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SOLTESZ

Dickerson: Power Plant

STORMWATER MANAGEMENT NARRATIVE

June, 2023

Prepared On Behalf of:
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STORMWATER MANAGEMENT NARRATIVE

1. INTRODUCTION:

The subject property is approximately 974.66 acres of land over two parcels of land. The site is old non-operating Dickerson Substation located in Dickerson Maryland and sitting west of Darnestown Road. Access to the property is provided off of the existing Martinsburg Road. The subject property is split-zoned IH-2.5, H-70' ("Heavy Industrial") and AR ("Agricultural Reserve"). The surrounding areas are a mix of industrial and agricultural zoning as well.

2. EXISTING SITE CONDITIONS:

The subject property is currently improved with various industrial uses, including coal-fired and natural gas/oil generating facilities. However, these facilities are no longer in production. The site varies drastically in topography, water features including the little Monocacy River and other streams, and areas of forestation.

The Web Soil Survey indicates that the site consists of Category B, C, and D Hydrologic Soil Groups. For the sake of this study and narrative, it is assumed that all proposed improvements will take place on "B" type soils requiring the most intensive Stormwater Management treatment. Please refer Appendix A for NRCS web soil survey report.

3. PROPOSED SITE CONDITIONS:

The project will consist of a demolition of the existing onsite industrial facilities and then the development of data centers and battery facilities. These improvements will be constructed predominately on the south side of the subject project and predominately in the Heavy Use Industrial zoning with some being in the Agricultural Zoning as well. The exact locations for each typical layout/site is not known at this time, but existing

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driveways and on site roads will be used to their maximum potential. SOLTESZ has included an exhibit for a typical layout for a data center or battery facility.

4. STORMWATER MANAGEMENT COMPLIANCE:

The Maryland Department of the Environment _2009 Stormwater Management Design_ Manual and the Montgomery County Code requires that all new development meet the criteria for Water Quality Volume (WQ_v), Recharge Volume (Re_v) and Channel Protection Volume (Cp_v) through environmental site design (ESD) practices to the maximum extent practicable (MEP). The subject site is a new development and requires to meet the above criteria.

Stormwater Management will be proposed throughout the project according to the current Maryland Department of the Environment (MDE) and Montgomery County Department of Permitting Services (DPS) regulations and standards. In compliance with these standards, Environmental Site Design (ESD) practices will be implemented to meet the 100% ESD requirement through a combination of planning techniques, alternative cover, and micro-scale practices. These ESD practices optimize conservation of natural features, like drainage patterns, soil and vegetation etc., along with slowing down runoff to maintain discharge timing and to increase infiltration and evapotranspiration. These strategies better mimic natural hydrologic runoff characteristics as opposed to implementing structural techniques. The proposed facilities will be utilized to capture and treat runoff from impervious surface areas to minimize the impact of land development on downstream water resources.

At the conceptual phase, the site development layout is being configured with the locations of ESD practices and site resources taken into consideration. Although not yet designated on plans, practices such as micro-bioretention, swales, and planter boxes are just a few examples of what may be proposed to meet the ESD requirements. Where applicable, these practices will incorporate natural systems, vegetation, and soils to create

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a more natural drainage system, promoting runoff reduction and water quality treatment and recharge at the source.

ESDs will be designed to cover all of the guidelines set forth in the above mentioned manuals. Few of the additional design techniques in Table 5.2 of MDE Manual will be applied to this site as closely as possible.

- Rooftop drainage will be directed to ESD facilities.
- Parking ratios will be minimized.
- Open vegetated channels will be provided where possible.
- Parking lot runoff to micro-bioretention islands will be utilized.
- Clearing, grading, and earth disturbance will be limited to that required to develop the site.
- Tree conservation will be provided along with the overall site development.

Soil Erosion and Sediment Control practices for the proposed construction will be provided according to the current practices of the 2011 Maryland Standards and Specifications for Soil Erosion and Sediment Control. Review and approval of this plan will be obtained from Montgomery County DPS prior to any clearing, grading or excavation. All disturbed areas will be stabilized in accordance with local jurisdictional.

Landscaping: Plants utilized in the ESD facilities will be chosen and located for their functional performance and their aesthetic qualities. Plants selected will be sturdy, low maintenance plants that can tolerate both wet and dry conditions. Plant spacing will be set so that they have room to grow in a healthy manner while being spaced closely enough that the facilities will not appear barren and under planted while plants are still immature. To maintain visual interest even in winter, the majority of the plants will be evergreen or have attractive bark.

5. CONCLUSION

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All stormwater management requirements will be met or exceeded by providing, at a minimum, Water Quality requirements via non-structural practices. As the engineering design is further defined, ESD targets for each of the outfalls will be met via ESD methods and the actual location, size and number of ESDs required will be determined. The exhibit shows over treatment at the Typical site. Depending on site conditions, some sites might be over treated in order to make up for more difficult stormwater management engineering for other sites as well as providing treatment for other impervious features on site such as roads, driveways, etc.

