APPENDICES

APPENDIX A

STORMWATER MANAGEMENT AND BMP PLAN APPLICATIONS

APPENDIX A-1.

STORMWATER MANAGEMENT EXEMPTION APPLICATION

BOROUGH FILE NO._____
DATE OF RECEIPT/FILING _____
(FOR BOROUGH USE ONLY)
PROPERTY NO.: _____

The undersigned hereby applies for an exemption under the West Grove Borough Stormwater Management Ordinance for the proposed improvement(s) outlined in the application submitted herewith and described below:

1. Name of Property Owner(s): _____
2. Address: _____
3. Phone No.: Home: _____ Cell: _____
4. Email Address: _____
5. Application Date: _____
6. Total Property Acreage: _____
7. Existing impervious areas being demolished or removed? (Y or N) How much:_____

NOTE: The allowable impervious coverage per lot is subject to the regulations of the Borough Zoning Ordinance, as amended, and any subdivision and land development plan impervious coverage limits for existing developments.

8. Description of Proposed Improvements: _____

_____

_____

9. Total Impervious Added (maximum 1,000 Sq. Ft) since (April 2, 2014) : _____

The undersigned hereby represents that, to the best of his/her knowledge and belief, all information listed above and on the land disturbance plan herewith submitted is true, correct, and complete. No part of the proposed construction is located within an existing easement or wetland area.

_____ _____
Signature of all property owners Date

Attach Sketch of Project Site and Proposed Improvements to the application. Refer to Appendix A-5 for information to be included in site sketch.

APPENDIX A-2.

STORMWATER MANAGEMENT SMALL PROJECTS PLAN/APPLICATION

Borough of West Grove, Chester County, Pennsylvania

This application pertains to projects that qualify as a Small Project (between 1,001 and 2,000 square feet of impervious area (cumulative)). If a formal Stormwater Management Plan is required in accordance with the West Grove Borough Stormwater Management Ordinance, **please consult a qualified professional (ex. Engineer, Surveyor, Landscape Architect).**

Property Owner's Name _____

Address of Property _____

Parcel ID _____

Phone Number: Home:_____ Cell: _____

Email Address: _____

1000 SF Exemption Used since (April 2, 2014): _____ No_____ Yes: how much: _____

New Impervious Area Associated with this Project: _____

Lot Size (Sq. Ft.): _____

Existing Impervious Coverage (Sq. Ft.): _____

Total New Impervious Area since Adoption of SWM Ordinance_____

NOTE: The allowable impervious coverage per lot is subject to the regulations of the Borough Zoning Ordinance, as amended.

Acknowledgement - I declare that I am the property owner, or representative of the owner, and that the information provided is accurate to the best of my knowledge. I understand that stormwater may not adversely affect adjacent properties or be directed onto another property without written permission. I also declare that the proposed construction is not within an existing easement or wetland area. I also understand that false information may result in a stop work order or revocation of permits. Borough representatives are also granted reasonable access to the property for review and/ or inspection of this project if necessary.

Signature(s)_____ Date _____

*All owners must sign

Small Project – Regulated Activities that involve 1,000 to 2,000 square feet of Proposed Impervious Surfaces and 5,000 to 10,000 square feet of proposed Earth Disturbance may apply the modified requirements presented in the "Small Projects Application" (Appendix A- 2) to comply with the requirements of Sections 304, 305, 306, 307, 308, 309, and 310, and Article IV, Article V, Article VI and Article VII of this Ordinance (as shown in Table 106.2).Small projects are not required to provide for Rate Control. Small projects are required to address at least the first one (1) inch of runoff from new impervious surfaces or an equivalent volume shall be permanently removed from the runoff flow – i.e. it shall not be released into the surface Waters of this Commonwealth. Removal options include reuse, evaporation, transpiration and infiltration. **The Small project plan application is not valid if the applicant has as of April 2, 2014 previously filed any stormwater permit application for impervious area greater than 2,000 SF.**

Impervious Surface – A surface that has been compacted or covered with a layer of material so that it prevents or is resistant to infiltration of water, including but not limited to: structures such as roofs, buildings, storage sheds; other solid, paved or concrete areas such as streets, driveways, sidewalks, parking lots, patios, tennis or other paved courts; or athletic playfields comprised of synthetic turf materials. For the purposes of determining compliance with this Ordinance, compacted soils or stone surfaces used for vehicle parking and movement shall be considered impervious. Surfaces that were designed to allow infiltration (i.e. areas of porous pavement) will be considered on a case-by-case basis by the Borough Engineer, based on appropriate documentation and condition of the material, etc. The allowable impervious coverage per lot is subject to the regulations of the Borough Zoning Ordinance, as amended.

Step 1: Determine the amount of new impervious surface area (as defined above) created by the proposed project. New stone and gravel areas are considered impervious. Impervious surface areas existing before April 2, 2014 are not included in this calculation. Use additional sheets if necessary.

Calculate new impervious area by completing this table.

Surface	Length (ft.)	x	Width (ft.)	=	Impervious Area (ft^2)
Buildings		x		=	
Driveway		x		=	
Parking Areas		x		=	
Other		x		=	
Existing Impervious Area to be Removed (if applicable)					
Surface	**Length (ft.)**	**x**	**Width (ft.)**	**=**	**Impervious Area (ft^2)**
		x		=	
Total Proposed Impervious Surface Area (Sum of all new impervious areas – all existing impervious area to be removed)					

Step 2: Determine the amount of runoff associated with the proposed amount of impervious area associated with this project, existing impervious is not included. The total calculated in Step 1 shall be inserted into the calculation below.

Impervious Area (ft²) to be Managed (Sum of Step 1)	X	1/2 in/12 in = 0.083	=	Amount of Stormwater to be Managed (ft³)
	X	0.083	=	

Step 3: Using the volume calculated in Step 2, the required stormwater volume to be removed from the runoff of the site has been determined. Reasonable stormwater management facility options to handle the runoff removal required under this application include:

Stone infiltration bed
Stone infiltration trench
Rain Barrels
Infiltration basin
Rain Garden
Dry Well

The Borough has a worksheet for each option listed above (Refer to Appendix A-3) that includes a typical construction detail, sizing calculations, and design/construction considerations. A copy of the completed worksheet for the proposed stormwater management facility or facilities shall be provided as part of the completed application for a Small Project. Bring the Small Project Application, Site Plan (Appendix A-5), completed stormwater facility worksheet (size, location, etc.), signed Owner Acknowledgement and completed BMP Facilities and Maintenance Agreement to the Borough.

OWNER ACKNOWLEDGMENT

- Development activities shall begin only after West Grove Borough or its designee approves the Small Project application.

- The installed Stormwater BMPs will not adversely affect any property, septic systems or drinking water wells on this or any other property.

- The landowner shall keep on file with the Borough the name, address and telephone number of the person or company responsible for maintenance activities; in the event of a change, new information shall be submitted to the Borough within 10 days of the change.

- If, after approval of the Small Project Application by the Borough, the Applicant wishes to pursue alternative stormwater management measures in support of the project, the Applicant will submit revised Small Project information and worksheets to West Grove Borough for approval. If a site requires a more complex system or if problems arise, the Applicant may need the assistance of a licensed Professional Engineer, Landscape Architect or Surveyor.

- The Applicant acknowledges that the proposed Stormwater BMPs will be a permanent fixture of the property that cannot be altered or removed without approval by West Grove Borough.

I (we) _____, hereby acknowledge the above statements and agree to assume full responsibility for the implementation, construction, operation, and maintenance of the proposed Stormwater Management Facilities. Furthermore, I (we) also acknowledge that the steps, assumptions and guidelines provided in this submission, including, but not limited to: West Grove Borough Stormwater Application, Site Plan, Worksheets and the Stormwater Management / BMP Facilities and Maintenance Agreement will be adhered to.

Property Owner(s) Acknowledgement of Submission

Signature:_____ Date: _____

Signature:_____ Date: _____

*All property owners must sign.

West Grove Borough Acknowledgement of Receipt

Signature:_____ Date: _____

SMALL PROJECT STORMWATER BEST MANAGEMENT PRACTICES OPERATION, MAINTENANCE, AND INSPECTION PLAN AND AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 20___, by and between _____, (hereinafter the "Landowner"), and West Grove Borough, Chester County, Pennsylvania, (hereinafter "Borough").

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property by virtue of a deed of conveyance recorded in the land records of Chester County, Pennsylvania, at Deed Book _____ and Page _____, (hereinafter "Property"); and

WHEREAS, the Landowner recognizes that the stormwater management best management practices or BMPs (hereinafter referred to as "BMP" or "BMP(s)") located on the Property at _____ _____ (address of Property where BMP is located) must be inspected and maintained; and

WHEREAS, the Borough and the Landowner, for itself and for its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of the Borough and the protection and maintenance of water quality require that on-site BMP(s) be constructed and maintained on the Property; and

WHEREAS, for the purposes of this Agreement, the following definitions shall apply:

BMP – "Best Management Practice;" activities, facilities, designs, measures or procedures used to manage stormwater impacts from land development, to protect and maintain water quality and ground water recharge and to otherwise meet the purposes of the Borough's Stormwater Management Ordinance, including, but not limited to infiltration trenches, dry wells, bioretention, rain gardens, permeable paving, rain barrels and cisterns, etc. The BMP(s) are permanent appurtenances to the Property; and

Conveyance – As specifically identified in the Simplified Stormwater Management Site Plan (herein after "Plan"), a man-made, existing or proposed facility, structure or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, and like facilities or features. The conveyances identified in the Plan are permanent appurtenances to the Property; and

WHEREAS, the Borough requires that the BMP(s) and conveyances as shown on Plan and in accordance with the sizing calculations found on the Simplified Method Worksheet (herein after "Worksheet") be constructed by the Landowner; the BMP(s) shall further be maintained by the Landowner, its administrators, executors, successors, heirs, and assigns in accordance with the associated operation and maintenance requirements included herein. The Plan and Worksheet are attached hereto and incorporated herein together as Exhibit "A" hereto; and

WHEREAS, the Borough requires that stormwater management BMP(s) be constructed and adequately inspected, operated and maintained by the Landowner, its administrators, executors, successors, heirs, and assigns, in accordance with the following maintenance requirements:

1. **Stone Infiltration Trenches/Stone Infiltration Beds**
   a. At least twice a year and after significant rainfall events the Landowner is to inspect the infiltration trench and remove any accumulated debris, sediment and invasive vegetation.
   b. Vegetation along the surface of an infiltration trench is to be maintained in good condition, and any bare spots are to be revegetated as soon as possible.
   c. Vehicles are not to be parked or driven on an infiltration trench, and care is to be taken to avoid excessive compaction by mowers.
   d. Any debris, such as leaves blocking flow from reaching an infiltration trench, is to be routinely removed.

2. **Bioretention/Rain Garden**
   a. Any debris, such as leaves blocking flow from reaching a bioretention/rain garden, is to be routinely removed.
   b. Pruning and weeding are required as needed including removal of invasive species, especially while vegetation is being established for a bioretention/rain garden.
   c. Mulch cover is to be maintained in a bioretention/rain garden, re-spread and replaced as needed to prevent erosion, reduce weed growth and assist with plant survival, without restricting the infiltration of stormwater.
   d. At least twice a year the Landowner is to inspect the bioretention/rain garden for sediment buildup, ground cover and vegetative conditions and make any repairs as needed.
   e. Watering is required as needed, including during periods of extended dry weatber and drought.
   f. Trees and shrubs in a bioretention/rain garden are to be inspected at least twice per year by the Landowner to evaluate their health. If they are in poor health they are to be replaced.

3. **Dry Wells**
   a. Dry wells are to be inspected by the landowner at least four (4) times a year and after significant rainfalls, and debris, trash, sediment, and any other waste material need to be removed and disposed of at suitable disposal or recycling sites and in compliance with local, state, and federal waste regulations.
   b. For dry wells, gutters are to be regularly cleaned out and ensure that proper connections are maintained to facilitate the effectiveness of the dry well.
   c. The filter screen for downspouts or roof gutters which intercepts roof runoff and conveys it to the dry well must be cleaned and replaced as necessary.
   d. Dry wells that are damaged are to be fixed or replaced witbin two (2) weeks of being damaged.
   e. If an intermediate sump box exists in conjunction with a dry well, it must be cleaned out at least once per year.

4. **Rain Barrels and Cisterns**
   a. Rain Barrels and Cisterns are to be cleared of debris routinely at least every three (3) months and after significant storms to allow stormwater from gutters to enter them.
   b. Gutters that directly convey rain water to dry wells, rain barrels, and cisterns are to be routinely cleared of trash and debris at least every three (3) months and after significant rainfall events.
   c. Rain Barrels and cisterns should be routinely emptied to allow for storage of additional rain water.
   d. Overflow outlets from rain barrels and cisterns must be kept free and clear of debris.
   e. Rain Barrels and cisterns that are damaged are to be fixed or replaced within two (2) weeks of being damaged.

5. **Infiltration Basin**
   a. Catch basins and inlets (upstream of the infiltration basin) should be inspected and cleaned at least two (2) times per year and after significant runoff events.
   b. The vegetation along the surface of the Infiltration basin should be maintained in good condition, and any bare spots shall be re-vegetated as soon as possible.
   c. Vehicles should not be parked or driven on the infiltration basin and care should be taken to avoid excessive compaction by mowers.
   d. The property owner shall inspect the basin after runoff events to make sure that the runoff drains down within 72 hours. Mosquitos should not be a problem if the water drains in 72 hours.
   e. The property owner shall inspect for the accumulation of sediment, damage to the outlet control structures, erosion control measures, signs of water contamination/spills, and slope stability in the berms.
   f. The property owner shall remove the accumulated sediment from the basin as required. The original cross section and basin volume shall be restored, and the excess sediment shall be properly disposed of.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement and obligations of the Landowner as if fully set forth in the body of this Agreement.

2. The Landowner shall construct the BMP(s) in accordance with the specifications identified in the Plan and Worksheet.

3. The Landowner shall inspect, operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Borough and in accordance with the specific inspection and maintenance requirements outlined in this Agreement.

4. The Landowner hereby grants permission to the Borough, its authorized agents and employees, to enter upon the Property from the public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) whenever it deems necessary for compliance with this Agreement and the Borough's Stormwater Ordinance. Whenever possible, the Borough shall notify the Landowner prior to entering the Property.

5. The Landowner acknowledges that, per the Borough's Stormwater Ordinance, it is unlawful, without written approval of the Borough, to:

a. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or conveyance that is constructed as part of the Plan;
b. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or conveyance that would limit or alter the functioning of the BMP or conveyance;
c. Allow the BMP or conveyance to exist in a condition which does not conform to the Plan or this Agreement; and

d. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals and automotive fluids to directly or indirectly enter any BMP or conveyance.

6. In the event the Landowner fails to operate and maintain the BMP(s) as shown on the Plan in good working order acceptable to the Borough the Landowner shall be in violation of this Agreement and the Landowner agrees that the Borough or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon the Property and take whatever action is deemed necessary to maintain said BMP(s). It is expressly understood and agreed that the Borough is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Borough.

7. In the event the Borough, pursuant to this Agreement, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Borough for all expenses (direct and indirect) incurred within 30 days of delivery of an invoice from the Borough. Failure of the Landowner to make prompt payment to the Borough may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.

8. The intent and purpose of this Agreement is to ensure the proper maintenance of the onsite BMP(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or effect any additional liability of any party for damage alleged to result from or be caused by stormwater runoff.

9. The Landowner, its executors, administrators, assigns, heirs, and other successors in interests, hereby release and shall release the Borough, its employees, agents and designated representatives from all damages, accidents, casualties, occurrences or claims which might arise or be asserted against the Borough and/or its said employees, agents or representatives, arising out of the construction, presence, existence, or maintenance of the BMP(s) either by the Landowner or Borough. In the event that a claim is asserted or threatened against the Borough, its employees, agents or designated representatives, the Borough shall notify the Landowner and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or threatened claim, suit, action or proceeding against the Borough or, at the request of the Borough, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Borough. If any judgment or claims against the Borough, its employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Borough, including attorney's fees, regarding said damages, judgment or claims.

10. The Borough may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Borough shall include its reasonable attorney's fees and costs incurred in seeking relief under this Agreement.

11. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Borough of its rights of enforcement hereunder.

12. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.

13. This Agreement shall inure to the benefit of and be binding upon, the Borough and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

This Agreement shall be recorded at the Office of the Recorder of Deeds of the County of Chester, Pennsylvania, and shall constitute a covenant running with the Property and/or equitable servitude, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Borough:

_____

(SEAL) For the Landowner:

_____

(CONTINUED ON NEXT PAGE)

ATTEST:

_____ (West Grove Borough)
County of Chester, Pennsylvania

I, _____, a Notary Public in and for the County and State aforesaid, whose commission expires on the _____ day of _____, 20__, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 20__, has acknowledged the same before me in my said County and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 20__.

_____ _____.

NOTARY PUBLIC **(SEAL)**

APPENDIX A-3.

Small Project Worksheets

Option #1 – Infiltration Bed
Option #2 – Infiltration Trench
Option #3 – Rain Barrels
Option #4 – Infiltration Basin
Option #5 – Rain Garden
Option #6 – Dry Well

Infiltration Bed Option #1

Step 3a:
Design Calculations:

Amount of Stormwater to be Managed from Step 2 ÷ 0.40 (stone void) = Required volume of infiltration bed

Required Bed Volume = _____

Step 3b:
Infiltration Bed Sizing:

Length (Feet) = _____

Width (Feet) = _____

Depth (Feet) =_____

Bed Volume (Cubic Feet): Length x Width x Depth = _____

Sizing Check:

Proposed Bed Volume = _____ > Required Bed Volume = _____

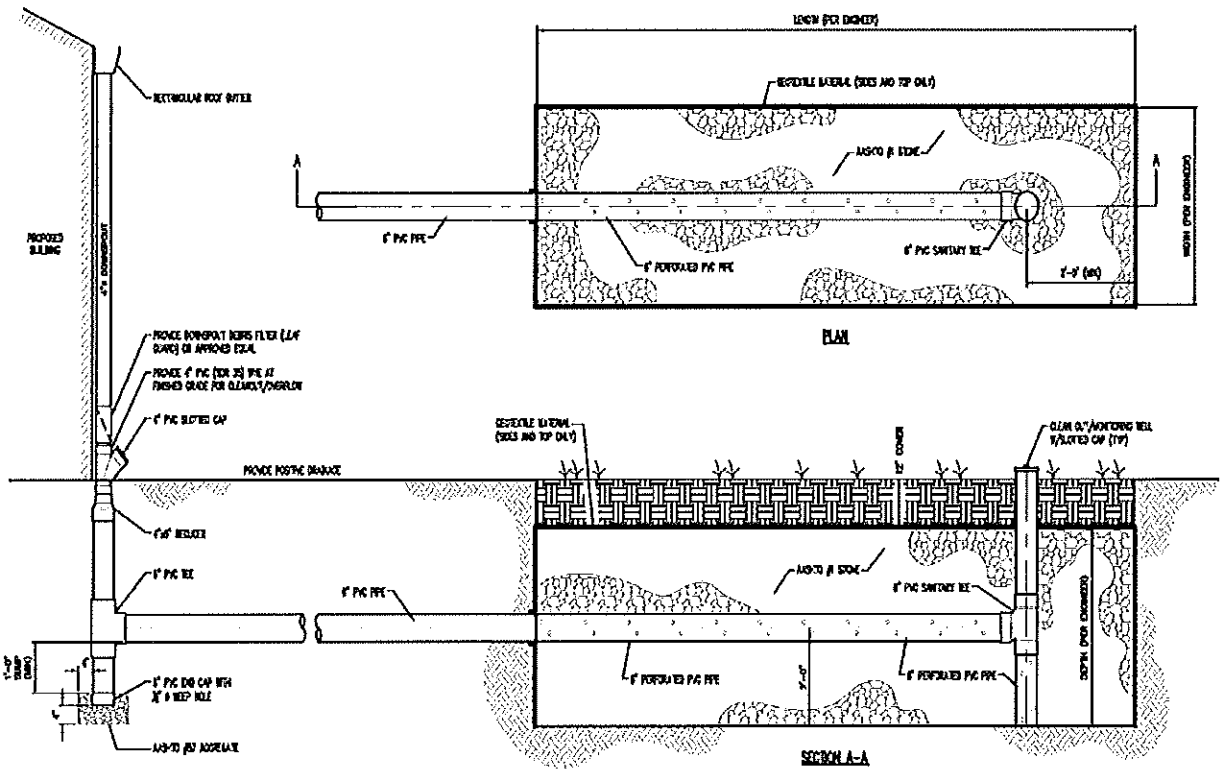
Step 4:

Infiltration Bed Criteria

- Stone bed shall not be located within 10 feet of any On-lot Sewage Disposal Systems.
- Stone used in the infiltration bed shall be "clean" stone, i.e. #67, #57, #5 or clean 2B stone for the smaller facilities, and #1 or #3 ballast or R-3 for larger deeper facilities. Copies of the receipt(s) shall be provided to the Borough for their records. NO MODIFIED STONE MIXES SHALL BE UTILIZED FOR INFILTRATION.
- The standard void ratio for stone is 0.40 (40% storage for each CF), this is accounted for in the calculations in Step 3.
- It is recommended that the property owner verify that the ground will infiltrate water; this can be accomplished by excavating a pit and placing a large amount of water into the pit to see how long it takes to infiltrate (seep into the ground).
- Non-woven geotextile (fabric) shall be placed along the sides and top of the facility. No fabric shall be placed on the bottom of the facility.

