: The larger design storm required for SA waters is one means for addressing removal of bacteria.)

- *Temperature Design Recommendation:* Supplemental design recommendations in addition to the MDC to optimize the device's effectiveness in reducing temperature impacts from stormwater.

Thus far, the MDC Team has developed MDC for the following:

- General MDC for all Stormwater Control Measures
- Wet ponds
- Stormwater wetlands
- Infiltration systems
- Bioretention cells
- Level spreader-vegetated filter strips
- Sand filters

The list of MDC for the completed items above is included in Appendix B.

Goals for the Future

The MDC Team's schedule for completing the remaining stormwater control measures before February 1, 2015 is:

- December 15, 2014: Disconnected impervious surfaces and swales
- January 12, 2015 (added meeting): Rainwater harvesting and green roofs
- January 26, 2015: Permeable pavement

DEMLR staff is incorporating the MDC into two very important products:

- Updates to the DENR Stormwater Guidance Manual so that it is consistent with the MDC developed by the MDC Team.
- Rule-making to codify the MDC into the 15A NCAC 2H .1000 rules, which govern the design, construction and maintenance requirements for stormwater control measures.

The MDC Team is aware of DEMLR's efforts to update the Stormwater Guidance Manual and the 15A NCAC 2H .1000 rules. Team members have been invited to provide input in both of these processes.

Beginning in February 2015, the MDC Team will commence with developing a fast-track permitting process for issuing state stormwater permits with a minimized technical review when all best management practices comply with all MDCs and the permit application is

prepared and certifed by a qualified individual. As a part of this process, the team will also better define compliance with the stormwater regular review process to determine what the baseline compliance requirements are and how these baseline requirements will be addressed in the fast-track process.

DEMLR staff have begun discussing the rule-making process with both the DENR rule-making coordinator as well as staff attorneys for the Rules Review Commission. Based on these discussions, staff have drafted the following rule-making process for the fast-track program:

Jul 8, 2015	WQC approves rule text
Jul - Oct 2015	DEMLR develops fiscal note
Nov 1, 2015	OSBM certifies fiscal note
Nov 12, 2015	WQC (30 day wavier) / EMC approves rule & fiscal note
Nov 20, 2015	DEMLR's files rule & fiscal note in Register
Dec 15, 2015	Comment period begins (hearing after 12/29)
Feb 16, 2016	Comment period ends
May 2016	WQC (30 day waiver) / EMC adopts rule

DEMLR staff presented the progress of the MDC to the EMC's Water Quality Committee on November 12, 2014, so they are aware of the process and the proposed timeframe for rule-making.