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Appendix A: NRCS Web Soil Survey

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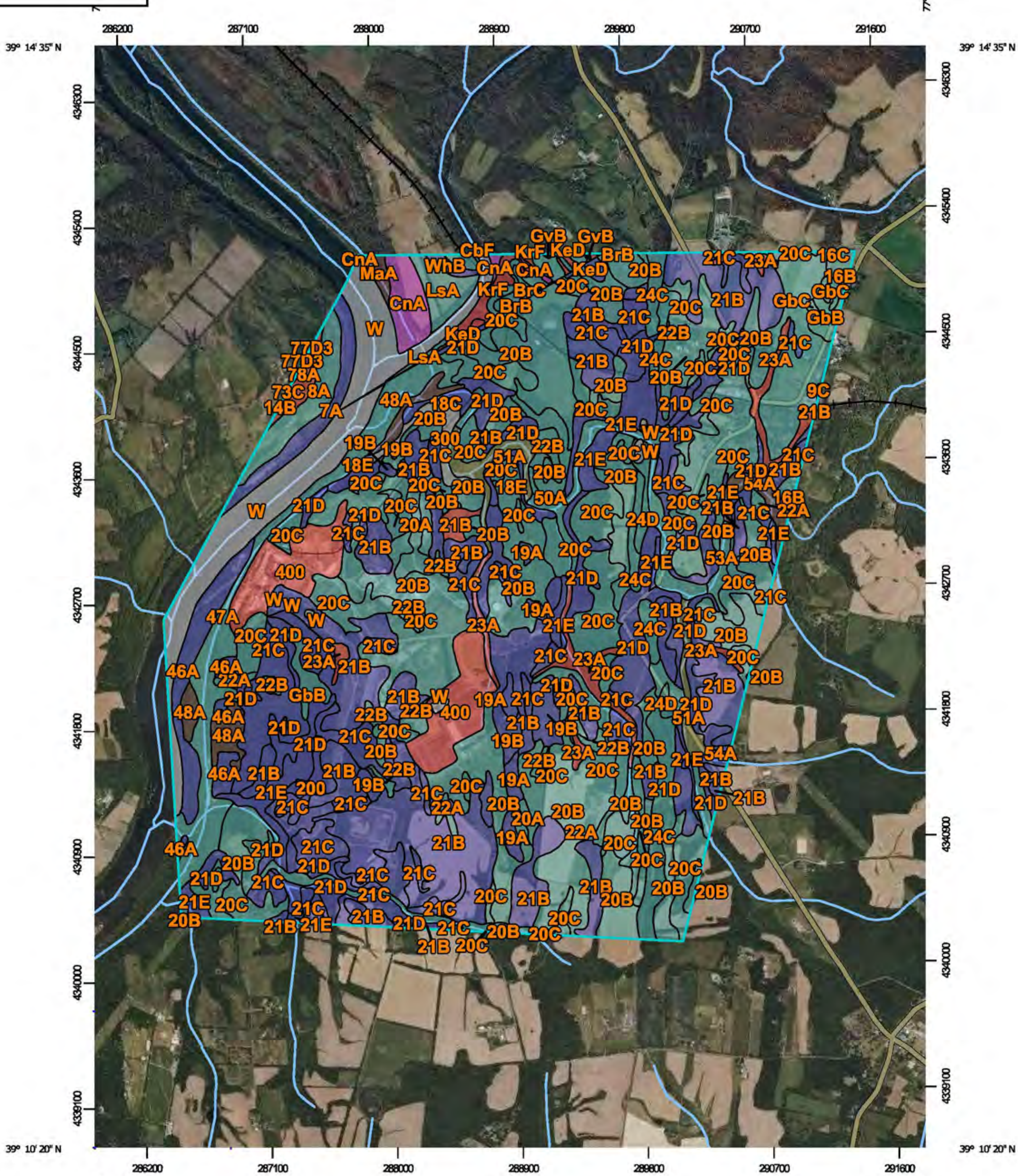

Map Scale: 1:38,400 if printed on A portrait (8.5" x 11") sheet.

Meters: 0 500 1000 2000 3000

Feet: 0 1500 3000 6000 9000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

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MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:12,000 to 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Frederick County, Maryland
Survey Area Data: Version 19, Sep 14, 2022

Soil Survey Area: Loudoun County, Virginia
Survey Area Data: Version 19, Aug 30, 2022

Soil Survey Area: Montgomery County, Maryland
Survey Area Data: Version 18, Sep 14, 2022

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Apr 14, 2011—Jun 18, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

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Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BrB	Brentsville channery loam, 3 to 8 percent slopes	C	10.7	0.2%
BrC	Brentsville channery loam, 8 to 15 percent slopes	C	17.4	0.4%
CaC	Cardiff channery loam, 8 to 15 percent slopes	C	4.8	0.1%
CbF	Cardiff channery loam, 25 to 65 percent slopes, rocky	C	0.5	0.0%
CnA	Combs silt loam, 0 to 3 percent slopes	A	44.3	0.9%
GvB	Glenville-Codorus complex, 3 to 8 percent slopes	C	1.6	0.0%
KeD	Klinesville very channery loam, 15 to 25 percent slopes	D	7.2	0.2%
KrF	Klinesville-Rock outcrop complex, 25 to 65 percent slopes	D	16.7	0.4%
LsA	Lindside silt loam, 0 to 3 percent slopes	C	34.0	0.7%
MaA	Melvin-Lindside silt loams, 0 to 3 percent slopes	B/D	9.0	0.2%
W	Water		84.3	1.8%
WhB	Wheeling gravelly loam, 0 to 8 percent slopes	B	6.7	0.1%
Subtotals for Soil Survey Area			**237.3**	**5.0%**
Totals for Area of Interest			**4,718.1**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
7A	Huntington silt loam, 0 to 2 percent slopes, occasionally flooded	B	44.1	0.9%
8A	Lindside silt loam, 0 to 2 percent slopes, occasionally flooded	C	49.8	1.1%
14B	Manassas silt loam, 2 to 7 percent slopes	B	0.1	0.0%
73C	Penn silt loam, 7 to 15 percent slopes	B	0.2	0.0%