(Standard Infiltration Bed Detail on Back of Worksheet)

Infiltration Bed Detail



A completed copy of this Worksheet shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

Infiltration Trench Option #2

Step 3a:
Design Calculations:

Amount of Stormwater to be Managed from Step 2	÷	0.40 (stone void)	=	Required volume of infiltration trench

Required Trench Volume = _____

Step 3b:
Trench Sizing:

Length (Feet) = _____

Width (Feet) = _____

Depth (Feet) =_____

Trench Volume (Cubic Feet): Length x Width x Depth = _____

Sizing Check:

Proposed Trench Volume = _____ > Required Trench Volume = _____

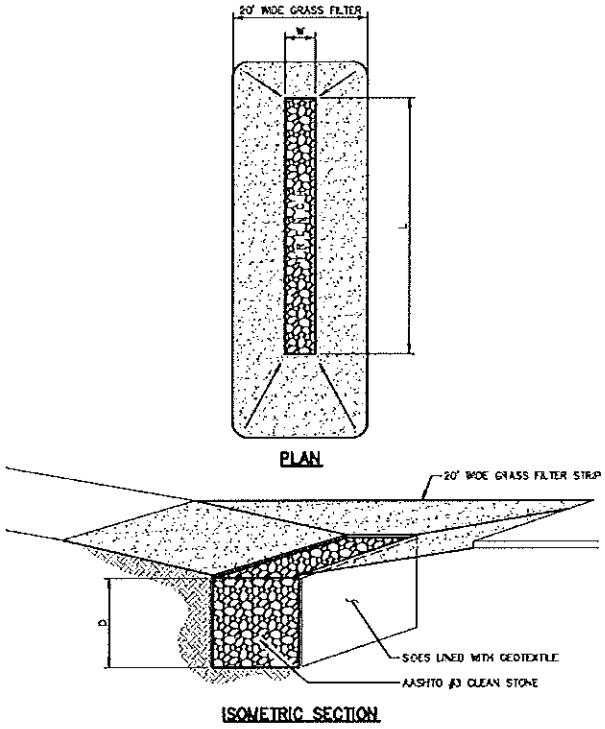
Step 4:

Infiltration Trench Criteria

- Stone trench shall not be located within 10 feet of any On-lot Sewage Disposal Systems.
- Stone used in the infiltration trenches shall be "clean" stone, i.e. #67, #57, #5 or clean 2B stone for the smaller facilities, and #1 or #3 ballast or R-3 for larger deeper facilities. Copies of the receipt(s) shall be provided to the Borough for their records. NO MODIFIED STONE MIXES SHALL BE UTILIZED FOR INFILTRATION.
- The standard void ratio for stone is 0.40 (40% storage for each CF), this is accounted for in the calculations in Step 3.
- It is recommended that the property owner verify that the ground will infiltrate water; this can be accomplished by excavating the trench or a pit and placing a large amount of water into the pit to see how long it takes to infiltrate (seep into the ground).
- Non-woven geotextile (fabric) shall be placed along the sides and top of the facility. No fabric shall be placed on the bottom of the facility.

(Standard Infiltration Trench Detail on Back of Worksheet)

Infiltration Trench Detail



A completed copy of this Worksheet shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

Rain Barrel Option #3

Rain Barrel – Barrel (or large container) that collects drainage from roof leaders and stores water until needed for irrigation.

Step 3a:
Design Calculations:

Amount of Stormwater to be Managed from Step 2	=	Required volume of Rain Barrel(s)

Required Rain Barrel Volume = _____

Step 3b:
Volume shall be according to the Manufacturer's Brochures/Specifications. A copy of the brochure or cut sheet for the rain barrel can be provided to the Borough as part of the Small Project Application.

Proposed Rain Barrel Volume = _____

Number of Required Rain Barrels to Meet Required Volume = _____

Sizing Check:

Proposed Rain Barrel Volume = _____ > Required Storage Volume = _____
(Total Volume of All Rain Barrels Combined)

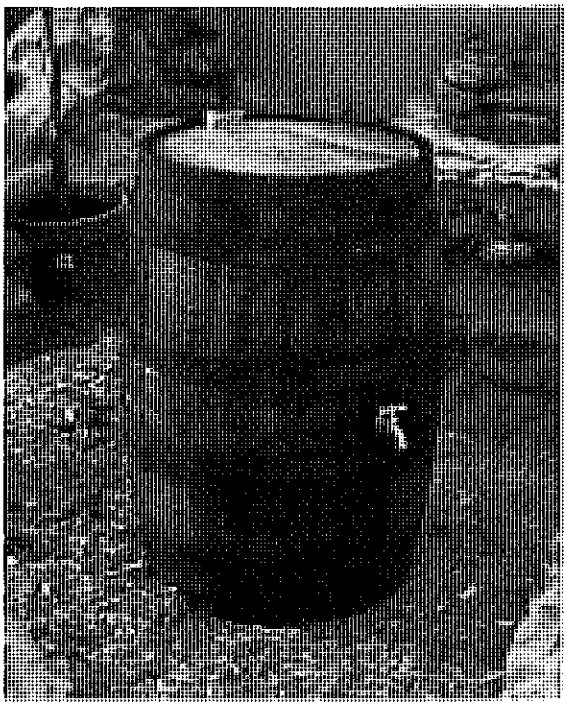
Step 4:

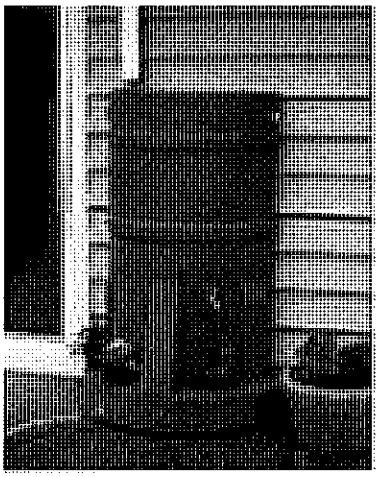
Rain Barrel Criteria

- Owner of the rain barrel(s) is required to use the stored water volume in between storms in order to maintain available storage volume within the rain barrel for the next storm event.
- The rain barrel(s) shall be protected from direct sunlight (positioning and landscaping). Limit the light into devices to minimize algae growth.
- The rain barrel(s) overflow shall be directed away from any house or building.
- Maintenance: Periodic tank and sump cleanout is required.
- Winter Concern: Empty out before water freezes during the winter months.

(Examples of Rain Barrel Detail on Back of Worksheet)

Rain Barrel Examples





Pictures from the PA DEP BMP Manual – December 30, 2006.

A completed copy of this Worksheet and any associated Rain Barrel Brochures or Specifications shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

Infiltration Basin Option #4

Infiltration basins are shallow depressions that store and infiltrate runoff.

Step 3a:

Design Calculations: Amount of Stormwater to be Managed from Step 2 = Required volume in infiltration basin

Required Bain Volume = _____

Step 3b:
Basin Sizing:

Length (Feet) = _____ Width (Feet) = _____

Depth (Feet) =_____

Approximate Basin Volume (Cubic Feet): Length x Width x Depth = _____

Sizing Check:

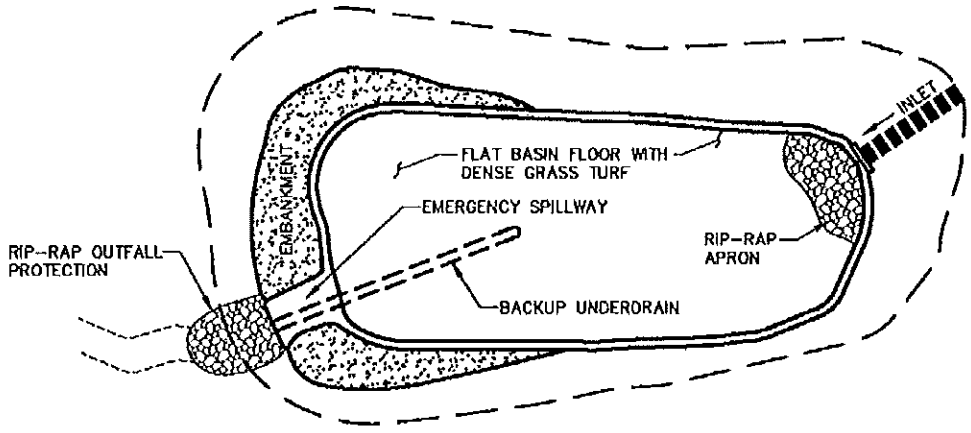
Proposed Basin Volume = _____ > Required Basin Volume = _____

Step 4:

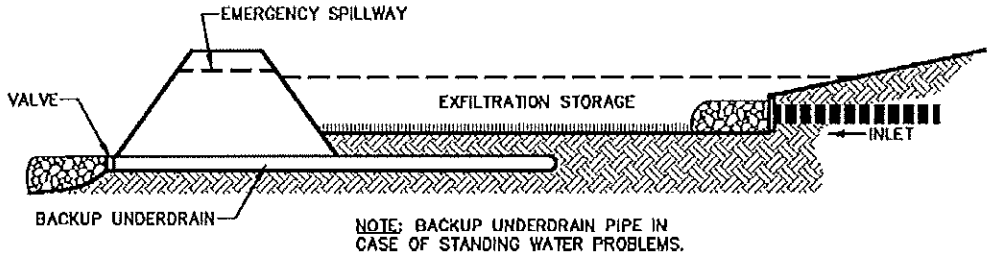
Infiltration Basin Criteria

- Compaction of soil must be prevented to maintain the infiltration capabilities of the soils.
- The basin/impoundment area must be stabilized to prevent erosion and aid in dewatering the stormwater runoff.
- The bottom of the infiltration basin should be level or have a slope no greater than 1%.
- The basin overflow shall be designed to discharge away from any houses, buildings or roadways.
- The basins shall have embankment slopes no steeper than 3:1, but 5:1 is recommended for maintenance.
- The top width of the berm shall be a minimum of two (2) feet wide.
- The use of fertilizers in the basin shall be avoided.
- Maintenance: Vehicles shall not be parked or driven through the basin. The owner should avoid excessive compaction by mowers.
- The owner should inspect the basin after large storms and verify the basin dewaters within 72 hours.
- Any proposed basin plantings shall be native to the area.
- It is recommended that the property owner verify that the ground will infiltrate water; this can be accomplished by excavating a pit and placing a large amount of water into the pit to see how long it takes to infiltrate (seep into the ground).

Infiltration Basin Detail



PLAN VIEW



SECTION VIEW

A completed copy of this Worksheet shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

Rain Garden Option #5

Rain Garden – A shallow excavated surface depression planted with specific selected native vegetation to capture and treat runoff.

Step 3a:

Design Calculations: Amount of Stormwater to be Managed from Step 2 = Required volume in Rain Garden

Required Rain Garden Volume = _____

Step 3b:
Rain Garden Sizing:

Length (Feet) = _____ Width (Feet) = _____

Depth (Feet) =_____

Approximate Rain Garden Volume (Cubic Feet): Length x Width x Depth = _____

Sizing Check:

Proposed Rain Garden Volume = _____ > Required Rain Garden Volume = _____

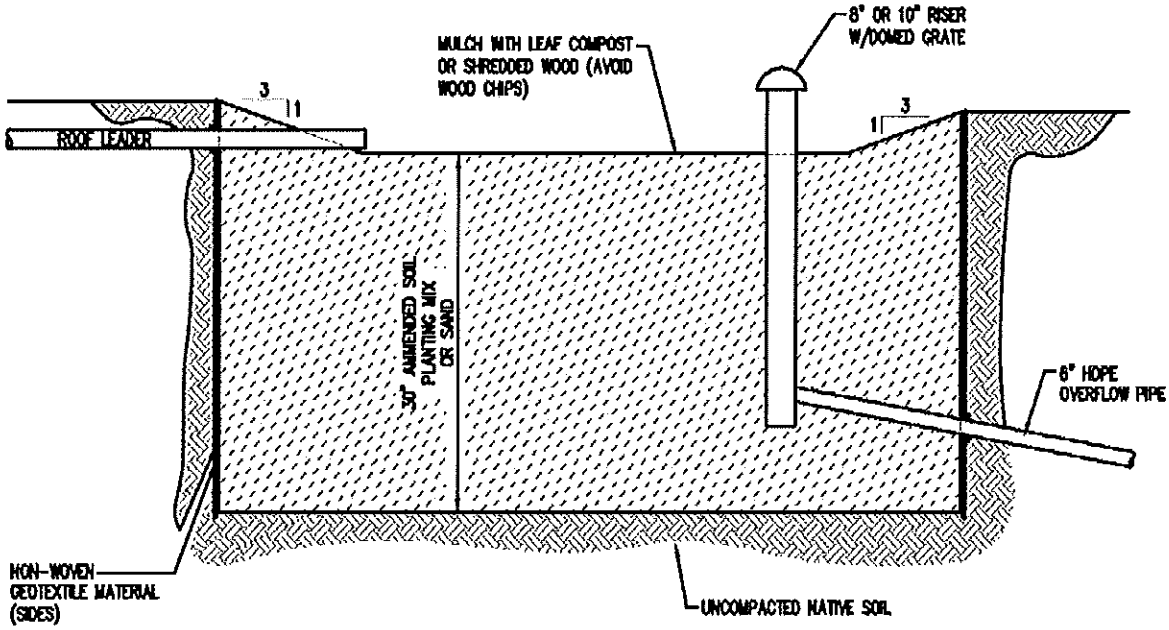
Step 4:

Rain Garden Criteria

- Typically 12 inch depth.
- Soils are modified with compost.
- The rain garden overflow shall be directed away from houses, buildings and roadways.
- The minimum recommended side slope is 3:1.
- The rain garden shall be designed to dewater in 72 hours.
- The ponding area should not exceed six (6) inches.
- Underdrains shall NOT be used.
- It is recommended that the property owner verify that the ground will infiltrate water; this can be accomplished by excavating the trench or pit and placing a large amount of water into the pit to see how long it takes to infiltrate.
- Maintenance: Mulch, if used, should be re-spread when erosion is evident or about once every two (2) to three (3) years.
- The rain garden area shall be inspected several times a year to check for sedimentation.

(Standard Infiltration Trench Detail on Back of Worksheet)

Rain Garden Detail



NOTES:

1. MOISTURE-TOLERANT PLANT MATERIAL SHALL BE USED AT BOTTOM EDGE. PLANT MATERIAL SHALL BE TOLERANT OF FLUCTUATING WATER CONDITIONS.
2. SOIL BENEATH RAIN GARDEN SHALL REMAIN UNCOMPACTED.
3. AS AN ALTERNATIVE, SAND OR GRAVEL CAN BE USED AS BEDDING FOR THE RAIN GARDEN.
4. IF SAND IS TO BE USED, ADDITIONAL DESIGN ELEMENTS AND VEGETATION PLANTINGS WILL NEED TO BE USED.

A completed copy of this Worksheet shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

Dry Well Option #6

Dry Well – a subsurface storage facility that temporarily stores and infiltrates stormwater runoff from the roof of structures. A dry well is typically an excavated pit filled with uniformly graded aggregate wrapped in geotextile or a prefabricated storage chamber or pipe segment.

Design Calculations:

Amount of Stormwater to be Managed from Step 2 ÷ 0.40 (stone void) = Required volume of dry well

Required Dry Well Volume = _____

Step 3b:
Dry Well Sizing:

Length (Feet) = _____ Width (Feet) = _____

Depth (Feet) =_____ (1.5 to 4 feet recommended)

Dry Well Volume (Cubic Feet): Length x Width x Depth = _____

Sizing Check:

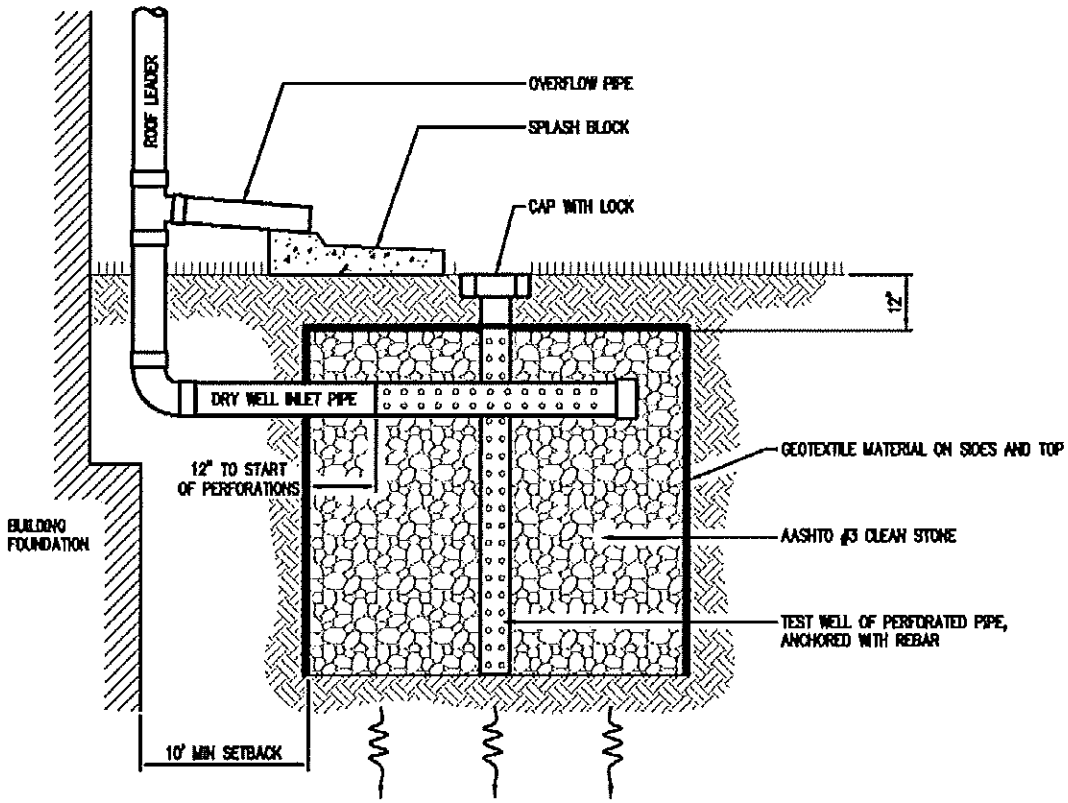
Proposed Dry Well Volume = _____ > Required Dry Well Volume = _____

Step 4: Dry Well Criteria

- Dry well shall maintain a minimum distance of 10 feet from any building foundation.
- The dry well base shall be a uniform, level un-compacted subgrade.
- Typically consist of clean washed, uniformly graded stone (i.e. AASHTO No. 3)
- Stone is wrapped in non-woven geotextile which should overlap by a minimum 24 inches within the trench.
- A minimum 12 inches of topsoil is placed over the stone dry well.
- Dry wells are not recommended where they would create a significant risk for basement seepage or flooding.
- A removal filter with a screened bottom or downspout debris filter (refer to SWM details) shall be installed in the downspout line to collect any leaves or debris prior to entering the dry well facility.
- Dry wells shall be inspected at least four (4) times a year and in accordance with the Small Project Stormwater Management Agreement.
- The property owner shall regularly clean out gutters and check the downspout connections to the dry well.