Appendix A: MDC Team Membership

Name	Group	Company / Representing	Phone	email
Marc Houle, PE	Eng	Yarbrough Williams & Houle Inc.	(704) 556-1990 (704) 361-3524	march@y-wh.com
Cameron Moore	Eng	Business Alliance for a Sound Economy	(910) 799.2611	cameron@wilmhba.com
Ronald Horvath, PE	Eng	Horvath Associates	(919) 490-4990	***ron.horvath***@horvathassociates.com
Tim Clinkscales, PE	Eng	Paramounte Engineering	(910) 791-6707	tclinkscales@paramounte-eng.com
Hunter Freeman, PE	Eng	Withers & Ravenel	(919) 469-3340	hfreeman@withersravenel.com
Mike Gallant, PE	Eng	Michael C. Gallant, PE	(910) 448-1046	gallantmc@yahoo.com
Tom Murray, PE	Eng	W.K. Dickson & Co., Inc. & PENC	(919) 782-0495	tmurray@wkdickson.com
JD Solomon, PE	Eng	CH2M Hill	(919) 760-4099	JD.Solomon@CH2M.com
Rob Weintraub	HBA	Home Builders Association	(919) 291-2213	amenitydeveloper@gmail.com
Jonathan Bivens, PE	Con	S. T. Wooten Corporation	(252) 291-5165	jonathan@stwcorp.com
Derek Pielech, PE	LG	City of Wilmington	(910) 341-5818	derek.pielech@wilmingtonnc.gov
Virginia Spillman, PE	LG	City of Greensboro	(336) 373-2055	claudia.spillman@greensboro-nc.gov
Robert Patterson, PE	LG	Town of Morrisville	(919) 463-6216	RPatterson@townofmorrisville.org
Mike MacIntyre, PE	LG	Charlotte-Mecklenburg Storm Water Services	(704) 432-5570	mmacintyre@ci.charlotte.nc.us
Todd Miller	Env	N.C. Coastal Federation	(252) 393-8185	toddm@nccoast.org
Peter Raab	Env	American Rivers	(919) 682-3500 (o)	praabe@americanrivers.org
Larry Ragland	LA	NcNeely Associates	(919) 782-9677x103 (919) 935-1029 (c)	larry@mcneelyassociates.com
Dr. Bill Hunt, PE	Ac	NCSU – Dept of Biological and Agricultural Engineering,	(919) 515-6751	wfhunt@ncsu.edu
Dr. Eban Bean, PE	Ac	East Carolina University Department of Engineering	(252) 328-9722	beaneb@ecu.edu
Brian Lipscomb, PE	DOT	NCDOT Hydraulics Unit	(919) 707-6735	blipscomb@ncdot.gov
Joseph Hinton,	Soil	ECS Carolinas, LL	(336) 856-7150	jhinton@ecslimited.com
Boyd DeVane	DWR	Webscape Unit	(919) 807-6375	boyd.devane@ncdenr.gov
Linda Lewis	DEMLR	Stormwater Program, Regional	(910) 796-7343	linda.lewis@ncdenr.gov
Bradley Bennett	DEMLR	Stormwater Program, Central	(919) 807-6378	bradley.bennett@ncdenr.gov
Annette Lucas, PE	DEMLR	Stormwater Program	(919) 807-6381	annette.lucas@ncdenr.gov

Eng = Engineering/design community
Con = Construction
Env = Environmental Group
Ac = Academia
HBA = Home Builder's Association
LG = Local government
LA = Landscape Architect
Soil = Soil Scientist

Appendix B: MDC to Date (October 28, 2014)

GENERAL MDC FOR ALL STORMWATER CONTROL MEASURES (SCMs):

(1) SIZING. The required treatment volume of SCMs shall take into account the runoff at the ultimate built-out potential from all surfaces draining to the system. Drainage from off-site areas may be bypassed.

(2) FULL TREATMENT VOLUME. The full treatment volume of volume-based SCMs shall be calculated using one of the following methods:

   i. The post-development runoff volume computed using the Simple Method with a design storm depth of, the 1-year, 24-hour storm in SA waters, 1.5" in Coastal Counties and 1.0" elsewhere;

   ii. The difference between pre- and post-development runoff volume computed using the Natural Resources Conservation Service (NRCS) Curve Number Method with a design storm depth of the 1-year, 24-hour storm in SA waters and the 90th percentile storm depth elsewhere; or

   iii. Another engineering method if it is demonstrated to provide equivalent protection as (i) and (ii) above.

(3) SHWT. SCMs shall not include an outlet structure that is set more than 6" below the SHWT unless it can be demonstrated that the device will not dewater waters of the state and that the treatment volume of the SCM will not be compromised by groundwater inflow.

(4) CONTAMINATED SOILS. SCMs that infiltrate stormwater shall not be located on or in areas with currently contaminated soils.

(4) SIDE SLOPES. Side slopes stabilized with vegetative cover shall be no steeper than 3:1 (horizontal to vertical). Retaining walls or hardened slopes may be steeper than 3:1. Steeper vegetated slopes may be considered on a case-by-case basis provided that it is demonstrated that the soils and vegetation will remain stable in perpetuity.

(5) EROSION PROTECTION. The areas receiving flow from the inlet and outlet devices shall be protected from erosion resulting from stormwater discharges.