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Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
77D3	Nestoria channery silt loam, 15 to 25 percent slopes, severely eroded	D	1.8	0.0%
78A	Dulles silt loam, 0 to 2 percent slopes	D	14.7	0.3%
Subtotals for Soil Survey Area			**110.6**	**2.3%**
Totals for Area of Interest			**4,718.1**	**100.0%**

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
9C	Linganore-Hyattstown channery silt loams, 8 to 15 percent slopes	C	0.5	0.0%
16B	Brinklow-Blocktown channery silt loams, 3 to 8 percent slopes	C	14.2	0.3%
16C	Brinklow-Blocktown channery silt loams, 8 to 15 percent slopes	C	0.3	0.0%
18C	Penn silt loam, 8 to 15 percent slopes, very stony	B	9.2	0.2%
18E	Penn silt loam, 15 to 45 percent slopes, very stony	B	18.2	0.4%
19A	Bucks silt loam, 0 to 3 percent slopes	B	34.4	0.7%
19B	Bucks silt loam, 3 to 8 percent slopes	B	53.6	1.1%
20A	Brentsville sandy loam, 0 to 3 percent slopes	C	26.2	0.6%
20B	Brentsville sandy loam, 3 to 8 percent slopes	C	1,119.4	23.7%
20C	Brentsville sandy loam, 8 to 15 percent slopes	C	485.1	10.3%
21B	Penn silt loam, 3 to 8 percent slopes	B	658.6	14.0%
21C	Penn silt loam, 8 to 15 percent slopes	B	365.2	7.7%
21D	Penn silt loam, 15 to 25 percent slopes	B	349.5	7.4%
21E	Penn silt loam, 25 to 45 percent slopes	B	119.0	2.5%
22A	Readington silt loam, 0 to 3 percent slopes	C	30.4	0.6%
22B	Readington silt loam, 3 to 8 percent slopes	C	56.5	1.2%

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Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
23A	Croton silt loam, occasionally ponded, 0 to 3 percent slopes	D	76.8	1.6%
24C	Montalto silt loam, 8 to 15 percent slopes, very stony	C	102.5	2.2%
24D	Montalto silt loam 15 to 25 percent slopes, very stony	C	23.9	0.5%
46A	Huntington silt loam, 0 to 3 percent slopes, occasionally flooded	B	79.6	1.7%
47A	Lindside silt loam, 0 to 3 percent slopes, occasionally flooded	C	148.6	3.1%
48A	Melvin silt loam, 0 to 2 percent slopes, occasionally flooded	B/D	42.0	0.9%
50A	Rowland silt loam, 0 to 3 percent slopes, occasionally flooded	C	90.3	1.9%
51A	Bowmansville-Melvin silt loams, 0 to 2 percent slopes, occasionally flooded	C/D	49.8	1.1%
53A	Codorus silt loam, 0 to 3 percent slopes, occasionally flooded	C	11.7	0.2%
54A	Hatboro silt loam, 0 to 3 percent slopes, frequently flooded	B/D	24.6	0.5%
109D	Hyattstown channery silt loam, 15 to 25 percent slopes, very rocky	D	9.8	0.2%
200	Pits, gravel	A	3.2	0.1%
300	Rock outcrop-Blocktown complex		26.6	0.6%
400	Urban land	D	155.1	3.3%
GbB	Goresville and Bucks soils, 3 to 8 percent slopes	C	29.9	0.6%
GbC	Goresville and Bucks soils, 8 to 15 percent slopes	C	7.2	0.2%
W	Census water		148.3	3.1%
Subtotals for Soil Survey Area			**4,370.0**	**92.6%**
Totals for Area of Interest			**4,718.1**	**100.0%**

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Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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Appendix B: Standard Details

DPS Montgomery County
Department of Permitting Services

2425 Reedie Drive, 7th Floor
Wheaton, Md 20902
240-777-0311
montgomerycountymd.gov/dps

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MICRO-BIORETENTION

The Micro-Bioretention methods described in the following section are based on the Micro-Bioretention design found in Chapter 5 of the Maryland Storm Water Design Manual and the ESD Process & Computations Supplement dated July 2010. Where deemed appropriate, the design specifications have been modified by the Montgomery County Department of Permitting Services (DPS). DPS requires that all Micro-Bioretention devices shall include a PVC pipe underdrain system.

A. Facility Description

Micro-Bioretention is a filtration system that treats runoff by passing it through a filter bed mixture of sand, soil, and organic matter. Principal components of the system include: a) surface planting with woody and herbaceous plant species, b) a surface 3 inch thick mulch layer, c) a 2-4 foot planting medium, d) a 6 inch thick sand layer, and e) perforated PVC pipe underdrain within a gravel bed. The facilities should be well landscaped to enhance their function and appearance. When providing additional storage for recharge below the underdrain, refer to the enhanced filter design specifications for additional requirements.

B. System Design Considerations

1. Applicability

The Micro-Bioretention device is appropriate for both new and redevelopment applications. The entire system fits into a relatively small space, making it applicable to concave parking lot islands, linear roadway or median filters, terraced slope facilities, and urban planter boxes. Currently, Micro-Bioretention devices are not permitted in residential cul-de-sac islands due to fire truck access concerns. The total drainage area to the facility, including pervious and impervious areas, is limited to 20,000 square feet. Micro-Bioretention facilities should not be located in areas which contain mature trees or other environmentally sensitive site features, or where existing slopes exceed 15 percent.