(Standard Dry Well Detail on Back of Worksheet)

Dry Well Detail



A completed copy of this Worksheet shall be provided to the Borough as part of the Small Project Application (Appendix A-2.)

APPENDIX A-4.

APPLICATION FOR A STORMWATER MANAGEMENT PLAN

West Grove Borough
Chester County, Pennsylvania

File No._____
Date Received_____
Property No.: _____

Application is hereby made to West Grove Borough for the issuance of a Stormwater Management Permit pursuant to the specifications herewith submitted.

1. Name of Property Owner(s):_____

   Address:_____

   Phone: Home:_____ _____ Cell: _____

   Email Address: _____

2. Project Location:_____

3. Type of Earth Disturbance Activity:

   A. New impervious or semi-impervious surface_____(sq. ft./ac.)
   B. Diversion or piping of natural or man-made watercourse_____(linear ft.)
   C. Installation of the following:

Culvert	_____	Infiltration Seepage Bed	_____
Detention basin	_____	Cistern	_____
Retention basin	_____	Underground Detention Basin	_____
Sediment basin	_____	Infiltration Basin	_____
Other	_____	Rain Garden	_____

   D. Removal of ground cover, grading, filling or excavation _____ (sq. ft./ac.)

4. Land disturbance plan prepared by:

   Name: _____

   Address:_____Phone_____

5. Name of applicant (if other than owner): _____

   Address:_____

Phone_____

The undersigned hereby represents that, to the best of his/her knowledge and belief, all information listed above and on the land disturbance plan herewith submitted is true, correct and complete.

_____ _____

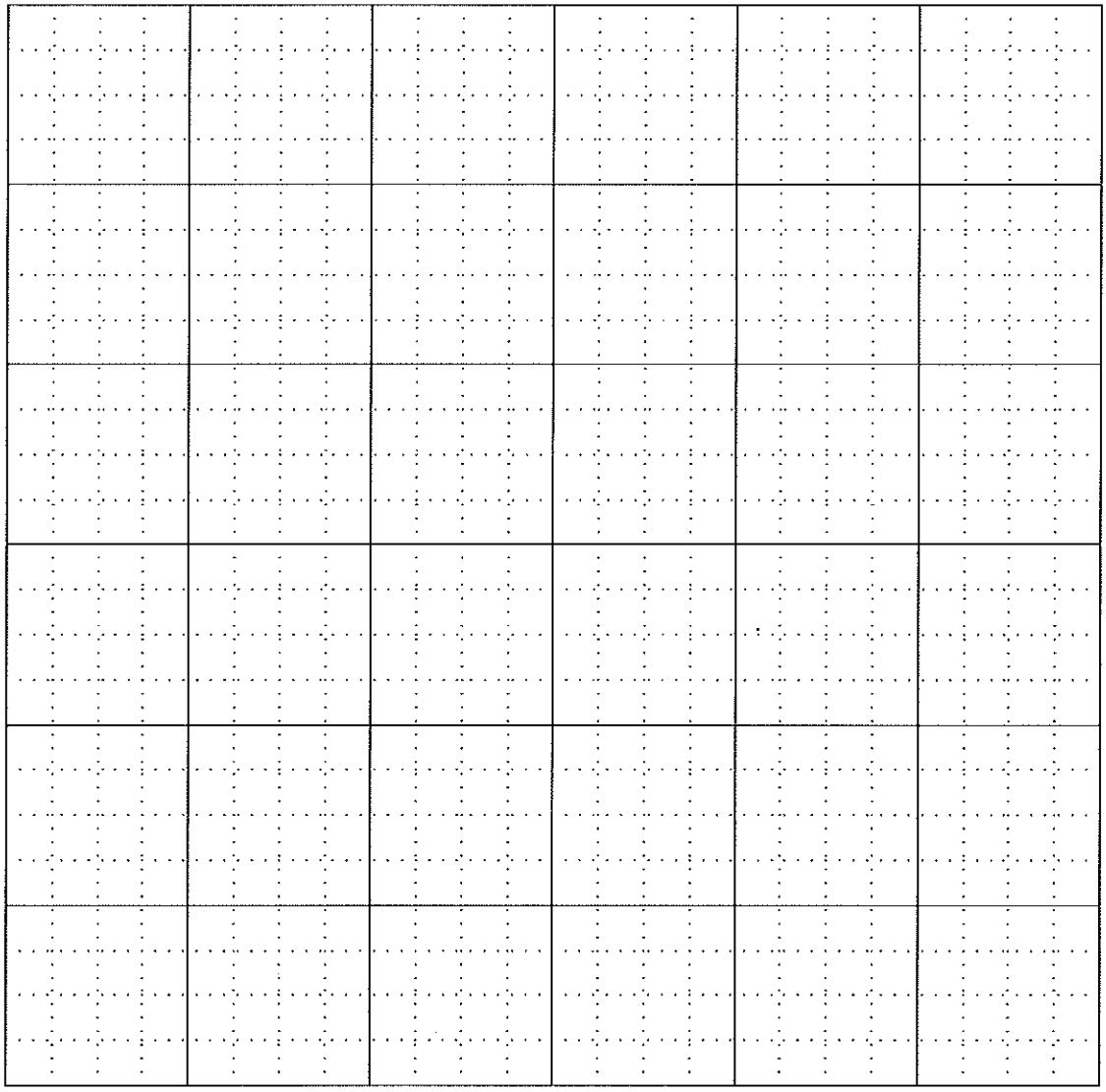
Signature of all property owners Date

APPENDIX A-5.

SITE PLAN FOR EXEMPTIONS OR SMALL PROJECTS

Property Owner: _____ Date:_____

Address: _____



Scale: 1" = _____(4 squares per inch)

The following shall be shown on the Plan:

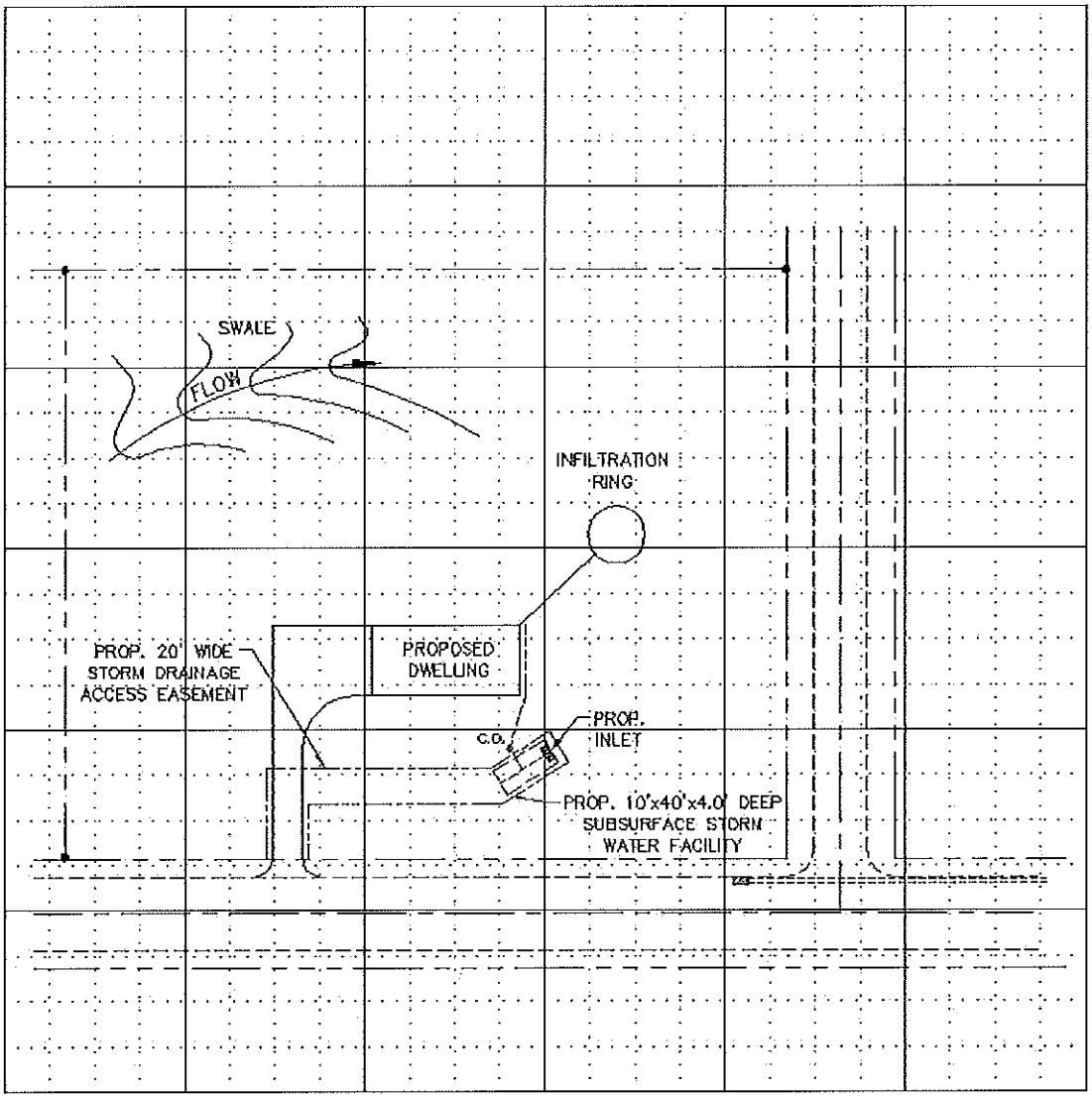
Lot Configuration	Berms	Infiltration System	Wells
Building Location	Terraces	Swales	On-Lot Septic
Contours or Flow Arrows	Bridges	Watercourses	Easements
Storm Sewers	Dams	Floodplains	
Detention Basins	Retention Basins	Inlets	
Cisterns	Seepage Beds	Leach Rings	
Sidewalks	Driveways	Patios	

APPENDIX A-5a.

SITE PLAN FOR EXEMPTIONS OR SMALL PROJECTS (EXAMPLE)

Property Owner: _____ Date: _____

Address: _____



Scale: 1" = _____(4 squares per inch)

The following shall be shown on the Plan:

Lot Configuration	Berms	Infiltration System	Wells
Building Location	Terraces	Swales	On-Lot Septic
Contours or Flow Arrows	Bridges	Watercourses	Easements
Storm Sewers	Dams	Floodplains	
Detention Basins	Retention Basins	Inlets	
Cisterns	Seepage Beds	Leach Rings	
Sidewalks	Driveways	Patios	

APPENDIX A-6.

CERTIFICATE OF APPROVAL BY BOROUGH COUNCIL

At a meeting on _____, 20___, the West Grove Borough Council approved this project, and all conditions have been met. This approval includes the complete set of plans and information that are filed with West Grove Borough in File No. _____, based upon its conformity with the standards of the West Grove Borough Stormwater Management Ordinance and with any modification, thereof, approved by the West Grove Borough Council.

_____ _____

Borough Manager Signature Borough Council President Signature

---

CERTIFICATE FOR REVIEW BY THE BOROUGH ENGINEER

(if required by the Borough)

Reviewed by the West Grove Borough Engineer this _____ day of _____, 20_____.

_____

STORMWATER MANAGEMENT CERTIFICATION

"I (name), on this date _____, hereby certify to the best of my knowledge that the SWM Site Plan meets all design standards and criteria of the West Grove Borough Ordinance No. _____, West Grove Borough Stormwater Management Ordinance." *[Note: include signature, name, discipline of professional license, and license stamp or seal here]*

_____, 20___ **

** Signature and seal of the qualified professional responsible for the preparation of the plan.

CERTIFICATE OF COMPLETION

I, _____, certify that all permanent SWM Facilities have been constructed according to the plans, specification and revisions as approved for the property located at _____.

_____

(Signature and seal of qualified person)

APPENDIX A-7.

AS-BUILT PLAN REQUIREMENT CHECKLIST – WEST GROVE BOROUGH

This checklist is compiled as a minimum list of information to be included on the required stormwater management as-built plans submitted to the Borough under this Ordinance.

YES NO (n/a)

GENERAL REQUIREMENTS

_____ _____ 1. Name of the project (consistent with approved plan)
_____ _____ 2. Name of the Borough
_____ _____ 3. Plan Status - Identify as "AS-BUILT PLAN"
_____ _____ 4. North point on each sheet
_____ _____ 5. Written and graphic scale to match original approved plan submission
_____ _____ 6. Date of plan and any subsequent revision dates
_____ _____ 7. Name and address of record owner and developer
_____ _____ 8. Name, address, seal, signature and certification of the registered surveyor responsible for plan
_____ _____ 9. Design engineer's name, project number, date, etc. (if different from as-built preparer)
_____ _____ 10. Names, book and page numbers of any abutting subdivision or land development, or abutting property owners
_____ _____ 11. Key Map if more than one sheet is needed
_____ _____ 12. Tract boundary lines with bearings and distances
_____ _____ 13. Right-of-way lines, lot lines and easement lines with bearings, distances, actual dimensions (width, radius, distance from centerline) and descriptive labels (road names, type of easement or right-of-way)
_____ _____ 14. Location and elevation of any actual monuments and pin locations
_____ _____ 15. Tract and lot areas
_____ _____ 16. Location and elevation of the benchmark which all site elevations tie into.

STREET REQUIREMENTS

_____ _____ 1. Streets and other paved areas (cartway width, pavement markings, spot elevations as needed to show positive drainage).
_____ _____ 2. Sidewalk and other concrete areas.

STORM DRAINAGE

_____ _____ 1. Any field changes that were not shown on the approved plan/permit.
_____ _____ 2. Stormwater Management easement boundaries.
_____ _____ 3. Storm sewer system - type of structure with top and invert elevations
-type of pipe, size, length, and slope
-riprap location, actual swale contours and cross sections.
_____ _____ 4. Floodplain by elevation and location from property line and any lot restrictions associated with the floodplain.
_____ _____ 5. Seepage Bed location, dimensions and pipe connections, cleanouts.
_____ _____ 6. Level spreader grading or structures.
_____ _____ 7. Detention basins -Outlet structure information, top elevation, orifice size and invert, outfall culvert type, size, slope, and invert elevation.
-As-built contours and volume
-Spillway type and location, dimensions, and invert
-Verification of anti-seep collar and clay core installation
-Low flow channel, width, slope and cross section
-Fencing around basin
-Underdrain pipe and cleanouts

OTHER SITE FEATURES

_____ _____ 1. Landscaping within 10 feet of any stormwater facility - Document single trees and planted areas showing compliance with approved landscape plan
-Screen fencing
_____ _____ 2. Buildings -first floor elevations, roof drains/leaders

When located within 25 feet of any stormwater facilities:

_____ _____ 3. Gas Line -valves, service, approx. depth =+-0.5'
_____ _____ 4. Electric Lines -electric transformer boxes, poles, manholes, approx. line location.
_____ _____ 5. Telephone, TV Cable -junction boxes, poles, manholes, approx. line location

ADDITIONAL PLAN REQUIREMENTS

_____ _____ 1. Sheet number located in the bottom right-hand corner of the drawings
_____ _____ 2. Manhole numbers
_____ _____ 3. Matchline information (if applicable)
_____ _____ 4. When located within 25 feet of any stormwater management facilities, any water and sewer lateral information station, size, length, material, depth) within a box on the corresponding lot; alternatively, a chart can be used to show this information

PLAN NOTES TO BE INCLUDED ON AS-BUILT PLANS

_____ _____ 1. All required post-construction maintenance notes and property owner inspection schedule.
_____ _____ 2. Note stating the amount of impervious coverage the stormwater facilities onsite have been designed for.

ADDITIONAL SUBMISSION REQUIREMENTS

_____ _____ 1. Provide two (2) sets of prints initially; upon approval of plans, provide one (1) electronic copy, two (2) set of prints, and two (2) sets of half-size prints.
_____ _____ 2. Pipe material, diameter, slope, length, encasement location and dimensions
_____ _____ 3. Provide individual Plot Plans and legal descriptions for each lot impacted for all water and sanitary sewer rights-of-way/easements for processing of right-of-way agreements (not required on as-built drawing sheets).
_____ _____ 4. Drawings need to be readable when reduced to half size.

The Borough Engineer and Borough Staff will review the plans for accuracy and completeness.

