CHAPTER VI

STORMWATER MANAGEMENT

CHAPTER VI
STORMWATER MANAGEMENT
CHAPTER CONTENTS

Page No.

III. DRAWINGS AND DOCUMENTS

Page No.

ANNE ARUNDEL COUNTY DESIGN MANUAL

CHAPTER VI

STORMWATER MANAGEMENT

I. GENERAL

A. Introduction

This chapter of the Anne Arundel County Design Manual outlines policies, design criteria and procedures for the preparation of feasibility reports, construction plans and specifications for both public and private stormwater management systems.

B. Ordinance and Authority

The Environmental Article Section 4-203 of the Annotated Code of Maryland mandated counties and municipalities to adopt ordinances necessary to implement Stormwater Management Programs. The Maryland Department of the Environment (MDE) through COMAR 26.09.02, Stormwater Management, instituted guidelines for implementation of these programs.

Anne Arundel County Council Bill 87-94 (Stormwater Management Ordinance), effective November 7, 1994, addresses the mandate as stated above and will be incorporated into the County Code as Article 21, Title 3, Sections 3-101 through 3-405.

1. Purpose

The purpose of stormwater management in Anne Arundel County as stated in the Stormwater Management Ordinance is as follows:

THE PURPOSE OF STORMWATER MANAGEMENT IN ANNE ARUNDEL COUNTY IS TO PROTECT AND PROMOTE THE PUBLIC HEALTH, SAFETY AND GENERAL WELFARE THROUGH THE MANAGEMENT OF STORMWATER, TO PROTECT PUBLIC AND PRIVATE PROPERTY FROM DAMAGE, TO REDUCE THE EFFECTS OF LAND USE CHANGES ON STREAM CHANNEL EROSION, TO ASSIST IN THE MAINTENANCE AND ATTAINMENT OF WATER QUALITY IMPROVEMENT, TO PRESERVE AND ENHANCE THE ENVIRONMENTAL QUALITY OF STREAMS AND STREAM VALLEYS, TO MINIMIZE ADVERSE IMPACTS ON WATER QUALITY AND CONSERVE PLANT, FISH AND WILDLIFE HABITAT, TO REDUCE FLOODING, TO MAINTAIN AS NEAR AS POSSIBLE PRE-DEVELOPMENT RUNOFF CHARACTERISTICS, AND TO ESTABLISH THE MINIMUM REQUIREMENTS AND PROCEDURES TO CONTROL THE ADVERSE IMPACTS ASSOCIATED WITH INCREASED STORMWATER RUNOFF.

2. Goal

   The primary goal of the Anne Arundel County Stormwater Management Program is to maintain after development, as nearly as possible, the pre-development runoff characteristics and to reduce stream channel erosion, pollution, siltation and sedimentation, and local flooding which would otherwise have adverse impacts on the water and land resources of this County and State.

3. Authority

   The Department of Planning and Code Enforcement (PACE) is mandated with the responsibility of implementing the County Stormwater Management Ordinance. PACE will prepare the Watershed Master Plans with the assistance of the Department of Public Works. The Stormwater Management Ordinance also mandates that PACE prepare and regularly update a stormwater management technical manual for stormwater management design, construction, and maintenance. Changes to the stormwater management technical manual may be made following public review and comment, including review and comment by the Anne Arundel Soil Conservation District. Questions regarding the interpretation of the policies and procedures contained herein shall be directed to PACE.

4. Minimum Control Regulations

   a. The minimum stormwater control regulations require that all development provide stormwater quantity management measures necessary to maintain the post-development peak discharges for a 2-year and 10-year frequency storm event at a level that is equal to or less than the respective 2- and 10-year pre-development peak discharge rate, through stormwater management practices that control the volume, timing, and rate of runoff.

   b. Stormwater management and development plans, where applicable, shall be consistent with adopted and approved watershed management plans or flood management plans, as approved by the Maryland Water Resources Administration in accordance with the Flood Hazard Management Act of 1976 (8-9A-01 et seq., Natural Resources Article).