2. Conveyance

Micro-Bioretention facilities should be designed offline whenever possible. A flow splitter should be used to safely convey flows in excess of the design treatment volume around the facility. If bypassing the facility is impractical, an internal overflow device must be used to safely convey the runoff to a stable outfall while providing adequate freeboard within the facility, as discussed in section C.3. (Overflow Design Criteria). Runoff shall enter, flow through, and exit the facility in a non-erosive manner. All Micro-Bioretention facilities shall include a PVC underdrain system to convey treated flows to a suitable outfall location.

3. Groundwater

Micro-Bioretention facilities shall not be located where the water table is within 2 feet of the bottom of the facility. If the 2 ft. clearance requirement cannot be met, an alternative stormwater practice must be proposed. An impervious liner may be used in some cases.

4. Setbacks

Micro-Bioretention practices shall be located at least 30 feet from water supply wells and 25 feet from septic systems. Practices should be located down gradient and setback at least 10 feet from building foundations. Micro-Bioretention variants (e.g., planter boxes) that must be located within 10 ft of building foundations must include an impermeable liner and shall not be a structural component of the building. Structural design of concrete planter box enclosures is required.

C. Specifications and Details

1. Sizing

The facility shall be sized to capture and store 100% of the target treatment volume. A minimum of 6" and maximum of 12" of surface ponding must be provided above the filter media. The surface area (A_f) of a Micro-Bioretention practice shall be at least 2% of the contributing drainage area. Planting media shall be between 24 and 48 inches deep. The total storage provided in the facility shall be computed as the storage provided in the temporary ponding area and the storage provided in the planting media and sand layers. Computations shall account for the porosity ($n = 0.40$) of the planting media and sand. Storage provided in excess of that required to treat the runoff for the 1 year, 24-hour design storm shall not be counted towards the total ESDv provided.

See "Enhanced Filter" design guidelines if additional storage is proposed below the underdrain pipe.

To the extent possible, facilities should have irregular outlines to blend naturally into the environment. Rectangular is not natural.

2. Inflow Design Criteria

Runoff shall enter the Micro-Bioretention facility in a non-erosive manner (less than 2 fps). Inflow may be through depressed curbs with wheel stops, curb cuts, level spreaders, bubblers, or conveyed directly using downspouts, covered drains, catch basins, over grass, or other acceptable conveyance methods. Particular care must be taken to prevent erosion of the surface mulch layer.

3. Overflow Design Criteria

If an internal overflow device is needed, a yard inlet or dome cap inlet may be used. Dome inlet caps may be stacked on top of clean-outs to serve as the overflow devices. When this method is used, the overflow invert of the domed cap must be set at the design storage level. Overflow devices cannot feed into perforated pipe sections.

A safe non-erosive outlet below the outfall must be provided. Safe conveyance of the developed 10-year storm through the facility must be demonstrated.

4. Underdrain Pipe

The underdrain pipe consists of 6-inch diameter schedule 40 or stronger perforated PVC pipe at 0.00% slope. The underdrain pipe will be placed within the gravel layer. A minimum of three inches of gravel must be placed under the pipe, with a minimum of 6 inches of gravel over the pipe. Perforations must be 3/8 inch in diameter and must be located 4 inches on center, every 90 degrees around the pipe. Perforated pipe must begin at least 12" inside the filter media. If this cannot be achieved, then sides of the filter media must be lined with filter fabric. Filter fabric must <u>not</u> be wrapped around the underdrain pipe. An acceptable alternative to perforated pipe is 6" diameter schedule 40 slotted PVC pipe with 0.125 inch slots. Slots shall be 0.125 inches wide and a minimum of 1.9 inches in length, with a minimum of 4 slots per row and 4 rows per linear foot of pipe.

Access for cleaning all underdrain piping is needed. Watertight clean-outs for each pipe shall be level with the top of the mulch. All cleanouts shall have a removable waterproof cap. Cleanouts must be capped immediately after the filter medium is in place.

The required number of perforated underdrain pipes is proportional to the surface area of the Micro-Bioretention facility. The length of perforated pipe shall be 0.05 times the surface area of the facility, rounded to the nearest foot. In no case shall less than 2 ft. of perforated pipe be provided.

5. Gravel Bed

The gravel layer surrounding the underdrain pipe(s) must meet MSHA size #7 (Table 901A), and must provide a minimum of 6 inches cover over the pipe(s), and minimum 3 inches under the pipe. No geotextile or filter fabric is allowed to be placed horizontally anywhere within the filter media. The gravel must be clean and must be stored and installed in such a manner that it does not become contaminated with sediment before or after installation.

6. Sand Bed

A minimum 6-inch fine aggregate sand layer shall be provided below the planting medium. ASTM C33 or AASHTO M6 Fine Aggregate Concrete Sand is required per Montgomery County sand specifications.

7. Planting Medium

The planting medium shall be 24"-48" thick and shall consist of 1/3 perlite or Solite, 1/3 compost and 1/3 topsoil. The perlite shall be coarse grade horticultural perlite. The compost shall be high grade compost free of stones and partially composted woody material. The topsoil component shall meet the following criteria: contain no more than 10% clay, 10-25% silt and 60-75% sand and be free of stones, stumps, roots or other similar objects larger than 2 inches.

The first layer of the planting medium shall be lightly tilled to mix it into the 6-inch sand layer, so as not to create a definitive boundary. The planting bed shall be flooded after placement. Any settlement that occurs shall be filled back to the design elevation.