APPENDIX B

STORMWATER MANAGEMENT AND BMP CALCULATION COEFFICIENTS

APPENDIX NO. B-1

RUNOFF COEFFICIENTS "C" FOR
RATIONAL FORMULA

TABLE 5.2
Runoff Coefficients for the Rational Equation*

LAND USE	A Soils[1]			B Soils[1]			C Soils[1]			D Soils[1]		
	< 2%	2 - 6%	>6%	< 2%	2 - 6%	>6%	< 2%	2 - 6%	>6%	< 2%	2 - 6%	>6%
Cultivated land	0.08	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
Residential lot size 1/8 acre	0.25	0.28	0.31	0.27	0.30	0.35	0.30	0.33	0.38	0.33	0.36	0.42
Residential lot size 1/4 acre	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
Residential lot size 1/3 acre	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
Residential lot size 1/2 acre	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
Residential lot size 1 acre	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.68	0.69	0.69	0.69	0.70
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
Streets	0.70	0.71	0.72	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
Open Space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.15	0.21	0.28
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
Construction Sites - Bare packed soil, smooth	0.30	0.35	.040	0.35	.040	0.45	0.40	0.45	0.50	0.50	0.55	0.60
Construction Sites - Bare packed soil, rough	.020	0.25	0.30	0.25	0.30	0.35	0.30	0.35	0.40	0.40	0.45	0.50

* Runoff Coefficients for storm recurrence intervals less than 25 years

Adapted from McCuen, R.H., Hydrologic Analysis and Design (2004)

1. According to the USDA NRCS Hydrologic Soils Classification System

APPENDIX NO. B-2

RUNOFF CURVE NUMBERS "CN" FOR SCS METHOD*

Runoff Curve Numbers "CN" for SCS Method												
Soil Group	A			B			C			D		
Slope / Land Use	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Cultivated Land												
winter conditions	48	60	75	62	73	82	68	78	90	77	88	95
summer conditions	35	51	58	48	55	65	57	65	73	64	69	79
Fallowed Fields	45	54	65	56	63	73	64	74	81	69	77	87
poor conditions	30	44	48	43	48	55	48	54	63	56	60	68
good conditions	30	40	43	42	46	50	45	50	53	50	56	61
Forest/Woodland												
Grass Areas	35	51	53	48	54	63	56	59	73	62	63	79
good conditions	45	53	58	52	55	65	60	63	75	65	69	82
average conditions	48	55	67	56	67	77	66	74	85	73	81	90
poor conditions	96	97	98	96	97	98	96	97	98	96	97	98
Impervious Areas												
Weighted Residential	71	75	78	74	76	82	78	80	87	81	83	90
Lot size 1/8 acre	62	67	71	66	69	76	67	69	76	75	78	88
Lot size 1/4 acre	59	65	69	64	66	74	65	66	75	74	77	87
Lot size 1/3 acre	57	63	68	62	64	73	63	65	73	72	76	86
Lot size 1/2 acre	55	62	67	61	63	72	61	64	72	71	75	85
Lot size 1 acre												

APPENDIX NO. B-3

NOAA Atlas 14, Volume 2, Version 3
Location name: West Grove, Pennsylvania, US*
Coordinates: 39.8182, -75.8276
Elevation: 434 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley
NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.349 (0.316 0.387)	0.416 (0.376 0.461)	0.487 (0.440 0.539)	0.537 (0.484 0.594)	0.596 (0.535 0.660)	0.636 (0.568 0.704)	0.676 (0.601 0.749)	0.710 (0.628 0.789)	0.749 (0.656 0.835)	0.778 (0.677 0.871)
10-min	0.557 (0.505 0.618)	0.665 (0.602 0.737)	0.780 (0.704 0.863)	0.859 (0.774 0.950)	0.950 (0.853 1.05)	1.01 (0.905 1.12)	1.07 (0.955 1.19)	1.13 (0.995 1.25)	1.19 (1.04 1.32)	1.23 (1.07 1.37)
15-min	0.697 (0.631 0.772)	0.835 (0.756 0.926)	0.987 (0.891 1.09)	1.09 (0.979 1.20)	1.20 (1.08 1.33)	1.28 (1.15 1.42)	1.36 (1.21 1.50)	1.42 (1.26 1.58)	1.49 (1.31 1.66)	1.54 (1.34 1.72)
30-min	0.955 (0.865 1.06)	1.15 (1.05 1.28)	1.40 (1.27 1.55)	1.57 (1.42 1.74)	1.78 (1.60 1.97)	1.93 (1.73 2.14)	2.08 (1.85 2.30)	2.21 (1.95 2.46)	2.37 (2.08 2.65)	2.49 (2.17 2.79)
60-min	1.19 (1.08 1.32)	1.45 (1.31 1.61)	1.80 (1.62 1.99)	2.05 (1.85 2.27)	2.37 (2.13 2.63)	2.62 (2.34 2.90)	2.86 (2.55 3.17)	3.10 (2.74 3.44)	3.41 (2.98 3.80)	3.64 (3.16 4.07)
2-hr	1.42 (1.28 1.58)	1.73 (1.56 1.92)	2.16 (1.94 2.40)	2.48 (2.23 2.76)	2.92 (2.61 3.24)	3.27 (2.90 3.63)	3.62 (3.20 4.02)	3.98 (3.49 4.43)	4.47 (3.87 4.98)	4.85 (4.15 5.42)
3-hr	1.54 (1.40 1.71)	1.87 (1.70 2.08)	2.34 (2.12 2.59)	2.70 (2.43 2.99)	3.19 (2.85 3.52)	3.57 (3.18 3.94)	3.97 (3.51 4.38)	4.37 (3.83 4.83)	4.92 (4.28 5.45)	5.35 (4.59 5.95)
6-hr	1.91 (1.73 2.12)	2.30 (2.09 2.56)	2.87 (2.60 3.19)	3.33 (3.01 3.69)	3.98 (3.57 4.40)	4.51 (4.01 4.98)	5.07 (4.47 5.60)	5.66 (4.94 6.26)	6.50 (5.58 7.21)	7.17 (6.07 7.99)
12-hr	2.33 (2.10 2.61)	2.81 (2.54 3.15)	3.53 (3.18 3.95)	4.12 (3.70 4.60)	5.00 (4.44 5.57)	5.73 (5.04 6.38)	6.54 (5.68 7.28)	7.41 (6.35 8.25)	8.69 (7.30 9.71)	9.77 (8.06 10.9)
24-hr	2.70 (2.49 2.96)	3.26 (3.00 3.56)	4.08 (3.75 4.46)	4.78 (4.37 5.21)	5.78 (5.26 6.29)	6.62 (6.00 7.19)	7.53 (6.78 8.17)	8.51 (7.61 9.23)	9.94 (8.79 10.8)	11.1 (9.76 12.1)
2-day	3.13 (2.88 3.43)	3.78 (3.47 4.14)	4.75 (4.36 5.19)	5.54 (5.07 6.05)	6.66 (6.07 7.27)	7.59 (6.88 8.27)	8.58 (7.75 9.34)	9.63 (8.65 10.5)	11.1 (9.92 12.1)	12.4 (10.9 13.5)
3-day	3.30 (3.03 3.61)	3.98 (3.65 4.35)	4.98 (4.57 5.45)	5.80 (5.31 6.33)	6.97 (6.35 7.60)	7.93 (7.19 8.64)	8.96 (8.08 9.75)	10.0 (9.01 10.9)	11.6 (10.3 12.6)	12.9 (11.3 14.0)
4-day	3.47 (3.18 3.79)	4.18 (3.83 4.56)	5.22 (4.78 5.70)	6.07 (5.55 6.62)	7.28 (6.62 7.93)	8.28 (7.49 9.00)	9.33 (8.41 10.2)	10.5 (9.37 11.4)	12.1 (10.7 13.1)	13.4 (11.8 14.6)
7-day	4.04 (3.74 4.40)	4.85 (4.49 5.28)	6.00 (5.54 6.53)	6.94 (6.40 7.54)	8.29 (7.61 8.99)	9.41 (8.60 10.2)	10.6 (9.63 11.5)	11.9 (10.7 12.8)	13.7 (12.2 14.8)	15.1 (13.4 16.4)
10-day	4.60 (4.27 4.97)	5.49 (5.11 5.94)	6.69 (6.21 7.24)	7.67 (7.10 8.27)	9.02 (8.33 9.72)	10.1 (9.31 10.9)	11.2 (10.3 12.1)	12.4 (11.3 13.4)	14.1 (12.7 15.2)	15.4 (13.8 16.6)
20-day	6.21 (5.80 6.65)	7.37 (6.88 7.88)	8.79 (8.21 9.41)	9.91 (9.23 10.6)	11.4 (10.6 12.2)	12.6 (11.7 13.5)	13.8 (12.7 14.8)	15.0 (13.8 16.1)	16.6 (15.2 17.8)	17.9 (16.3 19.2)
30-day	7.72 (7.26 8.19)	9.10 (8.55 9.66)	10.6 (9.98 11.3)	11.8 (11.1 12.5)	13.3 (12.5 14.2)	14.5 (13.6 15.4)	15.7 (14.6 16.6)	16.8 (15.6 17.9)	18.3 (16.9 19.5)	19.4 (17.9 20.7)
45-day	9.78 (9.26 10.3)	11.5 (10.9 12.1)	13.2 (12.5 14.0)	14.5 (13.7 15.3)	16.2 (15.3 17.1)	17.4 (16.4 18.4)	18.5 (17.5 19.6)	19.8 (18.5 20.7)	21.0 (19.7 22.2)	21.9 (20.5 23.2)
60-day	11.7 (11.1 12.3)	13.7 (13.0 14.4)	15.7 (14.8 16.5)	17.1 (16.2 18.0)	18.9 (17.9 19.9)	20.2 (19.1 21.3)	21.4 (20.3 22.6)	22.6 (21.3 23.8)	24.0 (22.6 25.3)	24.9 (23.5 26.3)

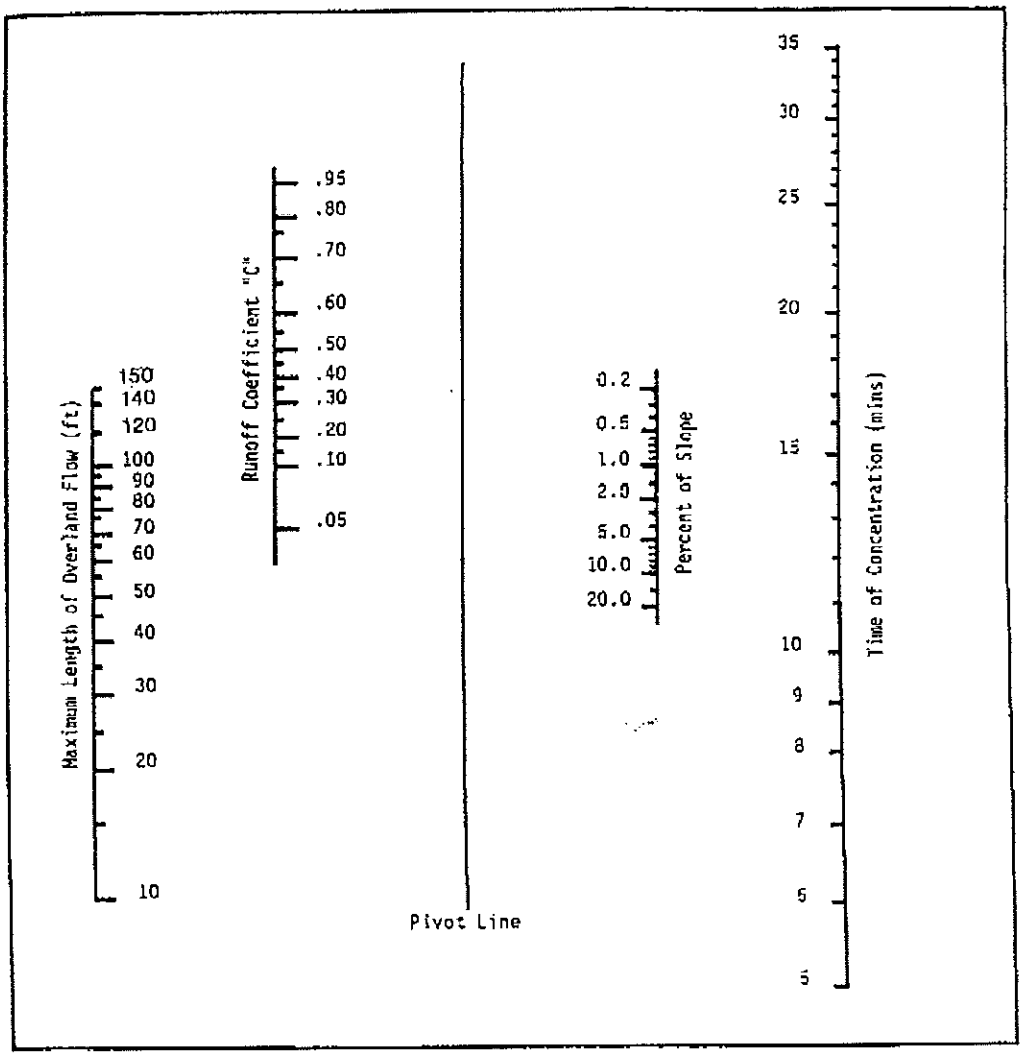
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

APPENDIX NO. B-4

NOMOGRAPH FOR DETERMINING SHEET FLOW

(for use with the Rational Method)



APPENDIX NO. B-5

Worksheet #1: Time of concentration (T_c) or travel time (T_t)

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

Circle one: T_c T_t through subarea _____

NOTES: Space for as many as two segments per flow type can be used for each worksheet.

Include a map, schematic, or description of flow segments.

Sheet flow (Applicable to T_c only)	Segment ID			
1. Surface description (table 3-1)				
2. Manning's roughness coeff., n (table 3-1)				
3. Flow length, L (total L ≤ **150 ft) ft				
4. Two-yr 24-hr rainfall, P_2 in				
5. Land slope, s ft/ft				
6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ Compute T_t hr		+		=

Shallow concentrated flow	Segment ID			
7. Surface description (paved or unpaved)				
8. Flow length, L ft				
9. Watercourse slope, s ft/ft				
10. Average velocity, V (figure 3-1) ft/s				
11. $T_t = \frac{L}{3600\,V}$ Compute T_t hr		+		=

Channel flow	Segment ID			
12. Cross sectional flow area, a ft^2				
13. Wetted perimeter, P_w ft				
14. Hydraulic radius, $r = \frac{a}{P_w}$ Compute r ft				
15. Channel slope, s ft/ft				
16. Manning's roughness coeff., n				
17. $V = \frac{1.49\,r^{\frac{2}{3}}\,s^{\frac{1}{2}}}{n}$ Compute V ft/s				
18. Flow length, L ft				
19. $T_t = \frac{L}{3600V}$ Compute T_t hr		+		=

20. Watershed or subarea T_c or T_t (add T_t in steps 6, 11, and 19) hr

*Table 3-1 per latest TR-55, Urban Hydrology for Small Watershed

**150' sheet flow length per latest TR-55 revision

APPENDIX NO. B-6

AVERAGE VELOCITIES FOR ESTIMATING TRAVEL TIME FOR SHALLOW CONCENTRATED FLOW

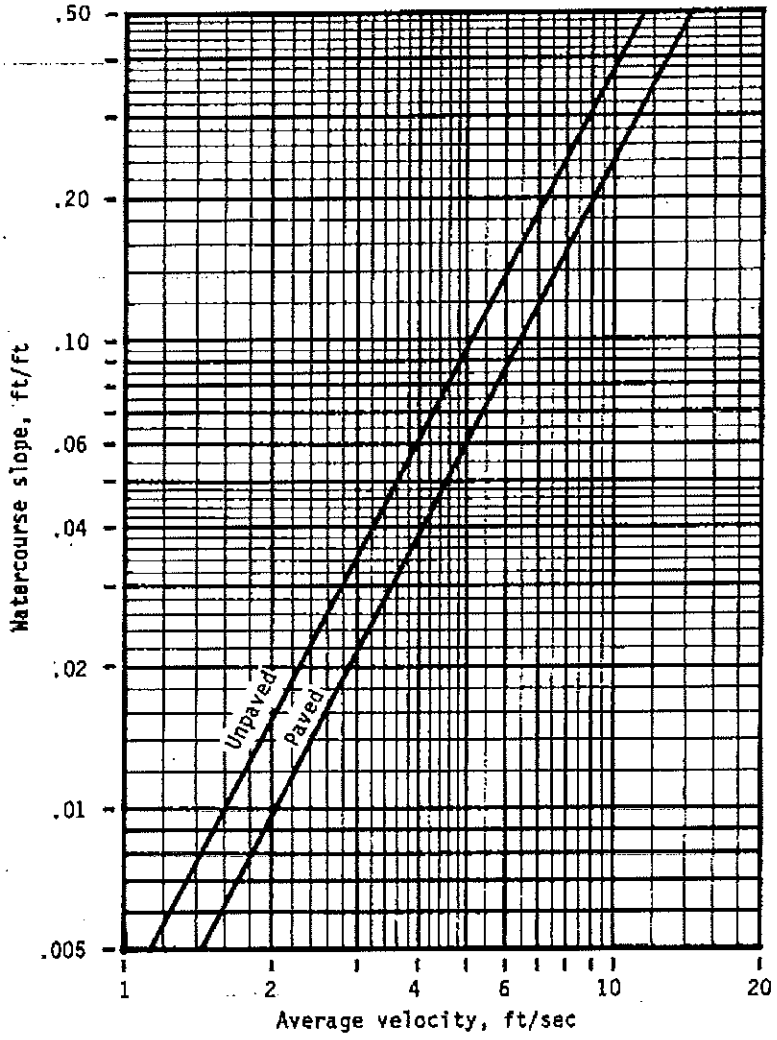


Figure 3-1.—Average velocities for estimating travel time *for* shallow concentrated flow.

APPENDIX NO. B-7.

Roughness Coefficients n-values for Manning's Equation (Pipes and Pavements)

Description	Manning's n-value
Polyvinyl Chloride (PVC) with smooth Inner Walls	0.010
Corrugated High-Density Polyethylene (HDPE) with Smooth Inner Walls	0.012
Corrugated High-Density Polyethylene (HDPE) with Corrugated Inner Walls	0.015
Concrete Pipe	0.012
Smooth-lined Corrugated Metal Pipe	0.012
Corrugated Plastic Pipe	0.024
Annular Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated)	
68 mm × 13 mm (2 2/3 in × 1/2 in) Corrugations	0.024
75 mm × 25 mm (3 in × 1 in) Corrugations	0.027
125 mm × 25 mm (5 in × 1 in) Corrugations	0.025
150 mm × 50 mm (6 in × 2 in) Corrugations	0.033
Helically Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated) 75 mm × 25 mm (3 in × 1 in), 125 mm × 25 mm (5 in × 1 in), or 150 mm × 50 mm (6 in × 2 in) Corrugations	0.024
Helically Corrugated Steel And Aluminum Alloy Pipe (Plain or polymer coated) 68 mm × 13 mm (2 2/3 in × 1/2 in) Corrugations	
a. Lower Coefficients*	
450 mm (18 in) Diameter	0.014
600 mm (24 in) Diameter	0.016
900 mm (36 in) Diameter	0.019
1200 mm (48 in) Diameter	0.020
1500 mm (60 in) Diameter or larger	0.021
b. Higher Coefficients**	0.024
Annular or Helically Corrugated Steel or Aluminum Alloy Pipe Arches or Other Non-Circular Metal Conduit (Plain or Polymer coated)	0.024
Vitrified Clay Pipe	0.012
Ductile Iron Pipe	0.013
Asphalt Pavement	0.015
Concrete Pavement	0.014
Grass Medians	0.050
Grass – Residential	0.030
Earth	0.020
Gravel	0.030
Rock	0.035
Cultivated Areas	0.030 - 0.050
Dense Brush	0.070 - 0.140
Heavy Timber (Little undergrowth)	0.100 - 0.150
Heavy Timber (with underbrush)	0.40
Streams:	
a. Some Grass And Weeds (Little or no brush)	0.030 - 0.035
b. Dense Growth of Weeds	0.035 - 0.050
c. Some Weeds (Heavy brush on banks)	0.050 - 0.070

Notes: * Use the lower coefficient if any one of the following conditions apply:

a. A storm pipe longer than 20 diameters, which directly or indirectly connects to an inlet or manhole, located in swales adjacent to shoulders in cut areas, shoulders in cut areas or depressed medians.

b. A storm pipe which is specially designed to perform under pressure.

