APPENDIX 4

BMP Design Check List

The following checklists are provided as a guide for the designer / engineer in the design of a structural Best Management Practice (BMP) associated with the development of a watershed development plan. It is the sole responsibility of the designer / engineer to ensure all design, construction and certification requirements of the BMP as listed in the State BMP Design Manual and the City of Greensboro Stormwater Management Manual Supplement are met.

Wet Detention Basin Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
1	Basin sizing shall take into account all runoff at ultimate build-out, including off-site drainage.	
2	Vegetated slopes shall be no steeper than 3:1.	
3	BMP shall be located in a recorded Drainage Maintenance Utility Easement (DMUE over and 15' around BMP) with a recorded 20' wide access easement to a public ROW.	
4	Basin discharge shall be evenly distributed across a minimum 30 feet long vegetative filter strip unless BMP designed to remove 90% TSS.	
5	The design storage shall be above the permanent pool.	
6	Discharge rate following a 1-inch rainfall shall completely draw down the temporary storage volume between 2 and 5 days.	
7	The average depth of the permanent pool shall be a minimum of 3 feet.	
8	Permanent pool surface area determined using SA/DA tables 10-1, 10-2, 10-3, & 10-4	
9	Flow within the pond shall not short-circuit the pond.	
10	BMP shall be designed with a forebay.	
11	Basin side slopes shall be stabilized with vegetation above the permanent pool level.	
12	Pond side slopes shall be no steeper than 3:1	
13	BMP shall not be located to produce adverse impacts on water levels in adjacent wetlands.	
14	A minimum 10-foot wide vegetated shelf shall be installed around the perimeter. The inside edge of the shelf shall be 6” below the permanent pool elevation; the outside edge of the shelf shall be 6” above the permanent pool elevation.	
15	The forebay volume should be about 20% of the total permanent pool volume, leaving about 80% of the design volume in the main pool.	
16	Freeboard shall be a minimum of 1 foot above the maximum stage of the basin.	
17	Engineer's certification of BMP completion status box checked on watershed plan coversheet	
18	Final plat recordation status box checked on watershed plan coversheet	
19	Owners' maintenance responsibility note placed on watershed plan	
20	City of Greensboro right to access note placed on watershed plan	
21	BMP Construction completion note placed on watershed plan	

Wet Detention Basin Design Requirements (cont.)

Item *	Design Requirement	Addressed in Design (Yes / No)
22	Engineer's statement of pond and dam safety note placed on watershed plan	
23	BMP allocation table placed on coversheet	
24	Operation and Maintenance (O&M) plan included with BMP design	
25	Seepage control addressed in accordance with Section 5.6 of the Stormwater Management Manual	
26	Emergency spillway placed in cut portion of earthen embankment	
27	Spillway placed in fill portion of dam shall meet chute or free overfall spillway design requirements of Section 5.8.6 of Stormwater Management Manual	
28	Riser/Barrel spillway constructed of RCP, PVC, HDPE, ductile iron or corrugated aluminum. If RCP utilized, watertight joints specified	
29	Minimum sediment storage depth of 0.125 inches over the drainage area for the BMP	
30	Temporary storage volume calculated using the Simple Method as presented in Section 3.3.1 of the State BMP Design Manual	
31	Emergency spillway shall not be activated by 10 year / 24 hour storm event	
32	Top width of embankment dam ≥ 10'	
33	Trash guard provided on water quality orifice	
34	Earthen embankment key or cutoff trench provided along with fill and compaction specifications	
35	Invert of basin inlet pipes placed at or below permanent pool elevation	
36	Drain valve or other means to drain pond in 24 hour period	
37	Provide stage - discharge flow characteristics for principal spillway. For riser and barrel spillway designs, barrel discharge flows shall be analyzed for both inlet and outlet control.	
38	Pertinent water surface elevations shown on basin profile view (2, 10, 100 year storms)	
39	Energy dissipation details (size and material) include for all basin inlets and outlets	
40	Level Spreader is required if discharging to a stream buffer or adjacent property and 2 & 10 yr storm is not reduced to predevelopment levels	

* Items 1 -12 Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.