8. Mulch

The mulch layer is an important part of the Micro-Bioretention device. Much of the pollutant removal capacity of the Micro-Bioretention system is within the mulch layer. The surface mulch layer will consist of standard double shredded aged hardwood mulch. The mulch should be applied uniformly to a depth of 3 inches. Yearly replenishing may be necessary. Pine bark is not acceptable.

9. Plant Materials

Plants, through their pollutant uptake and evapo-transpiration of stormwater runoff, play a key role in the overall effectiveness of the Micro-Bioretention device. Both the number and type of tree and shrub plantings for the system may vary, especially where aesthetics or other considerations are critical to site development. While native plants are encouraged, they are not always appropriate in all situations. While no hard planting rule exists, the plants should be a mix of trees, shrubs and herbaceous materials. However, there should be 2 to 3 shrubs planted per tree and herbaceous plantings shall make up 40% of the total number of plants. Trees shall be a minimum of 1 ½ in. caliper, shrubs shall be minimum 2 gal. size and herbaceous plants shall be a minimum 1 gal size. Mature plant canopy should cover 85% of the Micro-Bioretention device. Alternative planting schemes, including use of grasses, may be considered in some situations, so long as the planting plan is designed by a Registered Landscape Architect registered in the State of Maryland, however lawn grasses are not appropriate for these facilities. All plantings shall be in accordance with the Montgomery County landscape guidelines. All landscape plans must be sealed by a registered landscape architect. Since

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the plants are an integral part of the Micro-Bioretention system, no changes to the approved landscape plan will be allowed unless an alternate plant list, prepared by a registered landscape architect, has been approved by DPS prior to installation. Since plant availability can change, DPS suggests including an alternate plant list on the landscaping plans.

D. Micro-Bioretention Sizing Example

A Micro-Bioretention facility is being designed to treat the runoff from a parking lot that is part of a larger development. The target ESD_V for the overall project has already been determined. The total treatment area to the facility is 20,000 square feet (17,500 square feet impervious area and 2,500 square feet of pervious area, yielding an impervious percentage of 88%).

Calculate the maximum volume that can be stored in the facility:

ESDv(MAX) = [(Pe) (Rv) (A)]/12 Rv = 0.05 + (.009 x I)

= [(2.6")(0.84)(20,000sf)]/12 = 0.05 + (.009*88) = 84

= 3,640 cf

Calculate the minimum volume that must be stored in the facility:

ESDv(MIN) = [(Pe) (Rv) (A)]/12 Rv = 0.05 + (.009 x I)

= [(1.0")(0.84)(20,000sf)]/12 = 0.05 + (.009*88) = 84

= 1,400 cf

To calculate the ESDv provided by this facility we will assume a ponding depth of 0.75' and a 2.5' thick media layer (2' planting media and 0.5' sand). The porosity for the media layer is n = 0.40. Assume the area of the filter bed (Af) is 2,500 sf.

ESDv = Ponding Depth + Storage in Filter Media

=(2,500* 0.75) + [0.4*(2,500*2.5)] = 4,375 cf

Since the proposed ESDv exceeds the maximum allowable storage of 3,640 cf the facility must be reduced in size. In this case, reducing the filter area to 1,500 sf will yield a treatment volume of 2,625 cf, which is larger than the minimum required storage in the facility. Therefore the design is acceptable.

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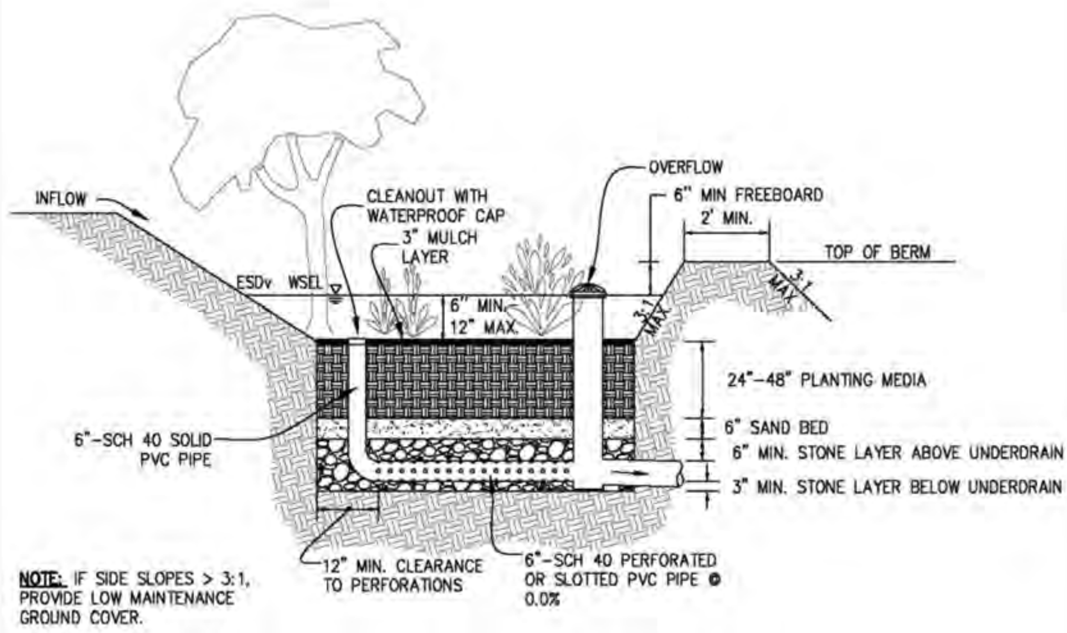