   c. Water quality management facilities shall be installed on all proposed development except for exemptions listed in the Stormwater Management ordinance, Article 21, 3-302. Any water quality device installed shall be sized for the entire drainage area draining to the device. As a minimum, water quality enhancement shall be provided by management of the first one-half-inch of site runoff or by extended detention of the one year storm for 24 hours, where infiltration is not feasible, to control runoff from any new impervious areas.

   d. Stormwater management facilities for a proposed development located in the critical area shall manage the increased runoff so that the two-year and 10-

year pre-development peak rates are not exceeded and the pre-development volume is released over a 36-hour period. Pollutant loadings from impervious surfaces shall be reduced by at least ten percent. Offsets will be allowed in accordance with the Technical Guide for 10% Rule Compliance (reference no. 6, appendix A). Stormwater runoff from impervious surfaces may not cause downstream property, watercourses, channels or conduits to receive stormwater runoff at a higher rate than would have resulted from a 10-year storm were the land in a pre-development state.

e. The minimum control regulations for the Parole Town Center Growth Management Area are as follows:

1) Regional stormwater management or regional water quality improvements are encouraged;

2) Stormwater management shall be provided in accordance with the Stormwater Management Ordinance;

3) Water quality enhancement shall be provided by management of the first one-half-inch of site runoff from all impervious surfaces, or by extended detention of the one year storm for 24-hours in areas where infiltration is not feasible; and

4) If the Department of PACE determines that there has been a diminution of water quality in the receiving body of water, each property owner, developer, or person controlling the property shall install retrofit improvements in the drainage or subdrainage area that will improve water quality caused by stormwater runoff from the property as directed by PACE.

C. Definitions

As-Built Plans: Plans that:

1. Are drawn to the same scale as the approved stormwater management plans;
2. Show the location, dimensions and elevations of all drainage structures, drainage systems and stormwater management quantity and quality control structures or devices including vegetative measures;
3. Are in substantial conformance with the approved stormwater management plans, and
4. Note any deviations from the approved plans.
5. Are in conformance with the Anne Arundel Soil Conservation District small pond approval, if applicable.

Attenuation: Reduction of peak discharge of stormwater runoff.

Best Management Practice: A structural facility that temporarily stores and/or treats urban stormwater runoff resulting in reduced flooding and pollutant removal; and provides, in some situations, environmental and human amenities.

Certification: A written statement signed by a professional engineer under seal specifying that construction, inspection and testing has been performed in compliance with the requirements of the Stormwater Management Ordinance.

Critical Area: All wetlands and all land and water areas in the County within 1000 feet measured planimetrically beyond the landward boundaries of tidal wetlands and the heads of tides.

Detention Structure: A permanent structure for the temporary storage of runoff designed in such a manner as not to create a permanent pool of water (Dry Pond).

Development: Any subdivision of land or any man-made change to improved or unimproved real estate. Development includes:

1. Any construction, reconstruction, modification, extension or expansion of buildings or other structures, placement of fill or concrete, construction of new or replacement infrastructure, dumping, mining, dredging, grading, paving, drilling operations, storage of materials, land excavation, land clearing, land improvement, landfill operation, or any combination of these activities, and

2. Any activity that will change the runoff characteristics of a parcel of land in conjunction with the construction on, or use of, that land.

Drainage Area: An area enclosed by a ridgeline that contributes runoff to a single point measured in a horizontal plane.

Dry Well: A small-excavated pit backfilled with aggregate. Inflow to dry well is by means of a inflow distribution pipe system or surface infiltration. Generally used to capture and store runoff from roof top areas.

Extended Detention: A permanent structure that provides for the temporary storage of runoff. Must have a minimum detention time of 24 hours for the one-year ultimate development storm.

Hydraulics: The study of the motion of water (especially in and on defined shapes such as channels, pipes, weirs, orifices, etc).

Hydrology: The study of the relationship of the properties, distribution and circulation of rainfall on land surfaces.

Impermeable Soil Strata: A layer of soil with an infiltration rate of less than 0.52 inches per hour.