** Use the higher coefficient if any one of the following conditions apply:

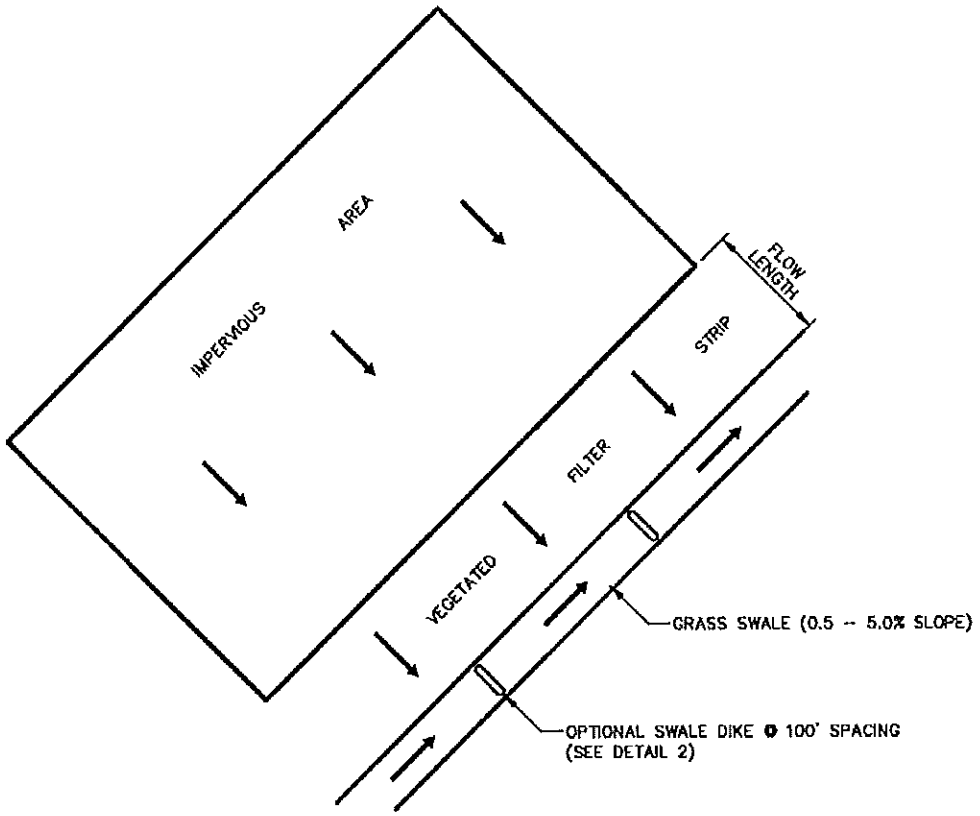
a. A storm pipe which directly or indirectly connects to an inlet or manhole located in highway pavement sections or adjacent to curb or concrete median barrier.

b. A storm pipe which is shorter than 20 diameters long.

c. A storm pipe which is partly lined helically corrugated metal pipe.

APPENDIX C

STORMWATER MANGEMENT AND BMP CONSTRUCTION DETAILS



NOTE:
FILTER STRIP MUST BE CONTIGUOUS TO IMPERVIOUS AREA. RUNOFF ACROSS IMPERVIOUS AREA SHALL ALSO BE IN SHEET FLOW.

FILTER STRIP/GRASS SWALE

STANDARD SWM SPECIFICATIONS

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Engineering Associates Inc
20 C Snyder Lane Ephrata, PA 17522-9101
717.721.7444 Fax 717.721.7447

DRAWN BY:	DES
CHECKED BY:	JAP/RJL
DATE:	JUNE 2013
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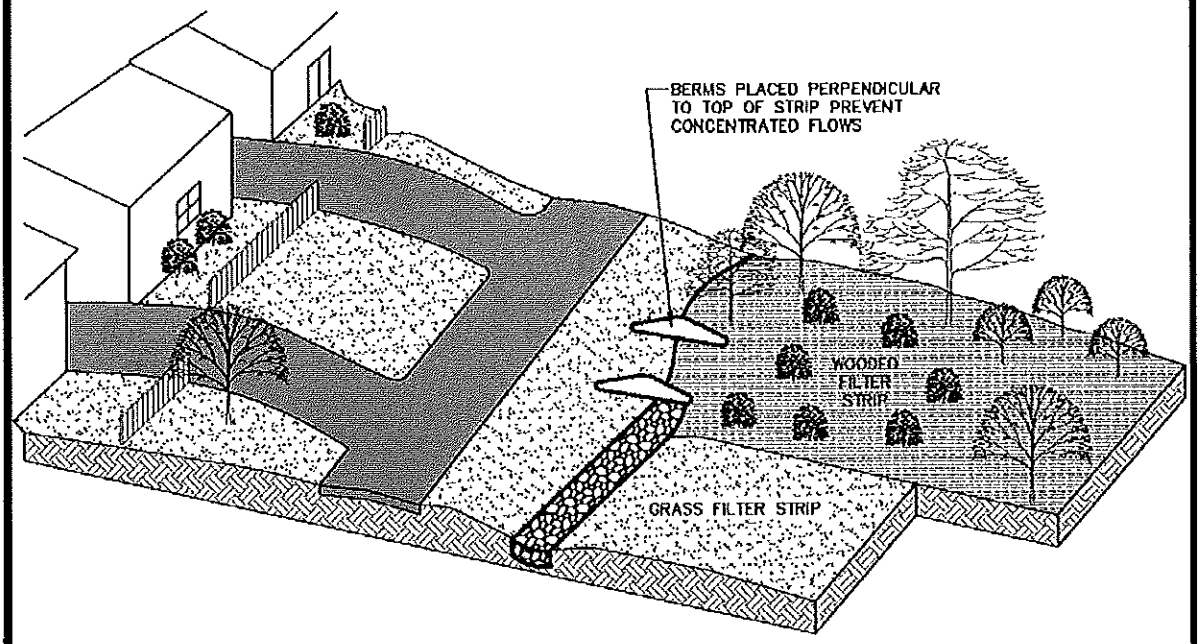

FILTER STRIP

STANDARD SWM SPECIFICATIONS

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DRAWN BY:	DES
CHECKED BY:	JAP/RJL
DATE:	JUNE 2013
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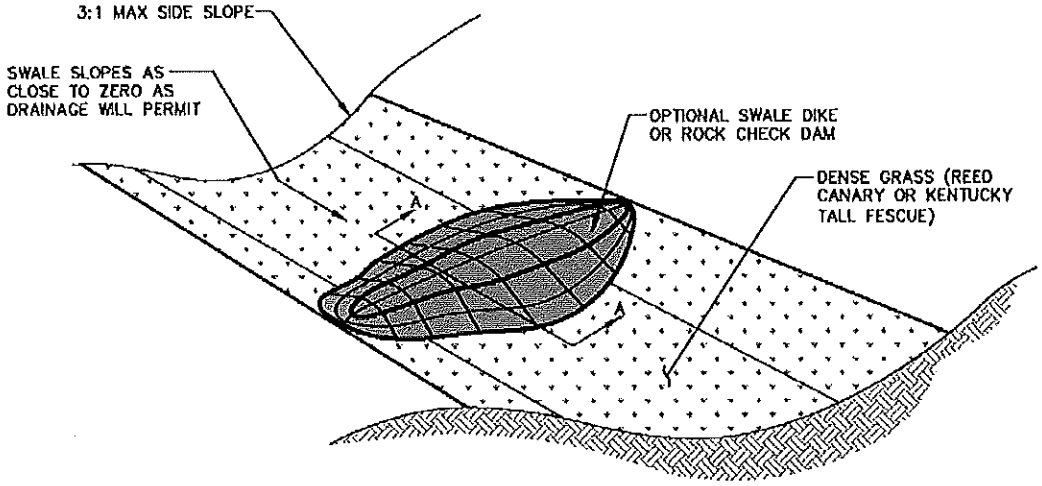

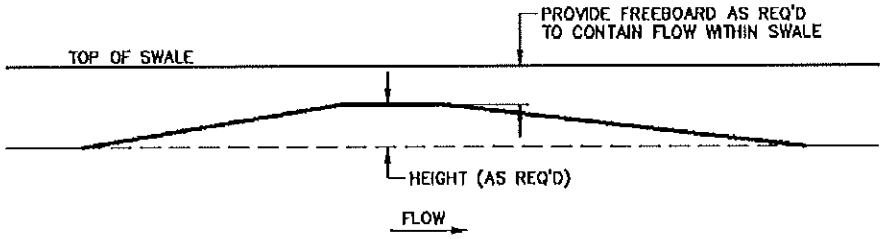

SECTION A–A

GRASS SWALE

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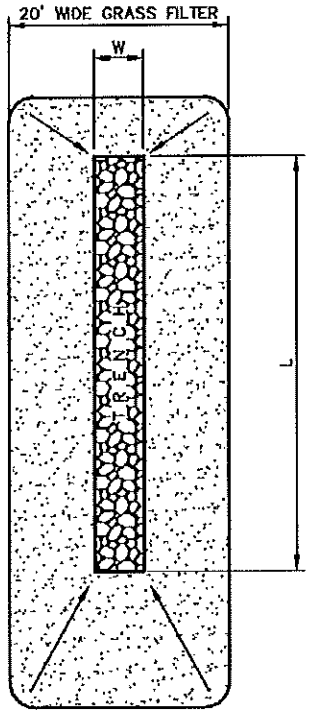
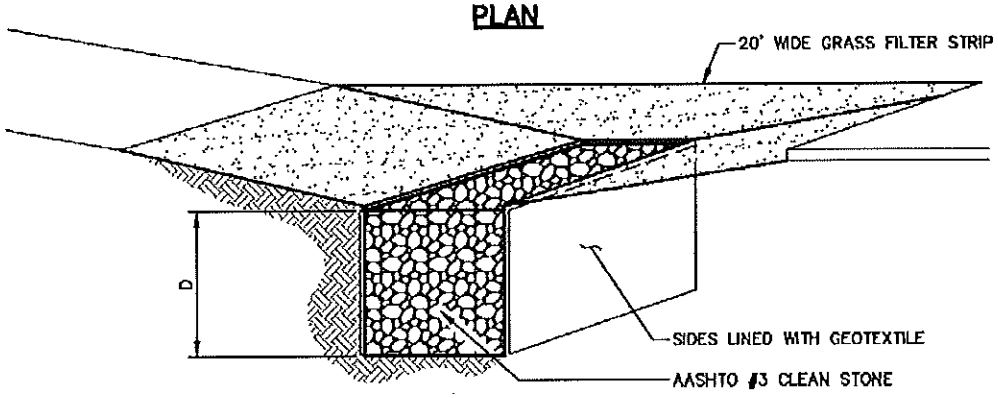


PLAN



ISOMETRIC SECTION

INFILTRATION TRENCH

STANDARD SWM SPECIFICATIONS

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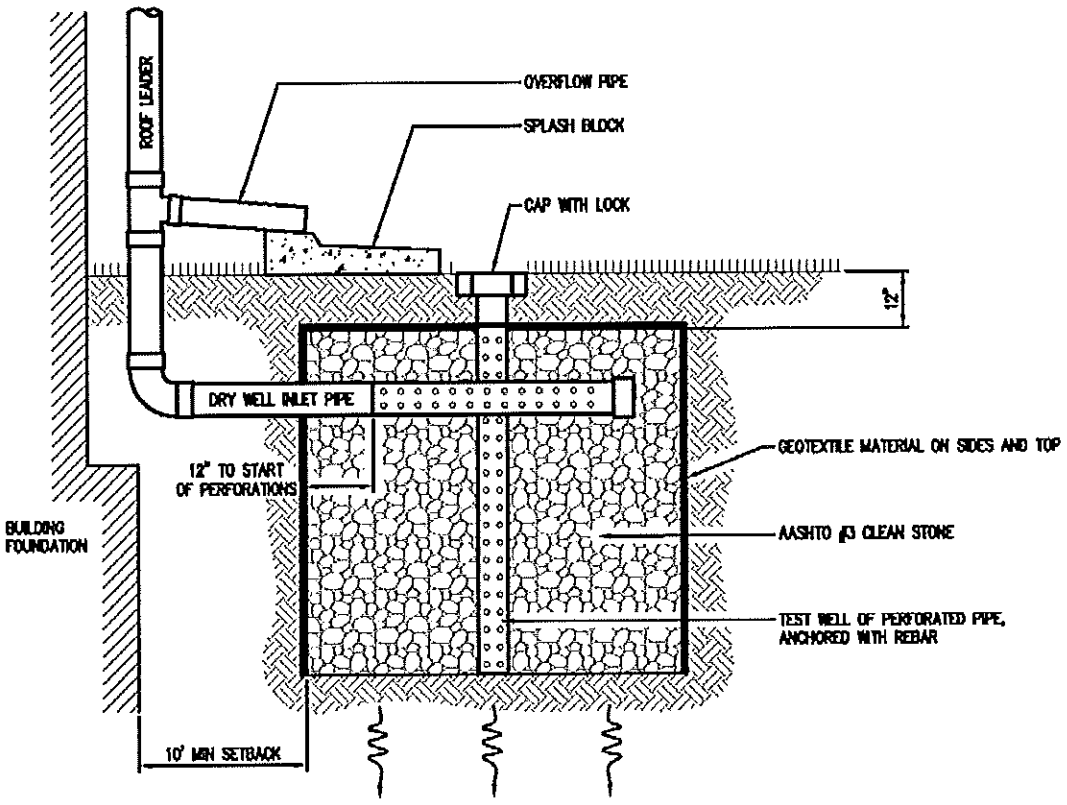

DRY WELL

STANDARD SWM SPECIFICATIONS

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DATE:	DEC 2013
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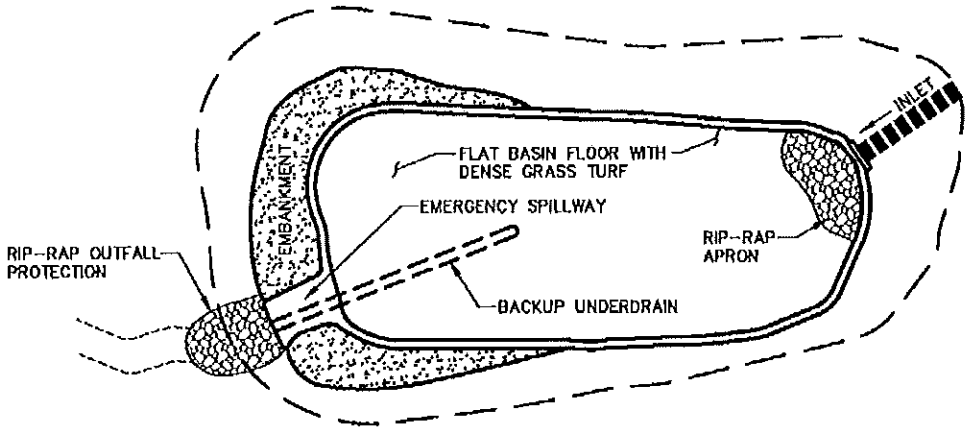
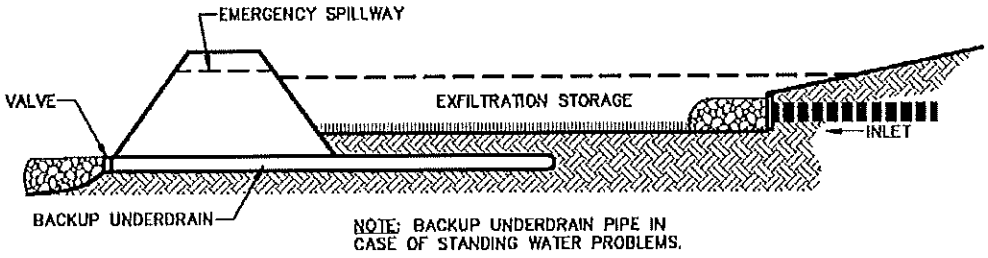


PLAN VIEW



NOTE: BACKUP UNDERDRAIN PIPE IN CASE OF STANDING WATER PROBLEMS.

SECTION VIEW

INFILTRATION BASIN

STANDARD SWM SPECIFICATIONS

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DATE:	MAR 2009
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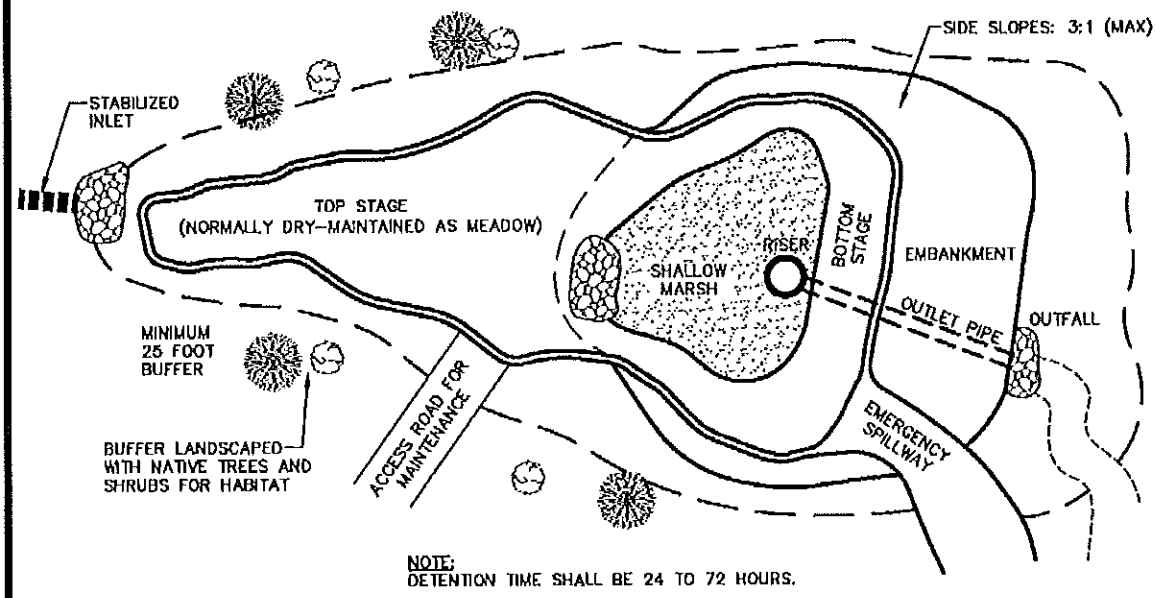
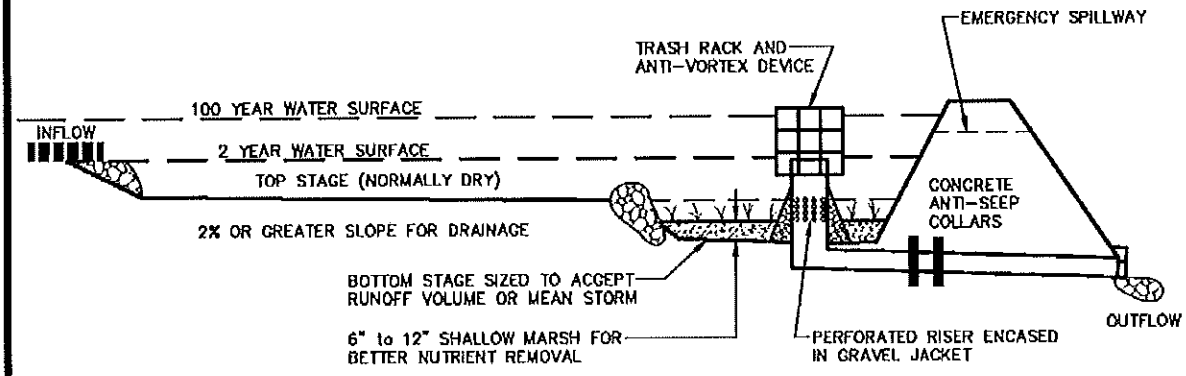


PLAN VIEW



SECTION VIEW

EXTENDED DRY DETENTION POND

STANDARD SWM SPECIFICATIONS

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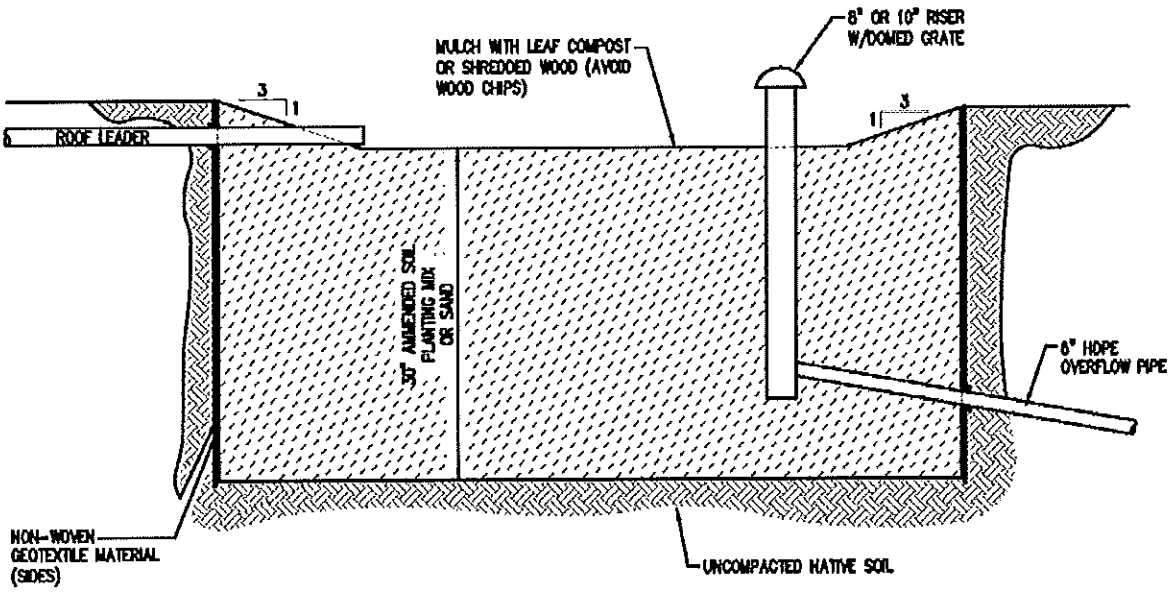

NOTES:

1. MOISTURE-TOLERANT PLANT MATERIAL SHALL BE USED AT BOTTOM EDGE. PLANT MATERIAL SHALL BE TOLERANT OF FLUCTUATING WATER CONDITIONS.
2. SOIL BENEATH RAIN GARDEN SHALL REMAIN UNCOMPACTED.
5. AS AN ALTERNATIVE, SAND OR GRAVEL CAN BE USED AS BEDDING FOR THE RAIN GARDEN.
6. IF SAND IS TO BE USED, ADDITIONAL DESIGN ELEMENTS AND VEGETATION PLANTINGS WILL NEED TO BE USED.