MICRO-BIORETENTION
TYPICAL CROSS SECTION
NTS

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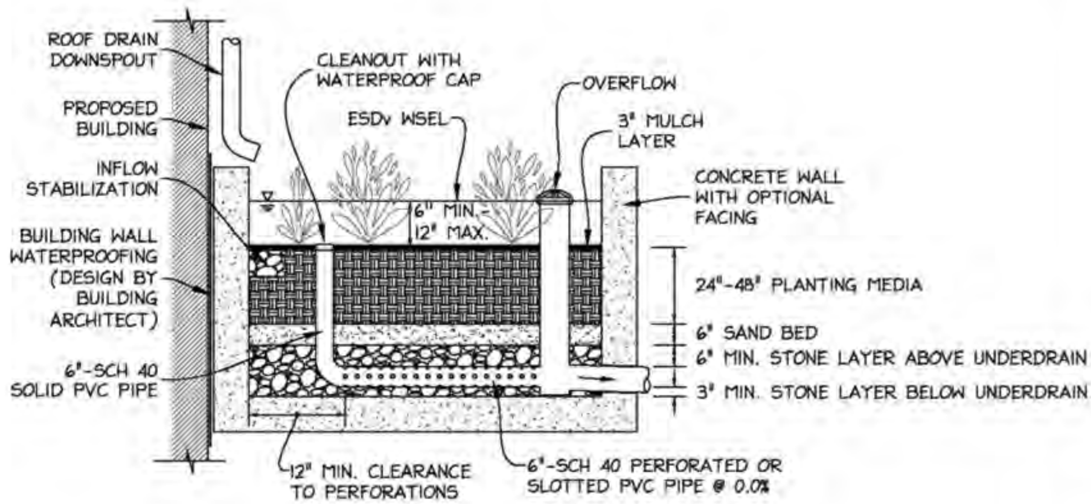

PLANTER BOX MICRO-BIORETENTION
TYPICAL CROSS SECTION
NTS

DPS Montgomery County Department of Permitting Services

2425 Reedie Drive, 7th Floor
Wheaton, MD 20902
240-777-0311
montgomerycountymd.gov/dps

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BIO SWALE (BS)

The Bio Swale methods described in the following section are based on the Bio Swale design found in Chapter 5 of the Maryland Storm Water Design Manual and the ESD Process & Computations Supplement dated July 2010. Where deemed appropriate, the design specifications have been modified by the Montgomery County Department of Permitting Services (DPS).

A. Facility Description

A Bio Swale is a channel that provides conveyance, water quality treatment and flow attenuation of stormwater runoff. Pollutant removal is achieved through vegetative filtering, sedimentation, biological uptake, and infiltration. Principal components of the system include: a) vegetated surface, b) a 2-foot planting media layer, c) a 6 inch thick sand layer, and d) a 12-inch gravel underdrain layer. The facilities should be heavily vegetated with appropriate grasses, and may also be landscaped to enhance their function and appearance.

B. System Design Considerations

1. Applicability

Bio Swales are appropriate for new and redevelopment applications. Because they incorporate an underdrain system, they are acceptable in fill soils. They may be used in public and private rights-of-way, and in other areas where swales would generally be incorporated into the project design.

2. Conveyance

Wherever practical, Bio Swales should be designed to receive flow along their entire length via sheet flow. They may be designed as treatment for piped flow or for other areas of concentrated flow when necessary and when safe inflow characteristics are employed. Overflow inlets should be installed as necessary.

The channel slope shall be between 1% and 4.0%. Maximum ESD flow velocity for the 1-year storm (2.6 inches) may not exceed 1.0 fps. Flow rate shall be calculated per Appendix D.10 of the 2000 Maryland Stormwater Design Manual. Channel side slopes may not exceed 3:1.

3. Groundwater

Bio Swales shall not be located where the water table is within 2 feet of the bottom of the facility. If the 2 ft. clearance requirement cannot be met, an alternative stormwater practice must be proposed.

4. Setbacks

Bio Swales shall be located at least 30 feet from water supply wells and 25 feet from septic systems. Practices should be located down gradient and setback at least 10 feet from building foundations.

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C. Specifications and Details

1. Sizing

The Bio Swale shall be sized to capture and store 100% of the target treatment volume within the filter media (planting medium, sand, and underdrain stone). Surface ponding may not be calculated for swales since swales do not pond water, they convey it away. The surface of the Bio Swale shall be 2 to 8 feet in width. Planting medium shall be 24 inches deep. The width of the filter medium shall not be greater than the bottom width of the swale. Subsurface storage provided beyond the limits of the swale surface, or storage provided in excess of that required to treat the runoff for the 1 year, 24-hour design storm shall not be counted towards
the total ESDv provided. The total storage provided in the facility shall be computed as the storage provided in the filter medium, sand and underdrain stone layers. Computations shall account for the porosity ($n = 0.40$) of the filter media.

Bio Swales may not be "enhanced" by placing additional stone storage below the 12-inch stone underdrain layer.

2. Inflow Design Criteria

Runoff shall enter the Bio Swale in a non-erosive manner (less than 2 fps). Inflow may be via sheet flow, depressed curbs with wheel stops, curb cuts, level spreaders, over grass, or other acceptable conveyance methods.

3. Overflow Design Criteria

Safe conveyance of the developed 10-year storm through the Bio Swale must be demonstrated. Overflow inlets may be installed as required. The invert of the inlet shall be 6 inches above the elevation of the flow channel to encourage filtration of flows, and a berm will be required to be installed behind the inlet. Berms or check dams are not allowed elsewhere in the swale. All underdrains must outfall to safe, stable locations. Overflow devices must not feed into perforated or slotted pipe sections or into the stone underdrain layer.