(6) EXCESS FLOWS. SCMs shall include an overflow or bypass device for inflow volumes in excess of the treatment volume, or, if applicable, the peak attenuation volume.

(7) DEWATERING. SCMs shall be designed with a device to draw down any water that is designed to pond water or that has the potential to pond water if soil media becomes clogged.

(8) CLEAN OUT AFTER CONSTRUCTION. SCMs impacted by sedimentation and erosion control during the construction phase shall be cleaned out and converted to their approved design state.

(9) COMPLIANCE WITH OTHER APPLICABLE REGULATORY PROGRAMS. Siting and design of SCMs shall comply with all applicable DENR requirements under General Statutes 143-214.1, 143-214.7, and 143-215.3(a)(1).

(10) EASEMENTS. All SCMs shall be located in recorded easements and shall have recorded access easements to the nearest public right-of-way. These easements shall be

granted in favor of the party responsible for operating and maintaining the stormwater management system.

(11) OPERATION AND MAINTENANCE. An operation and maintenance (O&M) plan shall be provided for every SCM. An O&M plan shall cover all SCM components, including the perimeter of the device, inlet structure, pretreatment measures, main treatment area, outlet structure, vegetation, and discharge point. An O&M plan shall indicate the steps that shall be taken and who shall be responsible for restoring a stormwater system to design specification if a failure occurs and shall include an acknowledgment by the responsible party. O&M plans shall be signed and notarized.

MDC FOR INFILTRATION SYSTEMS:

(1) SEPARATION FROM THE SHWT. The bottom of infiltration systems shall be a minimum of two feet above the SHWT. However, the separation can be relaxed to one foot when the applicant can prove that the water table will subside to its pre-storm elevation in five days or less.

(2) SOIL SUBGRADE SURFACE. The surface of the soil subgrade shall have a slope of less than or equal to two percent (level). Terraces and baffles may be installed to achieve a level subgrade.

(3) PRETREATMENT. Pretreatment devices must be provided to prevent clogging, except for stormwater conveyed from a rooftop. Pretreatment devices may include measures such as sumps in catch basins, gravel verges, screens on patio drains, filters, filter strips, grassed swales and forebays.

(4) DRAW DOWN TIME AND SOIL INVESTIGATION. Infiltration systems must be designed to completely dewater the treatment volume to the bottom of the infiltration device within 72 hours. A site-specific soil investigation shall be performed to establish the hydraulic properties and characteristics of the area in which the infiltration device will be sited.

(5) PLACEMENT OF INFILTRATION MEDIA. In-situ soils may be removed and replaced with infiltration media or infiltration media may be placed on top of in-situ soils if the applicant can demonstrate that the modified soil profile allows for drainage of the treatment volume within 72 hours.

(6) OBSERVATION WELL. For infiltration devices located under the ground surface, a minimum of one inspection port shall be provided.

MDC FOR BIORETENTION CELLS:

(1) SEPARATION FROM THE SHWT. The bottom of bioretention cell shall be a minimum of two feet above the SHWT. However, the separation can be relaxed to one foot when the applicant can prove that the water table will subside to its pre-storm elevation in five days or less.

(2) MAXIMUM PONDING DEPTH FOR TREATMENT VOLUME. The maximum ponding depth for the treatment volume shall be 12 inches above the planting surface.

(3) PEAK ATTENUATION DEPTH. Bioretention cells may store peak attenuation volume at a depth of up to 24 inches above the planting surface. The peak attenuation outlet shall be a maximum of 18 inches above the planting surface.

(4) MEDIA DEPTH. The minimum depth of the media depends on the design and the receiving stream of the cell as follows:
   i. Grassed cells with no internal water storage if the receiving water is class B, C, SB or SC with no supplementary classification: 18 inches;
   ii. All other grassed cells with no internal water storage: 24 inches; or
   iii. All tree/shrub cells and grassed cells with internal water storage: 36 inches.