* Items 13 -16 Required by DWQ Policy

* Items 17 – 40 Required by City of Greensboro Stormwater Management Manual

Stormwater Wetland Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
1	Basin sizing shall take into account all runoff at ultimate build-out, including off-site drainage.	
2	Side slopes stabilized with vegetation shall be no steeper than 3:1.	
3	BMP shall be located in a recorded Drainage Maintenance Utility Easement (DMUE over and 15' around BMP) with a recorded 20' wide access easement to a public ROW.	
4	The wetland must be drawdown in 2-5 days	
5	Flow through the wetland shall not be short circuited. It shall be made as lengthy as possible.	
6	A forebay is required	
7	Overflows shall pass through a minimum 30 feet long vegetative filter, 50 foot filter is required for some projects.	
8	Wetlands require pretreatment	
9	Sizing of wetland is based on storage volume requirements and shall be as described in Section 9	
10	The minimum treatment volume for a stormwater wetland shall be 3,630 ft3 of drainage. Lesser volumes will be reviewed on a case by case basis .	
11	Maximum ponding depth shall be 1 foot	
12	Minimum length to width ratio shall be 1.5:1	
13	The wetland must be stabilized within 14 days of construction	
14	One of the following two criteria must be met, 1) The deep pools shall be at least six inches below seasonable water table, or 2) A clay liner shall be installed such that the minimum infiltration rate is 0.01 in/hr. Appropriate topsoil will be added to the clay liner to support plant growth.	
15	Cattails are not be planted	
16	Discharge rate following a 1-inch rainfall shall completely draw down the temporary storage volume between 2 and 5 days.	
17	Low Marsh zone, High Marsh Zone, Deep pools are provided	
18	Non forebay :5-10% of wetland surface, Forebay: 10% of wetland surface, Shallow Water (low marsh) 40% wetland surface, Shallow Land (high marsh) 30-40% of wetland surface, upland is optional	
19	Determine depth of the pools, shallow water, shallow land, etc.	
20	Landscape plan that clearly depicts the plantings, locations, quantities. The delineation of plantings of pondscaping zones, a minimum of 10 different species with no more than 30% of a single specie, 10 foot grass buffer is recommended as Centipede (see BMP manual for planting information)	
21	BMP shall not be located to produce adverse impacts on water levels in adjacent wetlands.	
22	Freeboard shall be a minimum of 1 foot above the maximum stage of the basin.	

Stormwater Wetland Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
23	Engineer's certification of BMP completion status box checked on watershed plan coversheet	
24	Final plat recordation status box checked on watershed plan coversheet	
25	Owners' maintenance responsibility note placed on watershed plan	
26	City of Greensboro right to access note placed on watershed plan	
27	BMP Construction completion note placed on watershed plan	
28	Engineer's statement of pond & dam safety note placed on watershed plan	
29	BMP allocation table placed on coversheet	
30	Operation and Maintenance (O&M) plan included with BMP design	
31	Seepage control addressed in accordance with Section 5.6 of the Stormwater Management Manual	
32	Emergency spillway placed in cut portion of earthen embankment	
33	Spillway placed in fill portion of dam shall meet chute or free overfall spillway design requirements of Section 5.8.6 of Stormwater Management Manual	
34	Riser/Barrel spillway constructed of RCP, PVC, HDPE, ductile iron or corrugated aluminum. If RCP utilized, watertight joints specified	
35	One of the following two criteria must be met, 1) The deep pools shall be at least six inches below seasonable water table, or 2) A clay liner shall be installed such that the minimum infiltration rate is 0.01 in/hr. Appropriate topsoil will be added to the clay liner to support plant growth.	
36	Temporary storage volume calculated using the Simple Method as presented in Section 3.3.1 of the State BMP Design Manual	
37	Emergency spillway shall not be activated by 10 year / 24 hour storm event	
38	Top width of embankment dam $\geq$ 10'	
39	Trash guard provided on water quality orifice	
40	Earthen embankment key or cutoff trench provided along with fill and compaction specifications	
41	Invert of basin inlet pipes placed at or below permanent pool elevation	
42	Drain valve or other means to drain pond in 24 hour period	
43	Provide stage - discharge flow characteristics for principal spillway. For riser and barrel spillway designs, barrel discharge flows shall be analyzed for both inlet and outlet control.	
44	Pertinent water surface elevations shown on basin profile view (2, 10, 100 year storms)	
45	Energy dissipation details (size and material) include for all basin inlets & outlets. Level Spreader is required if discharging to a stream buffer or adjacent property and 2 & 10 yr storm is not reduced to predevelopment levels	

* Items 1 - 7 Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.

* Items 8 - 15 Required by DWQ Policy

* Items 16 - 45 Required by City of Greensboro Stormwater Management Manual

Bioretention Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
1	Sizing shall take into account all runoff at ultimate build-out including off-site drainage.	
2	Side slopes stabilized with vegetation shall be no steeper than 3:1	
3	Drainage Area to the bioretention area is ≤ 5 acres (Sec.12.3.3)	
4	BMP shall be located in a recorded Drainage Maintenance Utility Easement with a recorded 20 ft wide Access Easement to a public right of way (ROW). (Label DMUE as "DMUE over and 15ft around Bioretention Area")	
5	Volume in excess of the design volume, as determined from the design storm, shall bypass the bioretention cell.	
6	Volume in excess of the design volume, as determined from the design storm, shall be evenly distributed across a minimum 30ft long vegetated filter strip. (A 50ft filter is required in some locations). If this cannot be attained, alternate designs will be considered.	
7	Bioretention facilities shall not be used where the seasonally high water table is less than 2ft below bottom of BMP.	
8	Media permeability of 0.52-6" per hour is required, 1-2 in per hour is preferred. (Sec.12.3.4)	
9	Mulch and plantings must meet requirements. (Sec. 12.3.8 & Table 12-1)	
10	Pretreatment is required prior to entering bioretention. See Section 12.3.1 under Basic Layout Concepts for pretreatment devices.	
11	The design shall be located a minimum of 100ft from water supply wells.	
12*	Bioretention facilities shall not be used where slopes greater than 20% or in non-permanently stabilized drainage areas.	
13	Inflow must be sheet flow (1ft/sec) or utilized energy dissipating devices.	
14	Ponding depth shall be 12 inches or less - 9 inches is preferred.	
15	Media depth shall be specified for the vegetation used. For grassed cells, use 2 feet minimum. For shrubs or trees use 3 feet minimum	
16	The geometry of the cell shall be such that no dimension is less than 10 feet (width, length, or radius)	
17	Media should be specified as listed in this section (Sec.12.3.4)	
18	The phosphorus index (P-index) for the soil must be low, between 10 and 30. This is enough phosphorus to support plant growth without exporting phosphorus from the cell. (Provide complete soil analysis) For complete requirements see Sec.12.3.4.	
19	Pipe inlet cannot have flared end section or any other type of heavy end section. This will cause unnecessary settling of the soil media.	
20	Ponded water shall completely drain into the soil within 12 hours. It shall drain to a level of 24 inches below the soil surface in a maximum of 48 hours.	