4. Underdrain Pipe

Underdrain piping is only required where inlets are installed to intercept flow, such as at locations along a swale where the allowable velocity in the channel is exceeded, or at the downstream end of a facility where it becomes necessary to outlet the underdrain stone to grade. At these locations, a 10-foot section of perforated underdrain must be installed which will drain directly into the inlet.

The underdrain pipe consists of 6-inch diameter schedule 40 or stronger perforated PVC pipe at 0.00% slope. The underdrain pipe will be placed within the gravel layer. A minimum of three inches of gravel must be placed under the pipe, with a minimum of 3 inches of gravel over the pipe. Perforations must be 3/8 inch in diameter and must be located 4 inches on center, every 90 degrees around the pipe. Perforated pipe must begin at least 12" inside the filter media. Filter fabric must **<u>not</u>** be wrapped around the underdrain pipe. An acceptable alternative to perforated pipe is 6" diameter schedule 40 slotted PVC pipe with 0.125 inch slots. Slots shall be 0.125 inches wide and a minimum of 1.9 inches in length, with a minimum of 4 slots per row and 4 rows per linear foot of pipe.

Access for cleaning all underdrain piping is needed. Watertight clean-outs for each pipe shall be level with the surface of the media. All cleanouts shall have a removable waterproof cap. Cleanouts must be capped immediately after filter media is in place.

The stone layer must run the length of the swale, including under driveway crossings.

Exhibit # 12

5. Gravel Layer

The gravel layer must meet MSHA size #7 (Table 901A), and shall be 12-inckes in depth. No geotextile or filter fabric is allowed to be placed horizontally anywhere within the filter media, except at driveway crossings, as shown in the typical section.

6. Sand Bed

A minimum 6-inch fine aggregate sand layer shall be provided below the planting media. ASTM C33 or AASHTO M6 Fine Aggregate Concrete Sand is required per Montgomery County sand specifications.

7. Planting Medium

The planting media shall be 24" thick and shall consist of 1/3 perlite or Solite, 1/3 compost and 1/3 topsoil. The perlite shall be coarse grade horticultural perlite. The compost shall be high grade compost free of stones and partially composted woody material. The topsoil shall meet the following minimum criteria: contain no more than 10% clay, 10-25% silts and 60-75% sand. The soil shall be free of stones, stumps, roots or other similar objects larger than 2 inches. The first layer of the planting medium shall be lightly tilled to mix it into the sand layer, so as not to create a definitive boundary. The planting material shall be flooded after placement. Any settlement that occurs shall be filled back to the design elevation.

8. Mulch

When vegetated with grass, the Bio swale does not require a mulch layer. A typical location for a grassed Bio Swale would be in a public right-of-way. When the Bio Swale is landscaped with vegetation other than grass, a mulch layer is required. The surface mulch layer will consist of standard double shredded aged hardwood mulch. The mulch should be applied uniformly to a depth of 3 inches. Yearly replenishing may be necessary. Pine bark is not acceptable.

9. Plant Materials

Plants, through their pollutant uptake and evapo-transpiration of stormwater runoff, play a key role in the overall effectiveness of the Bio Swale. As mentioned above, the Bio Swale may be planted in turf grass where it is appropriate to do so, such as along roadways where visibility is a concern and where active landscape maintenance is unlikely. In cases where the Bio Swale is proposed to be landscaped in materials other than grass, tree, shrub and herbaceous plantings may be used. Both the number and type of tree and shrub plantings for the system may vary, especially where aesthetics or other considerations are critical to site development. While native plants are encouraged, they are not always appropriate in all situations. While no hard planting rule exists, the plants should be a mix of trees, shrubs and herbaceous materials. However, there should be 2 to 3 shrubs planted per tree and herbaceous plantings shall make up 40% of the total number of plants. Trees shall be a minimum of 1 ½ in. caliper, shrubs shall be minimum 2 gal. size and herbaceous plants shall be a minimum 1 gal size. Mature plant canopy should cover 85% of the Bio Swale. Alternative planting schemes, including use of ornamental grasses, may be considered in some situations, so long as the planting plan is designed by a Registered Landscape Architect registered in the State of Maryland, however lawn grasses are not appropriate for these facilities. All plantings shall be in accordance with the Montgomery County landscape guidelines. All landscape plans must be sealed by a registered landscape architect. Since the plants are an integral part of the Bio Swale system, no changes to the approved landscape plan will be allowed unless an alternate plant list, prepared by a registered landscape architect, has been approved by DPS prior to installation. Since plant availability can change, DPS suggests including an alternate plant list on the landscaping plans.

Exhibit # 12

Bio Swale Sizing Example

A Bio Swale is being designed to treat the runoff from a parking lot that is part of a larger development. The target ESD_V for the overall project has already been determined. The total treatment area to the facility is 20,000 square feet (17,500 square feet impervious area and 2,500 square feet of pervious area, yielding an impervious percentage of 88%).

Calculate the maximum volume that can be stored in the facility:

ESDv(MAX)	= [(Pe) (Rv) (A)]/12	Rv	= 0.05 + (.009 x I)
	= [(2.6")(0.84)(20,000sf)]/12		= 0.05 + (.009*88) = 84
	= 3,640 cf		

Calculate the minimum volume that must be stored in the facility:

ESDv(MIN)	= [(Pe) (Rv) (A)]/12	Rv	= 0.05 + (.009 x I)
	= [(1.0")(0.84)(20,000sf)]/12		= 0.05 + (.009*88) = 84
	= 1,400 cf		

To calculate the ESDv provided by this facility we will assume a 4' wide channel width and 3.5' thick media layer (2.0' planting medium, 0.5' sand, 1.0' gravel). The porosity for the media layer is n = 0.40. Assume the swale is 350 feet in length, resulting in area of the filter bed (Af) = 4*350 = 1,400 sf.