(5) MEDIA MIX. The media shall be a homogeneous soil mix of with approximate volumes of: 75 to 85 percent medium to coarse washed sand (ASTM C33)) 10 percent fines (silt and clay), and 5 to 15 percent organic matter (such as pine bark fines). If total nitrogen is the target pollutant, it is recommended to use 10 to 15 percent fines in the media mix.

(6) MEDIA P-INDEX. The phosphorus index (P-index) for the media shall not exceed 30 in NSW waters and shall not exceed 50 elsewhere.

(7) NO MECHANICAL COMPACTION. The media shall not be mechanically compacted. It is recommended to either water it or walk on it as it is placed.

(8) MAINTENANCE OF MEDIA. The bioretention cell shall be maintained in a manner that results in a drawdown of at least one inch per hour at the planting surface.

(9) PLANTING PLAN. The planting plan shall be designed to achieve 50% coverage with either canopy, ground cover, or a combination of canopy and ground cover at five years after planting. If sod is used, then it shall be a non-clumping, deep-rooted species. (Rec in manual: Plant high to encourage drainage.)

(10) UNDERDRAIN. An underdrain with internal water storage shall be installed unless it can be demonstrated that the in-situ soil infiltration rate is two inches per hour or greater immediately prior to the initial placement of the media. The internal water storage zone shall extend to a minimum of 18” below the planting surface.

(11) MULCH. For tree/shrub bioretention cells, double or triple shredded hardwood mulch shall be used for the portion of the cell that will be inundated. Mulch shall be uniformly placed 2 to 4 inches deep.

(12) CLEAN-OUT PIPES. At least one clean-out pipe shall be provided on each underdrain line. Clean out pipes shall be capped.

MDC FOR WET PONDS:

(15) PERMANENT POOL SURFACE AREA AND VOLUME. The permanent pool shall be sized using either:

i. The Hydraulic Retention Time (HRT) Method;
ii. The SA/DA and Average Depth Method; or
iii. Another engineering method if it is demonstrated to provide equivalent protection.

(2) PERMANENT POOL DEPTH. The minimum depth of the permanent pool above the sediment storage elevation shall be three feet. The maximum depth of the permanent pool shall be 20 feet.

(3) SEDIMENT STORAGE. The forebay and main pool shall have a minimum sediment storage depth of six inches.

(4) LOCATION OF INLET AND OUTLET STRUCTURES. The inlet and outlet structures shall be located in a manner that avoids short circuiting.

(5) PRETREATMENT. A forebay shall be included; its volume shall be approximately 20 percent of the total permanent pool volume, leaving approximately 80% of the volume in the main pool. The water flowing over or through the separation structure shall be at a nonerosive velocity.

(6) VEGETATED SHELF. The pond shall be designed to provide for a vegetative shelf around the perimeter of the basin. This shelf shall be no steeper than 6:1 (horizontal to vertical) and shall consist of native vegetation. The minimum width shall be six feet.

(7) DRAWDOWN TIME. The treatment volume shall draw down to the permanent pool level between two and five days.

(8) DISCHARGE RATE. The pond shall discharge the storage volume at a rate equal to or less than the predevelopment discharge rate for the one-year, 24-hour storm.

(9) FOUNTAINS. Fountains may be provided within ponds if it can be shown that they will not resuspend sediment or cause erosion in the pond.

(10) TRASH RACK. A trash rack or other device shall be provided to prevent large debris from entering the outlet system.

(11) VEGETATION. The following criteria apply to vegetation in and around the wet pond:

i. Trees and woody shrubs shall not be planted on the dam structure;
ii. Wet ponds should incorporate a minimum of three diverse species of shallow water emergent and shallow land herbaceous vegetation on the vegetated shelf; A minimum of 50 plants per 200 sf of shelf area shall be planted;
iii. Turf grass shall be provided on the tops of berms and on the exterior slopes of containment berms; and
iv. Weeping love grass shall not be used on the vegetated side slopes because it does not provide long-term slope stabilization.