RAIN GARDEN

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DATE:	DEC 2013
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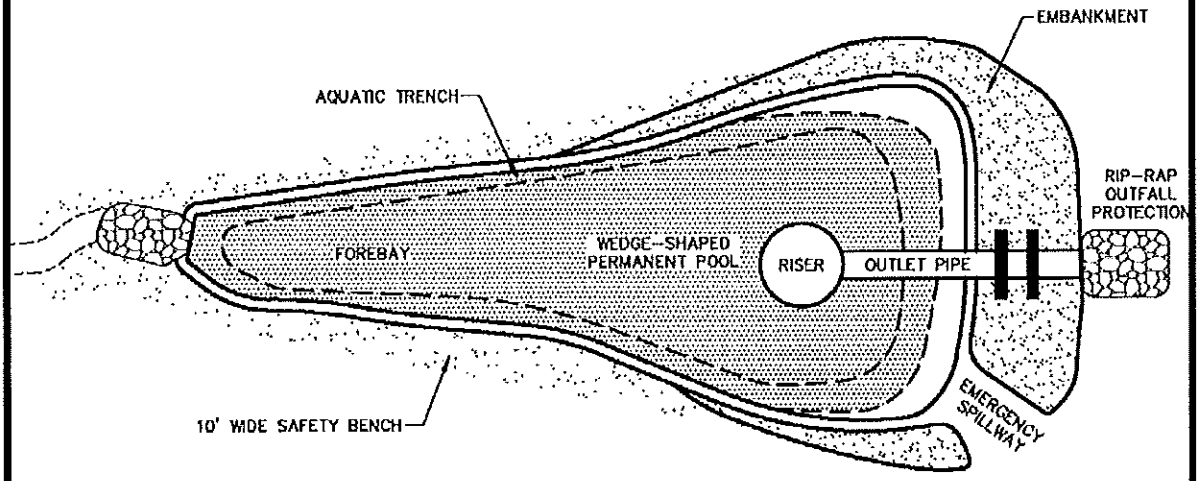

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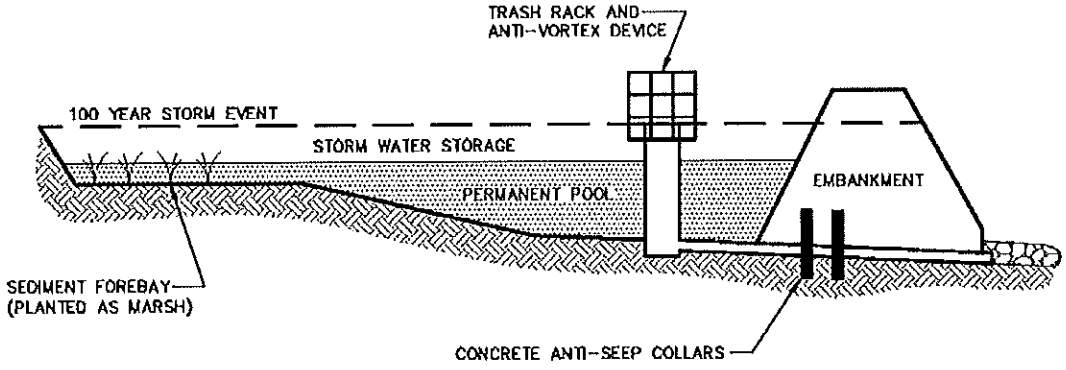

SECTION VIEW

WET POND

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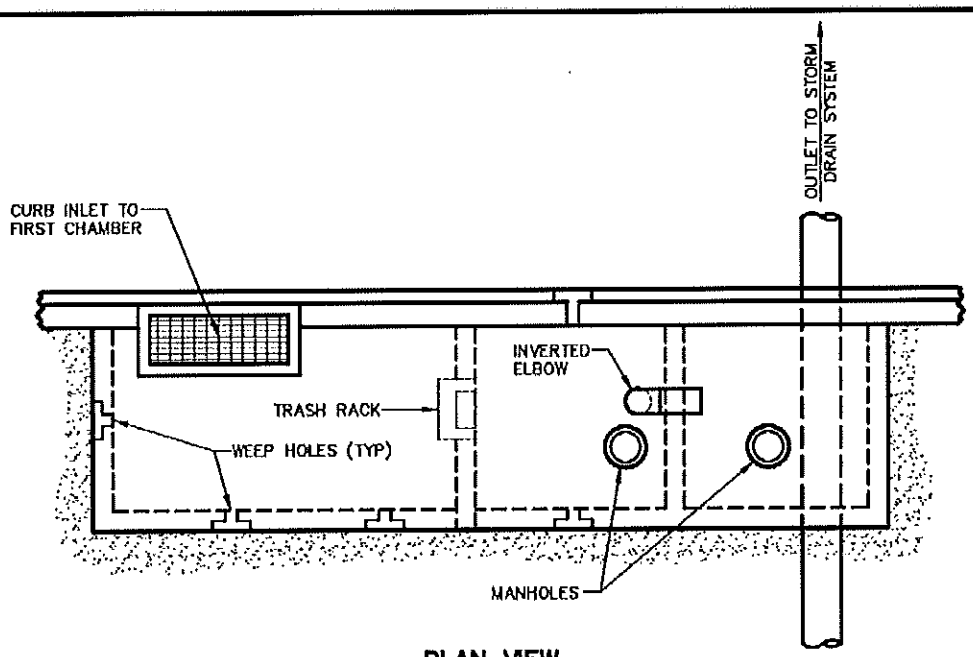

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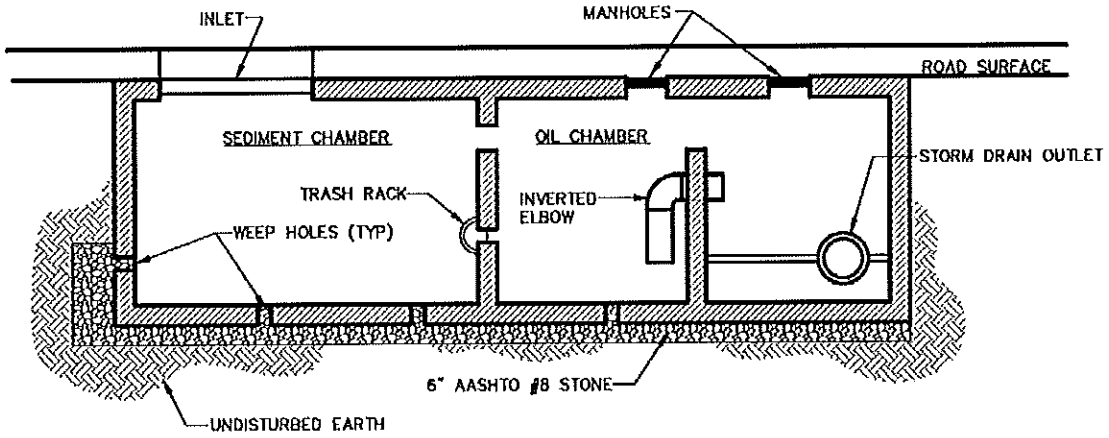

SECTION VIEW

WATER QUALITY INLET

STANDARD SWM SPECIFICATIONS

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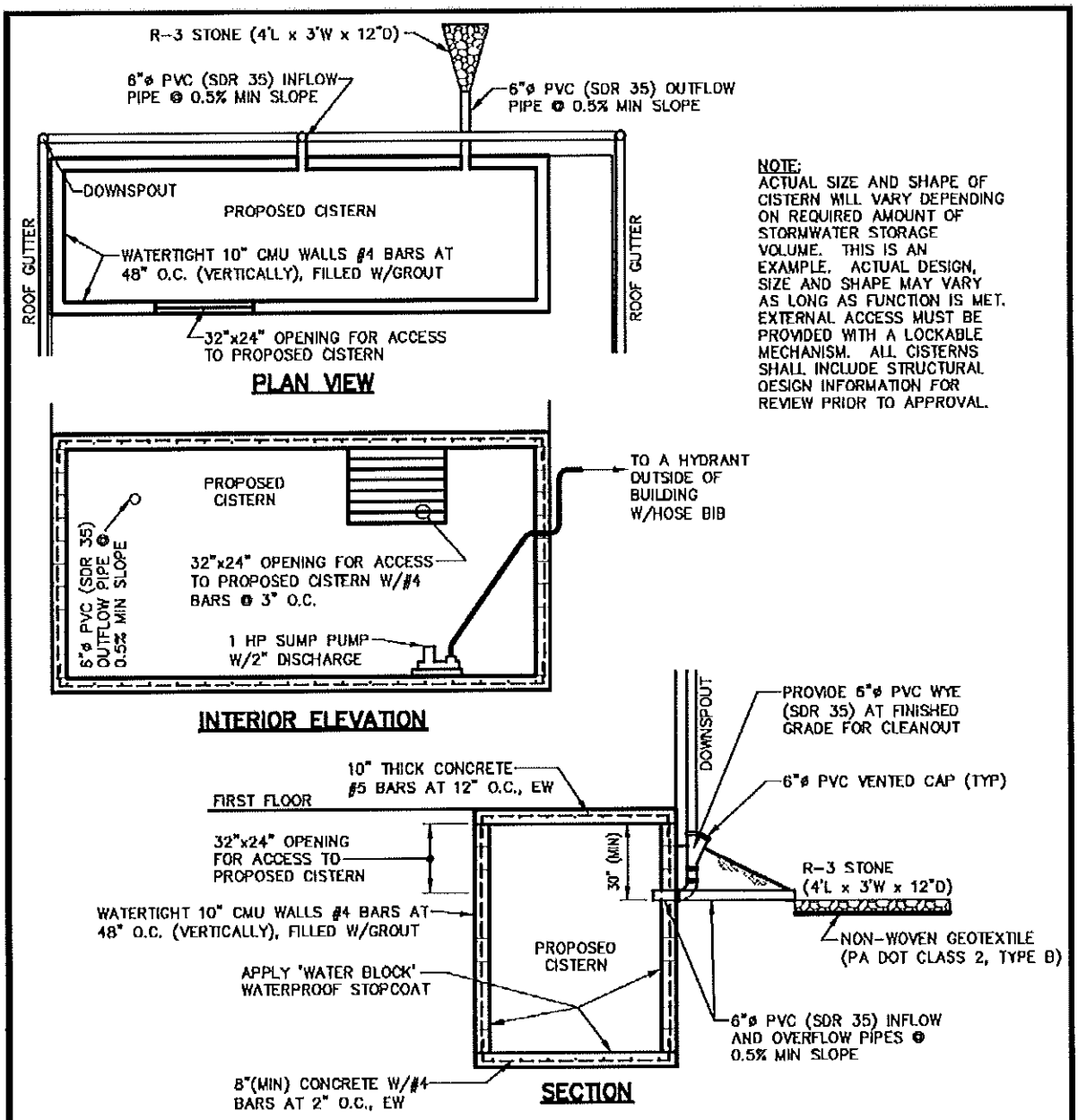

CISTERN

STANDARD SWM SPECIFICATIONS

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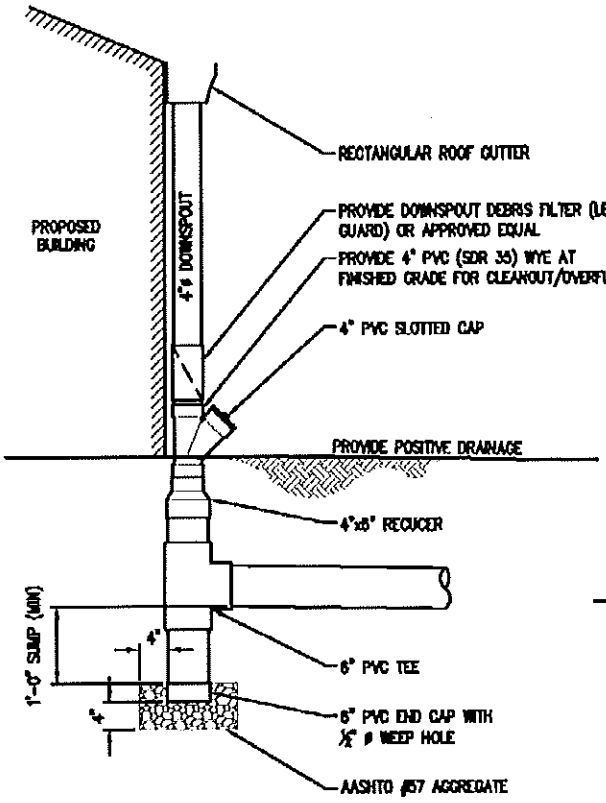
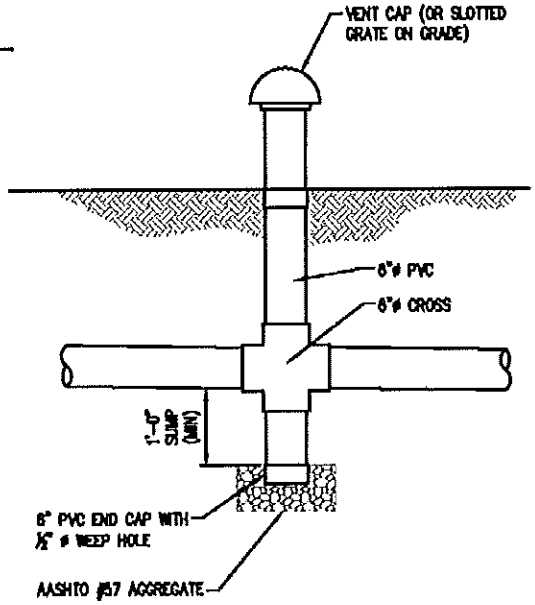


ROOF DRAIN LATERAL/CLEANOUT DETAIL



IN-LINE CLEANOUT DETAIL

ROOF DRAIN & IN-LINE LATERAL/CLEANOUT

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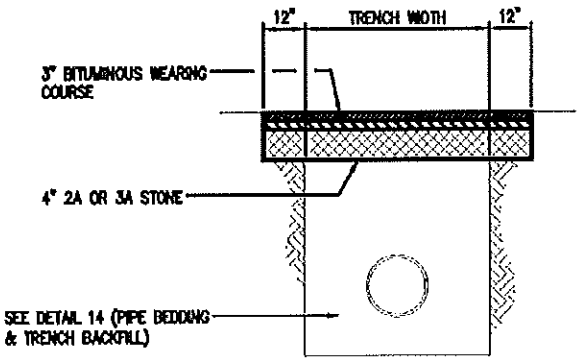
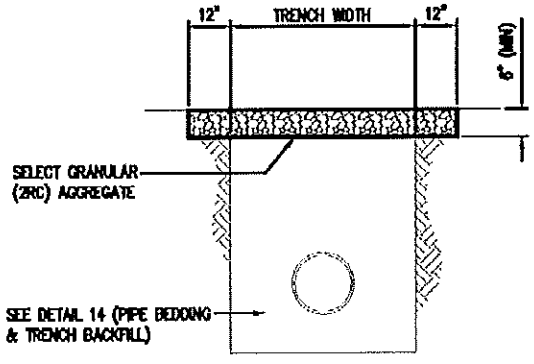


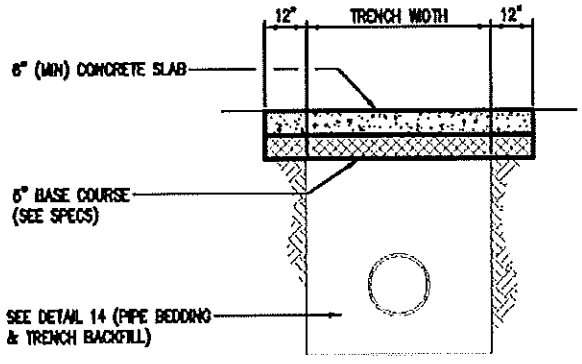
NOTE: MATCH EXISTING WIDTH OF DRIVEWAY

PAVED DRIVEWAY RESTORATION



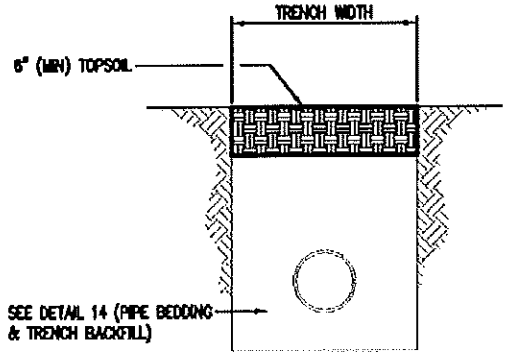
NOTE: MATCH EXISTING WIDTH OF DRIVEWAY

STONE DRIVEWAY RESTORATION



NOTE: MATCH EXISTING WIDTH OF DRIVEWAY

CONCRETE DRIVEWAY RESTORATION



NOTE: MATCH EXISTING WIDTH OF DRIVEWAY

LAWN RESTORATION

PERMANENT RESTORATION FOR AREAS OTHER THAN ROADWAYS

STANDARD SWM SPECIFICATIONS

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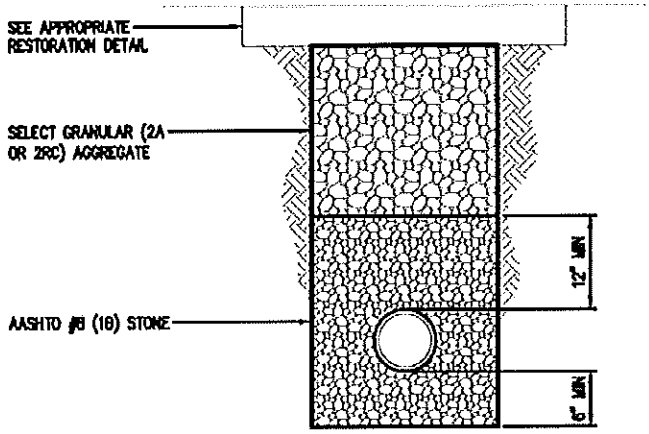
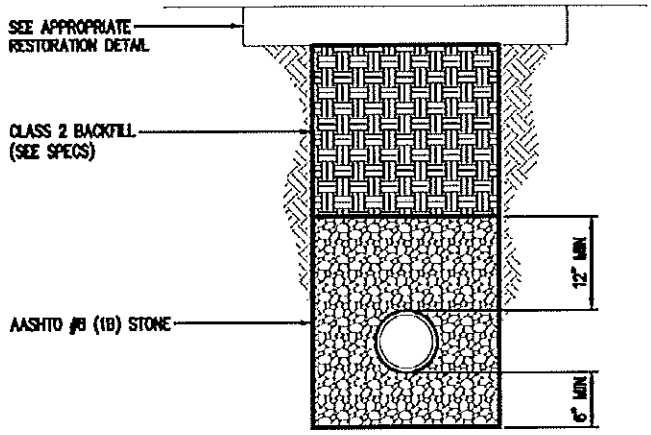


ROADWAYS & SHOULDERS



OTHER THAN ROADWAYS & SHOULDERS

PIPE BEDDING AND TRENCH BACKFILL

STANDARD SWM SPECIFICATIONS

NOTES:

1. BACKFILL MATERIAL SHALL BE PLACED IN 12" (MAX) LIFTS. THOROUGHLY COMPACT EACH LIFT WITH MECHANICAL TAMPERS OR BY OTHER ACCEPTABLE METHODS FOR THE FULL TRENCH WIDTH. COMPACT TO NOT LESS THAN 100% OF THE DETERMINED DRY WEIGHT DENSITY OF THE BACKFILL MATERIAL.