- ESDv = Storage in Filter Media

  = 0.4*(1,400*3.5) = 1,960 cf

Since the proposed ESDv exceeds the minimum storage required, the Bio Swale design is acceptable.

DPS Montgomery County Department of Permitting Services
2425 Reedie Drive, 7th Floor
Wheaton, MD 20902
240-777-0311 or 311 in Montgomery County
montgomerycountymd.gov/dps

Exhibit # 12

GRASSED SWALE (GS)

The Grassed Swale methods described in the following section are based on the Grassed Swale design found in Chapter 5 of the Maryland Storm Water Design Manual and the ESD Process & Computations Supplement dated July 2010. Where deemed appropriate, the design specifications have been modified by the Montgomery County Department of Permitting Services (DPS).

A. Facility Description

A Grassed Swale is a channel that provides conveyance, water quality treatment and flow attenuation of stormwater runoff. Pollutant removal is achieved through vegetative filtering, sedimentation, biological uptake, and infiltration.

B. System Design Considerations

1. Applicability

Grassed Swales are intended to be used in lieu of curb and gutter conveyance for roadways and driveways only. They are appropriate for new and redevelopment applications. They may be used in public and private rights-of-way, and for other areas such as driveways where swales can be incorporated into the project design in place of curb and gutter. Grassed Swales are not appropriate as treatment for roof downspouts, parking lots, or other non linear applications. Grassed Swales must be as long as the treated surface.

The channel slope shall be between 1% and 4.0%. Maximum ESD flow velocity may not exceed 1.0 fps. Channel side slopes may not exceed 3:1. In cases where the flow velocity exceeds 1 fps, overflow inlets shall be employed to keep the average flow in the swale below 1 fps.

2. Conveyance

Grassed Swales shall be designed to receive flow along their entire length via sheet flow. They may not be designed as treatment for piped flow or for other areas of concentrated flow. Overflow inlets should be installed as necessary to maintain conveyance and keep ESD velocity to 1 fps or less. All swales shall be sized to safely convey runoff from a 10-year storm event in a non erosive fashion to an acceptable outfall.

3. Groundwater

Grassed Swales shall not be located where the water table is within 2 feet of the bottom of the facility. If the 2 ft. clearance requirement cannot be met, an alternative stormwater practice must be proposed.

4. Setbacks

Grassed Swales shall be located at least 30 feet from water supply wells and 25 feet from septic systems. Practices should be located down gradient and setback at least 10 feet from building foundations.

Exhibit # 12

C. Specifications and Details

1. Sizing

When sized per the criteria below, the Grassed Swale may be credited as providing treatment volume for a Pe of 1.0 inch for the impervious area draining to it. Surface ponding may not be calculated for Grassed Swales since they do not pond water, they convey it away.

The surface of the Grassed Swale shall be 2 to 8 feet in width. Maximum velocity for the runoff from a one inch rainfall may not exceed 1.0 fps. Flow rate shall be calculated per Appendix D.10 of the 2000 Maryland Stormwater Design Manual. Where channel width, slope, and ESD flow rate requirements are met within a Grassed Swale for a drainage area, a credit of Pe = 1.0 inch shall be given. The treatment area used for calculating the ESD credit is considered to be only the impervious vehicular area draining directly to the swale along its length. Other areas that may drain to the swale, such as yards, rooftops and parking lots, will not be given ESD credit within the Grassed Swale.

Grassed Swales may not be "enhanced" by placing additional stone storage below them.

2. Inflow Design Criteria

Runoff shall enter the Grassed Swale in a non-erosive manner (less than 2 fps) as sheet flow from the surface being treated.

3. Overflow Design Criteria

Safe conveyance of the developed 10-year storm through the Grassed Swale must be demonstrated. Overflow inlets may be installed as required. All piped overflows must outfall to safe, stable locations.

4. Planting Media

Formal planting medium is not employed in the construction of Grassed Swales. However, the soil must be prepared for planting per Montgomery County tilling/topsoiling specifications prior to planting.

5. Mulch

Mulch is not employed in Grassed Swales. Swales must be stabilized with sod or with seed and erosion control matting at the time of grading.

6. Plant Materials

Plants, through their pollutant uptake and evapo-transpiration of stormwater runoff, play a key role in the overall effectiveness of the Grassed Swale. The swale should be densely planted in appropriate grasses.

Grassed Swale Sizing Example

A Grassed Swale is being designed to treat the runoff from a street that is part of a larger development. The target ESD_V for the overall project has already been determined. The total treatment area (roadway surface) to the swale is 10,000 square feet of roadway area. The longitudinal flow slopes at an average of 3.5%, and the bottom width has been adjusted to provide $\leq$ 1 fps for the ESD flow velocity (in this case a 2 foot bottom width). Treated roadway area is 1,000 feet long by ten feet wide. The swale runs the entire length of the treated area.

A = 10,000 sq. ft. of impervious area being treated directly in the swale
Pe = 1.0
Rv = .05 + 0.009(I) = .05 + 0.009(100) = 0.95

ESDv provided = (1.0) (.95) (10,000) / 12 = 792 cf

For calculation of maximum velocity and 10-year conveyance, the entire developed drainage area to the swale must be considered