MDC FOR STORMWATER WETLANDS:

(1) TEMPORARY PONDING DEPTH AND SURFACE AREA. The ponding depth for the treatment volume shall be 15 inches above the permanent pool. The surface area of the wetland is based on the surface area at the designed temporary pool elevation. The surface area shall be sized sufficiently to limit the ponding depth to 15 inches.

(2) PEAK ATTENUATION DEPTH. The wetland may be designed to temporarily pond peak attenuation volume at a depth exceeding 15 inches.

(3) SOIL AMENDMENTS. The pH, compaction and other attributes of the first 12" depth of the soil shall be adjusted if necessary to promote plant establishment and growth.

(4) LOCATION OF INLET AND OUTLET STRUCTURES. The inlet and outlet structures shall be located in a manner that avoids short circuiting.

(5) FOREBAY. A forebay shall be provided at the inlet to the stormwater wetland. The forebay shall comprise approximately 10-15% of the wetland surface area as measured at the temporary pool elevation. The forebay shall be 24 to 40 inches in depth with respect to the permanent pool. The forebay entrance shall be deeper than the exit.

(6) NON-FOREBAY DEEP POOLS. Deep pools shall be provided throughout the wetland. A deep pool shall be located adjacent to the outlet structure to prevent clogging. The non-forebay deep pools shall comprise 5-15% of the wetland surface area and shall be designed to retain water between storm events. The minimum depth of a deep pool at its deepest point is 18 inches below the top of the permanent pool.

(7) SHALLOW WATER ZONE. The shallow water zone shall be zero to nine inches deep with respect to the permanent pool and shall comprise approximately 40% of the wetland surface area. It is recommended to only plant the six to nine inch depth range if there is an adjustable outlet structure to keep the permanent pool at a lower depth during the first year.

(8) TEMPORARY INUNDATION ZONE. The temporary inundation zone shall be between 0 and 15 inches above the permanent pool elevation. The temporary inundation zones shall comprise approximately 30-45% of the surface area of the stormwater wetland.

(9) DRAWDOWN TIME. The treatment volume shall draw down to the permanent pool level between two and five days.

(10) DISCHARGE RATE. The wetland shall discharge the storage volume at a rate equal to or less than the predevelopment discharge rate for the one-year, 24-hour storm.

(11) LANDSCAPING PLAN. A landscape plan prepared by a qualified design professional licensed in North Carolina must be provided. The landscaping plan shall include the following:

i. Delineation of planting zones;
ii. Plant layout with species names and locations; and
iii. Total number and sizes of all plant species.

(12) SHALLOW WATER PLANTINGS. The shallow water zone shall be planted at a minimum density of 50 herbaceous plants per 200 square feet (equivalent to 2 foot on center spacing). A biodegradable mat is recommended to hold the plantings in place.

(13) TEMPORARY INUNDATION ZONE PLANTINGS. The temporary inundation zone shall be planted according to one of the following options:

i. 50 herbaceous plants per 200 square feet (equivalent to 2 foot on center spacing);
ii. 8 shrubs per 200 square feet (equivalent to 5 foot on center spacing); or
iii. One tree and 40 grass-like herbaceous plants per 100 square feet.

(14) VEGETATION. The following requirements apply to vegetation:

i. Trees and woody shrubs shall not be planted on the dam structure;
ii. Cattails shall not be planted;
iii. Turf grass shall be provided on the tops of berms and on the exterior slopes of dams; and
iv. Weeping love grass shall not be planted on vegetated side slopes.

(15) TRASH RACK. A trash rack or other device to trap debris shall be provided on piped outlet structures.