Bioretention Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
21	An underdrain shall be typically installed in in-situ soil drainage is less than 2 in/hr if there is in situ loamy soil (~12% or more of fines). This is usually the case for soil tighter than sandy loam or if there has been significant soil compaction from	
22*	Underdrains are required and clean-out pipes must be provided. (Sec.12.3.6) (See Sec. 5.7 for Underdrain System requirements)	
23	Engineer's certification of BMP completion status box checked on watershed plan coversheet	
24	Final plat recordation status box checked on watershed plan coversheet	
25	Engineer's certification of BMP completion will be required prior to final plat or certificate of occupancy	
26	Owners' (homeowners association) maintenance responsibility note placed on watershed plan	
27	City of Greensboro right to access note placed on watershed plan	
28	BMP Construction completion note placed on watershed plan	
29	A BMP allocation table placed on coversheet	
30	Operation and Maintenance (O&M) plan included with BMP design	
31	Overflow must be located at the upstream portion of the bioretention area. Level Spreader is required if discharging to a stream buffer or adjacent property and 2 & 10 yr storm is not reduced to predevelopment levels.	

* Items 1 -11 Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.

* Items 12 -21 Required by DWQ Policy

* Items 22 - 31 Required by City of Greensboro Stormwater Management Manual

Sand Filter Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
1	Basin sizing shall take into account all runoff at ultimate build-out, including off-site drainage.	
2	Vegetated side slopes shall be no steeper than 3:1.	
3	BMP shall be located in a recorded Drainage Maintenance Utility Easement (DMUE over and 15' around BMP) with a recorded 20' wide access easement to a public ROW.	
4	Seasonally high groundwater table must be at least 2 feet below the bottom of the filter for open-bottom designs	
5	Volume in excess of the design volume, as determined from the design storm, shall bypass the sand filter	
6	Volume in excess of the design volume, as determined from the design storm, shall be evenly distributed across a minimum 30 feet long vegetative filter, 50 foot filter is required for some projects. If this can not be attained, alternate designs will be considered on a case by case basis	
7	The design shall be located a minimum of 100 feet from water supply wells.	
8	Seasonally high groundwater table must be at least 1 foot below the bottom of the filter for closed-filter designs in order to prevent draining the water table and floatation. Exemptions will be made if these concerns are mitigated.	
9	Maximum contributing drainage basin is 5 acres	
10	Minimum width (parallel to flow) of a sedimentation chamber or forebay shall be 1.5 feet.	
11	Sand filters must completely drain within 40 hours	
12	Sand media shall be specified below and shall be a minimum of 18" deep (minimum 12" over the drainage pipes)	
13	For underground sand filters provide at least 5 feet of clearance between the surface of the sand filter and the bottom of the roof of the underground structure.	
14	Engineer's certification of BMP completion status box checked on watershed plan coversheet	
15	Final plat recordation status box checked on watershed plan coversheet	
16	Owners' maintenance responsibility note placed on watershed plan	
17	City of Greensboro right to access note placed on watershed plan	
18	BMP Construction completion note placed on watershed plan	
19	Engineer's statement of pond and dam safety note placed on watershed plan	
20	BMP allocation table placed on coversheet	

Sand Filter Design Requirements

Item *	Design Requirement	Addressed in Design (Yes / No)
21	Operation and Maintenance (O&M) plan included with BMP design	
22	Temporary storage volume calculated using the Simple Method as presented in Section 3.3.1 of the State BMP Design Manual	
23	Emergency spillway shall not be activated by 10 year / 24 hour storm event	
24	Drain valve or other means of dewatering the filter bed provided	
25	Pertinent water surface elevations shown on basin profile view (2, 10, 100 year storms)	
26	Energy dissipation details (size and material) include for all basin inlets and outlets. Level Spreader is required if discharging to a stream buffer or adjacent property and 2 & 10 yr storm is not reduced to predevelopment levels	

* Items 1 -7 Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.

* Items 8 -14 Required by DWQ Policy

* Items 15 – 26 Required by City of Greensboro Stormwater Management Manual