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DATE:	DEC 2013
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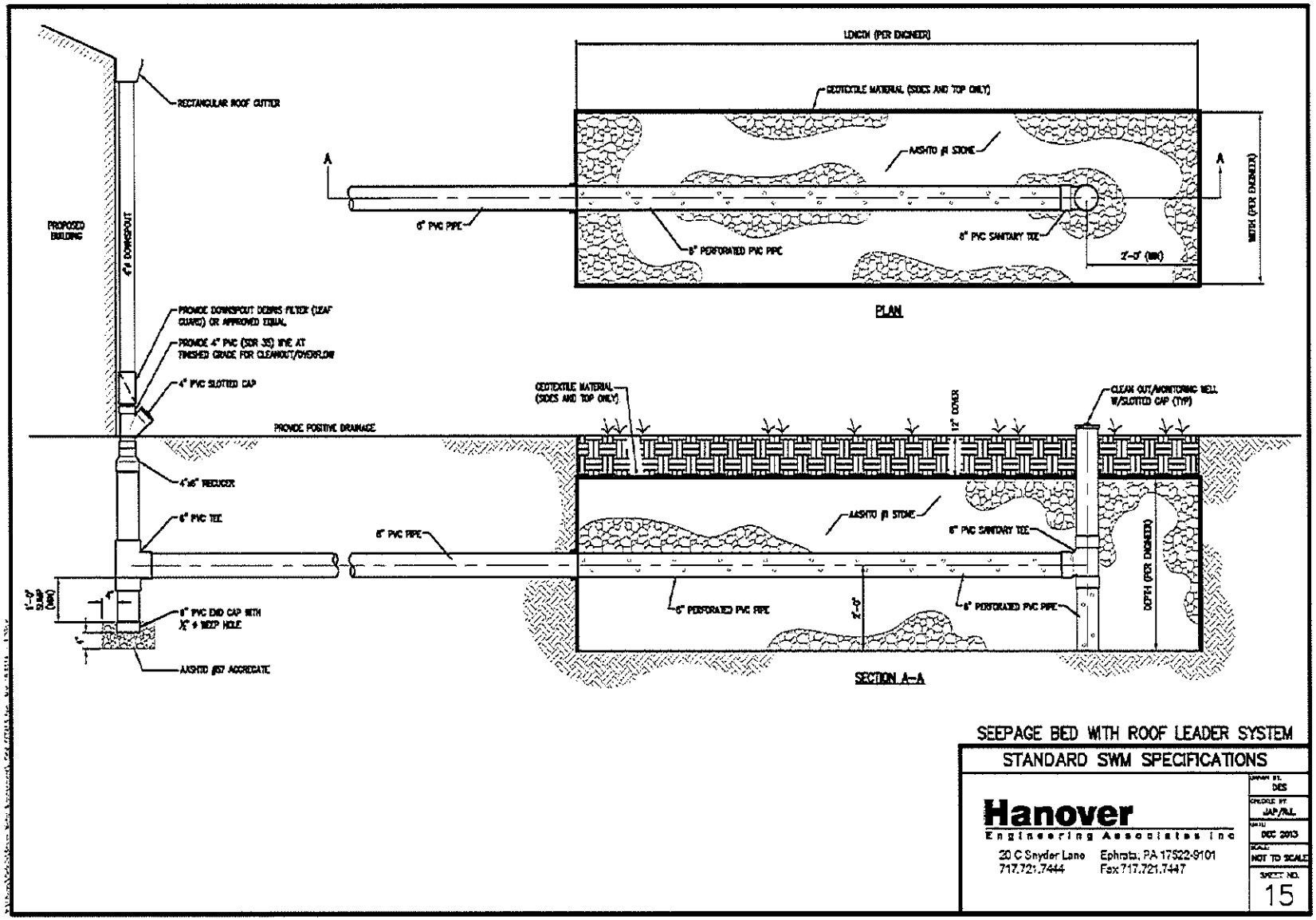

SEEPAGE BED WITH ROOF LEADER SYSTEM

STANDARD SWM SPECIFICATIONS

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20 C Snyder Lane Ephrata, PA 17522-9101
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CHECKED BY	JAP/ALL
DATE	DEC 2013
SCALE	NOT TO SCALE
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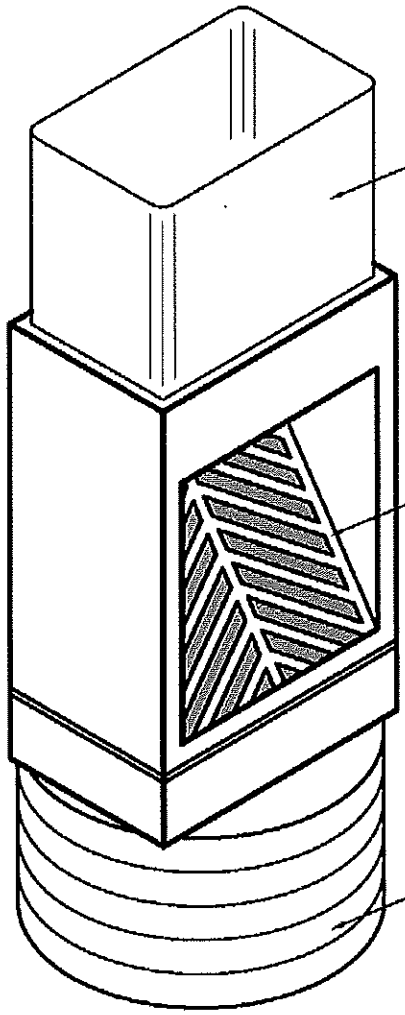

NOTE:
USE DOWNSPOUT DEBRIS FILTER
OR APPROVED EQUAL.

WATERPROOF.COM LLC
1253 HALLMARK CT.
N. OAKDALE, MN 55128
(651) 644-2000

DOWNSPOUT DEBRIS FILTER

STANDARD SWM SPECIFICATIONS

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DATE:	DEC 2013
SCALE:	NOT TO SCALE
SHEET NO.	16

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APPENDIX D.

SITE DESIGN PROCESS

NATURAL HYDROLOGY SITE DESIGN PROCESS

INTRODUCTION

Section 304 identifies a natural hydrology site design process that strives to minimize disturbances to land, site hydrology, and natural resources, and maintain the natural hydrologic regime, drainage patterns and flow conditions of a site to the maximum extent practicable. This appendix is intended to build on that process by providing additional information for achieving site designs that best maintain pre-construction stormwater runoff conditions, protect site amenities, and preserve natural resources. This appendix describes the following components of the natural hydrology site design process:

- Design Principles and Techniques;
- Design Process;
- Design Practices; and
- References.

Some common drainage design approaches for land development radically alter natural hydrologic conditions by constructing collection and conveyance systems that are designed to remove runoff from a site as quickly as possible and capture it in a detention basin. This approach has often led to the degradation of water quality, reduced groundwater recharge, and increased volumes of runoff, as well as the expenditure of additional resources for detaining and managing increased volumes of concentrated runoff at some downstream location.

The natural hydrology site design process encourages land development site designs that minimize post-development runoff rates and volumes, and that minimize needs for artificial conveyance and storage facilities. This process strives to incorporate the desired land development into the natural hydrologic landscape in a manner that maintains and utilizes existing site hydrology features and functions to minimize generation of new stormwater. This avoids cumulative environmental impacts often associated with land development, and reducing the need for and size of constructed stormwater facilities. This approach minimizes the disturbance of land area, natural features and site hydrology; preserves significant concentrations of open space, woodlands, and corridors of environmentally sensitive features; and incorporates landscape-based BMPs and low impact development techniques to minimize the utilization of more intrusive structural stormwater facilities.

With this design process, the primary goals of a land development project can be achieved while minimizing the negative environmental impacts and avoiding management costs associated with unnecessary stormwater runoff. The fundamental principle of this design process is that site hydrology features are considered "up front" in the land development design process and are prioritized as integral aspects to be maintained and utilized within the site design, rather than being first sacrificed for space needed for traditional site layout or for construction of more intrusive stormwater facilities.

Natural hydrology site design is not a new approach but rather a holistic process that combines certain principles of Low Impact Development, Conservation Design, and Sustainable Design, and focuses on reducing unnecessary alterations to the natural patterns and functions of existing on-site hydrologic features. These natural hydrologic features tend to perform their "hydrologic function" (i.e., infiltration, evapotranspiration, flow attenuation, pollutant removal, etc.) very efficiently and sometimes have the hydrologic capacity to perform that function on increased runoff loadings from the built environment. However, care must be taken to adequately characterize the capacity of their hydrologic function and avoid overwhelming the feature with excessive runoff loadings, thus causing unintended impairments that are completely counter-productive to the purpose of natural hydrology site design.

Preserving natural hydrologic conditions requires careful site design considerations. Natural hydrology site design should serve as the foundation of the overall site design approach, and when applied in conjunction with the design professional's overall land development goals and desired outcomes, can help shape the overall vision and conceptual layout of the land development project.

Site design practices include preserving natural drainage features, minimizing impervious surface area, reducing the hydraulic connectivity of impervious surfaces, and protecting natural depression storage. Applying this site design process helps maintain site hydrology and manage stormwater by: minimizing the generation of stormwater runoff (achieved by designing to the land, considering site drainage patterns and infiltration characteristics, reducing grading and compaction, and considering scale and placement of buildings); managing stormwater as close to the point of generation as possible (by disconnecting impervious surfaces and distributing storm flows to landscaped-based BMPs); providing open and vegetated channel conveyance (as needed to treat water quality, reduce velocity and infiltrate); and managing remaining conveyed stormwater in common open space (as needed to disperse low velocity storm flows, treat water quality, infiltrate, and release). A well-designed site will contain a mix of all those features.

DESIGN PRINCIPLES AND TECHNIQUES

Natural hydrology site design involves identifying and prioritizing natural resources and natural and man-made hydrologic features, and incorporating such features into the overall site design to take advantage of their efficiencies of hydrologic performance, their cost efficiencies of reducing the need for or size of constructed stormwater facilities, and their aesthetic amenities. The five Design Principles to be achieved by this approach are as follows:

- Minimize land disturbance – both surface and subsurface.
- Minimize the cumulative area to be covered by impervious and compacted surfaces.
- Designing to the land, so that the layout of constructed and landscape features utilizes the natural topography and minimizes grading.
- Design the constructed stormwater management system to take advantage of the natural hydrologic landscape to achieve the required stormwater runoff control standards.
- Refine the site design and layout to optimize the cumulative benefits of the natural hydrologic features, the constructed stormwater management system, and the land development components to achieve the minimum post-construction runoff volume, peak discharge rates and pollutant loads from the proposed land development site.

Techniques to be applied to achieve the design principles are presented in Table B.1.

DESIGN PROCESS

The first step in applying natural hydrology site design is to identify, delineate and assess the functions of all existing natural resources and natural and man-made hydrologic features that: are located within the project site; will receive discharge from the project site; or, may be impacted by runoff or disturbance from the proposed land development project. This includes:

- Streams, waterways, springs, wetlands, vernal pools, and water bodies;
- Drainage patterns, conveyances and discharge points;
- Natural infiltration areas and patterns;
- Areas of natural vegetation that provide significant evapotranspiration, pollutant removal, bank stabilization, flow attenuation, or riparian buffer functions;
- Floodplains; and
- Other features that contribute to the overall hydrologic function and value of the site and its receiving streams.

Once this inventory and assessment are completed, these identified resources and features are then prioritized for their ability to provide hydrologic function and performance for managing runoff from the proposed site improvements. Specifically, they should be prioritized as follows:

- Those to be incorporated into the site design in a manner that provides for their protection from any disturbance or impact from the proposed land development;
- Those to be protected from further disturbance or impact and for which the proposed land development will provide improvement to existing conditions;
- Those that can be incorporated into and utilized as components of the overall site design in a manner that protects or improves their existing conditions while utilizing their hydrologic function (e.g., for infiltration, evapotranspiration, or reducing pollutant loads, runoff volume or peak discharge rates, etc.) to reduce the need for or size of constructed BMPs; and
- Those that may be considered for alteration, disturbance or removal.

These prioritizations are then applied as the basis on which to begin the site design lay-out, grading, construction, and permanent ground cover designs to achieve the five (5) Design Principles outlined above. The following section describes just a few of the many design practices, methods and techniques that are available to achieve the landowner's desired land development goals and the desired environmental efficiencies intended by natural hydrology site design.

Table B.1 – Site Design Process Principles and Techniques

Design Principles	Design Techniques
Minimize land disturbance – both surface and subsurface.	• Maintain the natural soil structure and vegetative cover that are often critical components of maintaining the hydrologic functions of natural infiltration, bioretention, flow attenuation, evapotranspiration, and pollutant removal. • Protect, or improve, natural resources to reduce the needs for environmental mitigation, future environmental restoration, and cumulative flow and water quality impacts of unnecessary disturbances within the watershed system. • Minimize the disturbance of natural surface and groundwater drainage features and patterns, discharge points and flow characteristics, natural infiltration and evapotranspiration patterns and characteristics, natural stream channel stability, and floodplain conveyance, etc.
Minimize the cumulative area to be covered by impervious and compacted surfaces.	• Minimize the size of individual impervious surfaces. • Separate large impervious surfaces into smaller components. • Disconnect runoff from one impervious surface to another. • Avoid unnecessary impervious surfaces. • Utilize porous materials where suited in lieu of impervious materials.
Designing to the land, so that the layout of constructed and landscape features utilizes the natural topography and minimizes grading.	• Prioritize on-site hydrologic features (i.e., for protection, improvement, utilization, or alteration) and natural site drainage patterns and infiltration characteristics and consider them for the cornerstones of the conceptual site design. • Reduce grading and compaction by applying selective grading design methods to provide final grading patterns that preserve existing topography where it most benefits natural hydrologic functions and where needed; this results in graded areas that evenly distribute runoff and minimize concentrated runoff flows. • Consider the scale and placement of buildings and other infrastructure to minimize impact to natural hydrologic features. • Incorporate unique natural, scenic, and historic site features into the configuration of the development, and ensure flexibility in development design to meet community needs for complimentary and aesthetically pleasing development, such as can be achieved through Conservation Design and Sustainable Design approaches.

Design Principles	Design Techniques
Design the constructed stormwater management system to take advantage of the natural hydrologic landscape to achieve the required stormwater runoff control standards.	• Incorporate natural hydrologic features that have been selected for their available capacity and function into the overall system of site runoff controls. • Incorporate Low Impact Development (or similar) BMPs and distribute storm flows to: o Reduce runoff; o Manage stormwater at or as close to the point of generation as possible; o Disconnect discharges from streets and municipal storm sewer systems; and o Select and design BMPs to give first priority to nonstructural and vegetation (landscape-based) BMPs, second priority to surface structural BMPs, third priority to subsurface structural BMPs, and design subsurface BMPs as shallow as possible. • Provide open channel conveyance, as needed, to: o Treat water quality; o Reduce runoff velocity; and o Promote infiltration and evapotranspiration of runoff. • Manage remaining conveyed stormwater from small storms in common open space areas to achieve multiple objectives: o Disperse storm flows and reduce velocity; o Treat water quality; and o Promote infiltrate and evapotranspiration of runoff. • Provide for appropriate conveyance to retention or detention storage facilities as needed for flows from large storm events. • Maintain open space functions consistent with common area uses (passive recreation, on-site sewage management, scenic vistas, etc.).
Refine the site design and layout to optimize the cumulative benefits of the natural hydrologic features, the constructed stormwater management system, and the land development components to achieve the minimum post-construction runoff volume, peak discharge rates and pollutant loads from the proposed land development site.	Apply site design techniques and practices as appropriate based on: • Conservation Design principles and practices. • Sustainable Design principles and practices. • Low Impact Development Design principles and practices.

DESIGN PRACTICES

Numerous practices and strategies can be considered where their aim is to sustain and utilize the benefits of existing site hydrology and minimize the generation of new stormwater runoff. Following are brief descriptions of various practices that can be used to achieve the principles of the natural hydrology site design process.

Site Layout Practices

The following site layout practices are but a few of the methods by which the natural hydrology site design process described above can be implemented. Such practices are less functions of regimented codes and procedures than about understanding and recognizing the benefits and values that existing resources can contribute to the desired outcomes of the land development project. In some circumstances, communication among design engineers, land planning and environmental professionals, knowledgeable developers, community representatives, and regulatory authorities is also beneficial to combine their collective understanding and perspectives to create effective planning efforts.