MDC FOR LEVEL SPREADER-FILTER STRIPS

(1) LEVEL SPREADER LENGTH. The level spreader shall be 10 feet in length per cfs of stormwater flow that is directed to it. A level spreader that receives flow directly from the drainage area shall be sized based on the flow rate during the 0.75 inch/hour storm, with a flow bypass system for larger storm events. A level spreader that receives flow from an SCM shall be sized based on the draw down rate of the treatment volume, with a flow bypass for larger storm events. A flow bypass system is not needed if the level spreader is sized to handle the flow during 10-year storm event. (Rec in chapter: It is OK to split flow to two separate level spreaders.)

(2) BLIND SWALE. Immediately upslope of the level spreader, there shall be a blind swale or other method of ponding water. The blind swale shall be designed to provide for uniform overtopping of the level spreader. (Rec in chapter text: Additional pretreatment may also include treatment in another SCM, a sump in a catch basin or lining the blind swale with rip rap. Also, water shall enter the blind swale in a nonerosive manner. If the blind swale is lined with grass, then stormwater shall be discharged parallel to the swale. If the blind swale is lined with rip rap, then there are no requirements for the entrance angle.)

(3) LEVEL SPREADER SPECIFICATIONS. The lip of the level spreader shall be at a uniform elevation with a construction tolerance of plus or minus ¼" at any point along its length. The level spreader shall be constructed of concrete or other stable material. (Rec in chapter: check every 10 feet.)

(4) LEVEL SPREADER SHAPE. The level spreader shall be straight or convex.

(5) TRANSITION ZONE. Immediately downslope of the level spreader, there shall be a one to three inch drop followed by an area that is protected against erosion via aggregate

or high performance turf reinforcement matting. The minimum width of this protected area is 12 inches.

(6) MINIMUM WIDTH OF THE FILTER STRIP. The minimum width measured perpendicular to the level spreader lip of the filter strip shall be 30 feet.

(7) NO DRAWS OR CHANNELS IN THE FILTER STRIP. The filter strip shall not contain draws or channels.

(8) FILTER STRIP SPECIFICATIONS. Filter strips shall be graded with a uniform transverse slope of eight percent or less. The pH, compaction and other attributes of the first 12" depth of the soil shall be adjusted if necessary to promote plant establishment and growth. The filter strip and side slopes shall be planted with non-clumping, deep-rooted grass sod.

MDC FOR SAND FILTERS

(1) SHWT SEPARATION. The SHWT shall be at least two feet below the bottom of the sand filter for open-bottom designs and one foot below the bottom of the sand filter for closed-bottom designs. Exceptions to the one foot SHWT separation may be made if the sand filter does not drain the water table and it does not float.

(2) PEAK ATTENTUATION. Sand filters may store peak attenuation volume above the treatment volume depth.

(3) TWO CHAMBER SYSTEM. The sand filter shall include a sediment chamber and a sand chamber. It is recommended to provide equivalent storage volume in each chamber.

(4) SEDIMENT/SAND CHAMBER SIZING. The volume of water that can be stored in the sediment chamber and the sand chamber above the sand surface combined shall be 0.75 times the treatment volume. The elevation of bypass devices shall be set above the ponding depth associated with this volume.

(5) MAXIMUM PONDING DEPTH. The maximum ponding depth from the top of the sand to the outlet elevation shall be six feet.

(6) FLOW DISTRIBUTION. Incoming stormwater shall be evenly distributed over the surface of the sand chamber.

(7) SAND MEDIA SPECIFICATION. Sand media shall meet ASTM C33.

(8) MEDIA DEPTH. The filter bed shall have a minimum depth of 18 inches, with a minimum depth of sand above the underdrain pipe of 12 inches.

(9) MAINTENANCE OF MEDIA. The sand filter shall be maintained in a manner that results in a drawdown of at least two inches per hour at the sand surface.

(10) CLEAN-OUT PIPES. At least one clean-out pipe shall be provided on each underdrain line. Clean out pipes shall be capped.

(11) RECOMMENDATION: INTERNAL WATER STORAGE. An underdrain with internal water storage may be installed if the in-situ soil infiltration rate is two inches per hour or greater immediately prior to the initial placement of the media.