Preserving Natural Drainage Features. Protecting natural drainage features, particularly vegetated drainage swales and channels, is desirable because of their ability to infiltrate and attenuate flows and to filter pollutants. Unfortunately, some common land development practices encourage just the opposite pattern -- streets and adjacent storm sewers typically are located in the natural headwater valleys and swales, thereby replacing natural drainage functions with an impervious system. As a result, runoff and pollutants generated from impervious surfaces flow directly into storm sewers with no opportunity for attenuation, infiltration, or filtration. Designing developments to fit site topography retains much of the natural drainage function. In addition, designing with the land minimizes the amount of site grading, reduces the amount of compaction that can alter site infiltration characteristics, and can result in cost savings to the developer.

Protecting Natural Depression Storage Areas. Depressional storage areas have no surface outlet, or drain very slowly following a storm event. They can be commonly seen as ponded areas in fields during the wet season or after large runoff events. Some development practices eliminate these depressions by filling or draining, thereby eliminating their ability to reduce surface runoff volumes and trap pollutants. The volume and release-rate characteristics of depressions should be protected in the design of the development site to assist in reducing runoff volumes and reducing runoff rates. Designing around the depression, or incorporating its storage as additional capacity in required detention facilities, treats this area as a site amenity rather than a detriment.

Avoiding Introduction of Impervious Areas. Careful site planning should consider reducing impervious coverage to the maximum extent possible. Building footprints, sidewalks, driveways, and other features producing impervious surfaces should be evaluated to minimize impacts on runoff. In many instances, municipalities have the ability to reduce impervious cover by providing incentives or opportunities in their zoning and subdivision/ land development ordinances to reduce road width, reduce or modify cul-de-sac dimensions, reduce or modify curbing requirements, and reduce or modify sidewalk requirements.

Disconnecting Impervious Surfaces. Impervious surfaces are significantly less of a problem if they are not directly connected to an impervious conveyance system (such as storm sewer). Two basic ways to reduce hydraulic connectivity are routing roof runoff over lawns and reducing the use of storm sewers. Site grading should promote increasing travel time of stormwater runoff from these

sources, and should help reduce concentration of runoff to a single point within the project site.

Routing Roof Runoff Over Lawns. Roof runoff can be easily routed over lawns in most site designs. The practice discourages direct connections of downspouts to "driveway-to-street-to-storm sewers" or parking lots. The practice also discourages sloping driveways and parking lots to the street. Crowning the driveway, to run off to the lawn, uses the lawn as a filter strip.

Reducing Street Widths. Street widths can be reduced by either eliminating on-street parking and/or by reducing roadway widths. Designers should select the narrowest practical street width for the design conditions (speed, curvature, etc.). Narrower neighborhood streets should be considered and encouraged under select conditions. Reduced street widths also can lower maintenance needs and costs.

Limiting Sidewalks to One Side of the Street. A sidewalk on one side of the street may suffice in low-traffic neighborhoods. The lost sidewalk could be replaced with bicycle/recreational trails that follow back-of-lot lines as an alternative to reduced sidewalks, where appropriate.

Reducing Building Setbacks. Reducing building setbacks (from streets) reduces the size of impervious areas of driveways and entry walks and is most readily accomplished along low-traffic streets where traffic noise is not a problem.

Constructing Compact Developments or Conservation Design: Low impact cluster or compact development can reduce the amount of impervious area for a given number of lots. Savings result from reduced street length, which also contributes to a reduction in development and long-term maintenance costs. Reduced site disturbance and preservation of open space help buffer sensitive natural areas and retain more of a site's natural hydrology. Development can be designed so that areas of high infiltration soils are reserved as stormwater infiltration areas. Construction activity can be focused onto les -sensitive areas without affecting the gross density of development.

Stormwater Best Management Practices

Stormwater best management practices (BMPs) are intended to supplement natural hydrology site design techniques where needed. Structural in nature, such practices include bioretention facilities, rain gardens, swales and other engineered stormwater BMPs. Listed here are techniques intended to help manage stormwater predominantly at or near the source, rather than traditional techniques that largely release runoff over an extended period of time to adjacent properties and streams. This list, in no way exhaustive, gives examples of a few of the most common practices.

Bioretention. This type of BMP combines open space with stormwater treatment. Soil and plants, rather than sand filters, treat and store runoff. Infiltration and evapotranspiration are achieved, often coupled with an underdrain to collect water not infiltrated or used in the root zone.

Rain Gardens. Typically rain gardens are shallow depression areas containing a mix of water tolerant native plant species. The intent is to capture runoff for storage and use in the root zone of plants. Intended largely as a way of managing stormwater through evapotranspiration (ET), rain gardens often function as infiltration facilities as well.

Reducing the Need for Storm Sewers. Increasing the use of natural or vegetated drainage swales can reduce the need for extending storm sewers for draining streets, parking lots, and back yards, the

potential for accelerating runoff from the development can be greatly reduced. The practice requires greater use of swales and may not be practical for some development sites, especially if there are concerns for areas that do not drain in a "reasonable" time. The practice requires educating local citizens, who may expect runoff to disappear shortly after a rainfall event.

Using Permeable Paving Materials. These materials include permeable interlocking concrete paving blocks or porous bituminous concrete, among others. Such materials should be considered as alternatives to conventional pavement surfaces, especially for low use surfaces such as driveways, overflow parking lots, and emergency access roads. Surfaces for which seal coats may be applied should refrain from using permeable paving materials.

SOURCES

Conservation Design for Stormwater Management, Delaware Department of Natural Resources and Environmental Control and the Brandywine Conservancy, September 1997.

Conservation Design: Techniques for Preserving Natural Hydrologic Functions, White Paper prepared for New Castle County, Delaware Drainage Code, John M. Gaadt, AICP, September 2007.

Growing Greener, Conservation by Design, a program of the Natural Lands Trust, www.natlands.org/.

Guidance on MS4 Ordinance Provisions, Document Number 392-0300-003, by the Pennsylvania Department of Environmental Protection.

Low Impact Development Center, http://www.lowimpactdevelopment.org/.

PA Department of Environmental Protection, Best Management Practices Manual, 2006.

APPENDIX E.

WEST NILE VIRUS DESIGN GUIDANCE

(This source is from the Monroe County, PA Conservation District that researched the potential of West Nile Virus problems from BMPs due to a number of calls they were receiving)

Monroe County Conservation District Guidance:
Stormwater Management and West Nile Virus

Source: Brodhead McMichaels Creeks Watershed Act 167 Stormwater Management Ordinance Final Draft 2/23/04

The Monroe County Conservation District recognizes the need to address the problem of nonpoint source pollution impacts caused by runoff from impervious surfaces. The new stormwater policy being integrated into Act 167 stormwater management regulations by the PA Department of Environmental Protection (PADEP) will make nonpoint pollution controls an important component of all future plans and updates to existing plans. In addition, to meet post-construction anti-degradation standards under the state National Pollutant Discharge Elimination System (NPDES) permitting program, applicants will be required to employ Best Management Practices (BMPs) to address nonpoint pollution concerns.

Studies conducted throughout the United States have shown that wet basins and in particular constructed wetlands are effective in traditional stormwater management areas such as channel stability and flood control and are one of the most effective ways to remove stormwater pollutants (United States Environmental Protection Agency 1991, Center for Watershed Protection 2000). From Maryland to Oregon, studies have shown that as urbanization and impervious surfaces increase in a watershed, the streams in those watersheds become degraded (CWP 2000). Although there is debate over the threshold of impervious cover when degradation becomes apparent (some studies show as little as 6% while others show closer to 20%), there is agreement that impervious surfaces cause nonpoint pollution in urban and urbanizing watersheds and that degradation is ensured if stormwater BMPs are not implemented.

Although constructed wetlands and ponds are desirable from a water quality perspective, there may be concerns about the possibility of these stormwater management structures becoming breeding grounds for mosquitoes. The Conservation District feels that although it may be a valid concern, **municipalities should not adopt ordinance provisions prohibiting wet basins for stormwater management.**

Mosquitoes

The questions surrounding mosquito production in wetlands and ponds have intensified in recent years by the outbreak of the mosquito-borne West Nile Virus. As is the case with all vector-borne maladies, the life cycle of West Nile Virus is complicated, traveling from mosquito to bird, back to mosquito, and then to other animals including humans. *Culex pipiens* was identified as the vector species in the first documented cases from New York in 1999. This species is still considered

the primary transmitter of the disease across its range. Today there are some 60 species of mosquitoes that inhabit Pennsylvania. Along with *C. pipiens*, three other species have been identified as vectors of West Nile Virus while four more have been identified as potential vectors.

The four known vectors in NE Pennsylvania are *Culex pipiens*, *C. restuans*, *C. salinarius*, and *Ochlerotatus japonicus*. All four of these species prefer, and almost exclusively use, artificial containers (old tires, rain gutters, birdbaths, etc.) as larval habitats. In the case of *C. pipiens*, the most notorious of the vector mosquitoes, the dirtier the water, the better they like it. The important factor is that these species do not thrive in functioning wetlands where competition for resources and predation by larger aquatic and terrestrial organisms is high.

The remaining four species, *Aedes vexans*, *Ochlerotatus Canadensis*, *O. triseriatus*, and *O. trivittatus*, are currently considered potential vectors due to laboratory tests (except the *O. trivittatus*, which did have one confirmed vector pool for West Nile Virus in PA during 2002). All four of these species prefer vernal habitats and ponded woodland areas following heavy summer rains. These species may be the greatest threat of disease transmission around stormwater basins that pond water for more than four days. This can be mitigated, however, by establishing ecologically functioning wetlands.

Stormwater Facilities

If a stormwater wetland or pond is constructed properly and a diverse ecological community develops, mosquitoes should not become a problem. Wet basins and wetlands constructed as stormwater management facilities should be designed to attract a diverse wildlife community. If a wetland is planned, proper hydrologic soil conditions and the establishment of hydrophytic vegetation will promote the population of the wetland by amphibians and other mosquito predators. In natural wetlands, predatory insects and amphibians are effective at keeping mosquito populations in check during the larval stage of development while birds and bats prey on adult mosquitoes.

The design of a stormwater wetland must include the selection of hydrophytic plant species for their pollutant uptake capabilities and for not contributing to the potential for vector mosquito breeding. In particular, species of emergent vegetation with little submerged growth are preferable. By limiting the vegetation growing below the water surface, larvae lose protective cover, and there is less chance of anaerobic conditions occurring in the water.

Stormwater ponds can be designed for multiple purposes. When incorporated into an open space design, a pond can serve as a stormwater management facility and a community amenity. Aeration fountains and stocked fish should be added to keep larval mosquito populations in check.

Publications from the PA Department of Health and the Penn State Cooperative Extension concerning West Nile Virus identify aggressive public education about the risks posed by standing water in artificial containers (tires, trash cans, rain gutters, bird baths) as the most effective method to control vector mosquitoes.

Conclusion

The Conservation District understands the pressure faced by municipalities when dealing with multifaceted issues such as stormwater management and encourages the incorporation of water quality management techniques into stormwater designs. As Monroe County continues to grow,

conservation design, infiltration, and constructed wetlands and ponds should be among the preferred design options to reduce the impacts of increases in impervious surfaces. When designed and constructed appropriately, the runoff mitigation benefits to the community from these design options will far outweigh their potential to become breeding grounds for mosquitoes.

APPENDIX F.

STORMWATER BEST MANAGEMENT PRACTICES (BMPs) AND CONVEYANCES OPERATION AND MAINTENANCE AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 20___, by and between _____, (hereinafter the "Landowner"), and West Grove Borough, Chester County, Pennsylvania, (hereinafter the "Borough");

WITNESSETH

WHEREAS, the Landowner is the owner of certain real property by virtue of a deed of conveyance recorded in the land records of Chester County, Pennsylvania, at Deed Book _____ and Page _____, (hereinafter "Property"); and

WHEREAS, the Landowner is proceeding to build and develop the Property; and

WHEREAS, the stormwater Best Management Practices (herein after BMP(s)) And Conveyances Operations and Maintenance Plan approved by West Grove Borough (hereinafter referred to as the "O&M Plan") for the Property, which is attached hereto as Appendix A and made part hereof, provides for management of stormwater within the confines of the Property through the use of BMP(s) and conveyances; and

WHEREAS, the Borough and the Landowner, for itself and its administrators, executors, successors, heirs, and assigns, agree that the health, safety, and welfare of the residents of West Grove Borough and the protection and maintenance of water quality require that stormwater BMP(s) and conveyances be constructed and maintained on the Property; and

WHEREAS, for the purposes of this agreement, the following definitions shall apply:
BMP – "Best Management Practice" –Those activities, facilities, designs, measures, or procedures as specifically identified in the O&M Plan, used to manage stormwater impacts from land development, to meet state water quality requirements, to promote groundwater recharge, and to otherwise meet the purposes of the Borough's Stormwater Management Ordinance. BMPs may include, but are not limited to, a wide variety of practices and devices, from large-scale retention ponds and constructed wetlands to small-scale underground treatment systems, infiltration facilities, filter strips, low impact design, bioretention, wet ponds, permeable paving, grassed swales, riparian or forested buffers, sand filters, detention basins, manufactured devices, and operational and/or behavior-related practices that attempt to minimize the contact of pollutants with stormwater runoff. The BMPs identified in the O&M Plan are permanent appurtenances to the Property; and

Conveyance – As specifically identified in the O&M Plan, a man-made, existing or proposed facility, structure or channel used for the transportation or transmission of stormwater from one place to another, including pipes, drainage ditches, channels and swales (vegetated and other), gutters, stream channels, and like facilities or features. The conveyances identified in the O&M Plan are permanent appurtenances to the Property; and

WHEREAS, the Borough requires, through the implementation of the O&M Plan, that stormwater management BMPs and conveyances, as required by said O&M Plan and the Borough's Stormwater Management Ordinance, be constructed and adequately inspected, operated and maintained by the Landowner, its administrators, executors, successors in interest, heirs, and assigns.

NOW, THEREFORE, in consideration of the foregoing promises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto, intending to be legally bound hereby, agree as follows:

1. The foregoing recitals to this Agreement are incorporated as terms of this Agreement as if fully set forth in the body of this Agreement.

2. The Landowner shall construct the BMP(s) and conveyance(s) in accordance with the final design plans and specifications as approved by the Borough _____(title of approved plans) _____(date).

3. The Landowner shall inspect, operate and maintain the BMP(s) and conveyance(s) as shown on the O&M Plan in good working order acceptable to the Borough and in accordance with the specific inspection and maintenance requirements in the approved O&M Plan.

4. The Landowner hereby grants permission to the Borough, its authorized agents and employees, to enter upon the Property from a public right-of-way or roadway, at reasonable times and upon presentation of proper identification, to inspect the BMP(s) and conveyance(s) whenever it deems necessary for compliance with this Agreement, the O&M Plan and the Borough's Stormwater Management Ordinance. Whenever possible, the Borough shall notify the Landowner prior to entering the Property.

5. The Borough intends to inspect the BMP(s) and conveyance(s) at a minimum of once every year to determine if they continue to function as required.

6. The Landowner acknowledges that, per the Borough's Stormwater Ordinance, it is unlawful, without written approval of the Borough, to:
   a. Modify, remove, fill, landscape, alter or impair the effectiveness of any BMP or conveyance that is constructed as part of the approved O&M Plan;
   b. Place any structure, fill, landscaping, additional vegetation, yard waste, brush cuttings, or other waste or debris into a BMP or conveyance that would limit or alter the functioning of the BMP or conveyance;
   c. Allow the BMP or conveyance to exist in a condition which does not conform to the approved O&M Plan or this Agreement; and
   d. Dispose of, discharge, place or otherwise allow pollutants including, but not limited to, deicers, pool additives, household chemicals, and automotive fluids to directly or indirectly enter any BMP or conveyance.

7. In the event that the Landowner fails to operate and maintain the BMP(s) and conveyance(s) as shown on the O&M Plan in good working order acceptable to the Borough, the Landowner shall be in violation of this Agreement, and the Landowner agrees that the Borough or its representatives may, in addition to and not in derogation or diminution of any remedies available to it under the Stormwater Ordinance or other statutes, codes, rules or regulations, or this Agreement, enter upon

the Property and take whatever action is deemed necessary to maintain said BMP(s) and conveyance(s). It is expressly understood and agreed that the Borough is under no obligation to maintain or repair said facilities, and in no event shall this Agreement be construed to impose any such obligation on the Borough.

8. In the event that the Borough, pursuant to this Agreement, performs work of any nature or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner shall reimburse the Borough for all expenses (direct and indirect) incurred within 30 days of delivery of an invoice from the Borough. Failure of the Landowner to make prompt payment to the Borough may result in enforcement proceedings, which may include the filing of a lien against the Property, which filing is expressly authorized by the Landowner.

9. The intent and purpose of this Agreement is to ensure the proper maintenance of the on-site BMP(s) and conveyance(s) by the Landowner; provided, however, that this Agreement shall not be deemed to create or affect any additional liability on any party for damage alleged to result from or be caused by stormwater runoff.

10. The Landowner, for itself and its executors, administrators, assigns, heirs, and other successors in interest, hereby releases and shall release the Borough's employees, its agents and designated representatives from all damages, accidents, casualties, occurrences, or claims which might arise or be asserted against said employees, agents or representatives arising out of the construction, presence, existence, or maintenance of the BMP(s) and conveyance(s) either by the Landowner or Borough. In the event that a claim is asserted or threatened against the Borough, its employees, agents or designated representatives, the Borough shall notify the Landowner, and the Landowner shall defend, at his own expense, any claim, suit, action or proceeding, or any threatened claim, suit, action or proceeding against the Borough, or, at the request of the Borough, pay the cost, including attorneys' fees, of defense of the same undertaken on behalf of the Borough. If any judgment or claims against the Borough's employees, agents or designated representatives shall be allowed, the Landowner shall pay all damages, judgments or claims and any costs and expenses incurred by the Borough, including attorneys, regarding said damages, judgments or claims.

11. The Borough may enforce this Agreement in accordance with its Stormwater Ordinance, at law or in equity, against the Landowner for breach of this Agreement. Remedies may include fines, penalties, damages or such equitable relief as the parties may agree upon or as may be determined by a Court of competent jurisdiction. Recovery by the Borough shall include its reasonable attorney's fees and costs incurred in seeking relief under this Agreement.

12. Failure or delay in enforcing any provision of this Agreement shall not constitute a waiver by the Borough of its rights of enforcement hereunder.

13. The Landowner shall inform future buyers of the Property about the function of, operation, inspection and maintenance requirements of the BMP(s) prior to the purchase of the Property by said future buyer, and upon purchase of the Property the future buyer assumes all responsibilities as Landowner and must comply with all components of this Agreement.

14. This Agreement shall inure to the benefit of and be binding upon, the Borough and the Landowner, as well as their heirs, administrators, executors, assigns and successors in interest.

15. Additional items or conditions, as required by the Borough (per Subsection 703.B of this Ordinance), as attached herein:

This Agreement shall be recorded at the Office of the Recorder of Deeds of Chester County, Pennsylvania, and shall constitute a covenant running with the Property, in perpetuity.

ATTEST:

WITNESS the following signatures and seals:

(SEAL) For the Borough:

_____

(SEAL) For the Landowner:

_____

ATTEST:

_____ (West Grove Borough)

County of Chester, Pennsylvania

I, _____, a Notary Public in and for the County and State aforesaid, whose commission expires on the _____ day of _____, 20__, do hereby certify that _____ whose name(s) is/are signed to the foregoing Agreement bearing date of the _____ day of _____, 20__, has acknowledged the same before me in my said County and State.

GIVEN UNDER MY HAND THIS _____ day of _____, 20__.

_____ _____

NOTARY PUBLIC **(SEAL)**