Infiltration Basin: A water impoundment made by constructing a dam or embankment or by excavating a pit or dugout in, or down to, a relatively permeable soil.

Infiltration Trench: A shallow excavated trench, backfilled with coarse stone aggregate, allowing for temporary storage of runoff in the voids (within the aggregate material) and gradual infiltration into the surrounding soil.

Offsite Stormwater Management: The design and construction of a facility necessary to control stormwater from more than one development.

Onsite Stormwater Management: The design and construction of systems necessary to control stormwater within a development.

PAC: Permit Application Center

PACE: The Department of Planning and Code Enforcement.

Pre-Development: The land use at the time of submittal or the predominant land covering during the previous five years, which ever yields the lower runoff curve number.

Private Stormwater Management Facility: Any stormwater management facility, which is not to be owned and maintained by Anne Arundel County or any other Government agency.

Public Stormwater Management Facility: Any stormwater management facility, which is owned and maintained by Anne Arundel County or other Government agency.

Regional Stormwater Management: Design and installation of stormwater management devices for an entire region within a planned urban setting in place of individual stormwater management devices for each development site within the region.

Retention Structure: A permanent structure that provides for the storage of runoff by means of a permanent pool of water with additional temporary storage.

Sediment: Soils or other surficial materials transported or deposited by the action of wind, water, ice or gravity as a product of erosion.

Stormwater Management:

1. A system of vegetative and structural measures used to maintain pre-development peak discharge rates through the control of volume, timing or rate of flows caused by man-made changes to the land if intended for quantity control; or

2. A system of vegetative, structural and surrounding measures used to reduce, capture or eliminate pollutants that might otherwise be carried by surface runoff if intended for quality control.

Stormwater Management Plan: A set of drawings or documents that contain the information and specifications required by the Stormwater Management Ordinance submitted to obtain stormwater management approval from PACE.

Tidal Outfall: The point of discharge of a storm drainage system at or below the mean high water line or into a tidal wetland. Mean high tide shall be determined by a land surveyor registered in the State of Maryland.

D. Water Quality Control Requirements

Water quality control consists of the treatment of the first 1/2-inch of runoff from impervious surfaces or 1 year 24 hour extended detention where infiltration cannot be employed. In the critical area water quality shall be improved by reducing the pollutant loadings from the development site to a level at least 10 percent below the level generated from the site prior to development. This requirement is known as the 10 percent rule. In order to achieve both water quantity and quality controls, various methodologies and practices, commonly known as Best Management Practices (BMPs), shall be utilized. BMPs chosen for a particular site shall meet the following guidelines:

- Reproduce, as nearly as possible, the pre-development hydrological conditions of the receiving stream.
- Provide a moderate level of removal for most urban pollutants. An equation for determining the pollutant removal necessary for compliance with the 10 percent rule is provided in the Technical Guide For 10% Rule Compliance (Reference No.6, Appendix A).
- Be appropriate for the site, given physical constraints.
- Be reasonably cost-effective in comparison with other BMPs.
- Have an acceptable future maintenance burden.

The designer, in determining the most suitable BMP, must address both the positive and negative aspects of each BMP option considered, including the following:

- Physical suitability for the site
- Stormwater benefits achieved
- Pollutant removal capability for a range of urban pollutants
- Environmental or community amenities provided by the BMP
- Maintenance requirements

1. Physical Suitability

The two physical factors that have the greatest influence on the type of BMP chosen for a site are the size of the contributory area and soil type.

Pond BMPs should receive a significant contributory drainage area to assure proper functioning while infiltration and vegetative BMPs should only receive stormwater runoff from on-site areas. Appendix D should be used to determine suitability.

Soil permeability directly impacts the function of some BMPs especially those incorporating infiltration. Soils with infiltration rates less than or equal to 0.52 inches/hour cannot be used as infiltration sites.

Other site conditions influencing BMP selection include:

- Slope
- High water table
- Depth to bedrock or impermeable soil strata
- Availability of land to site BMP
- Type of land use
- High sediment input
- Thermal impacts

Each of these items must be addressed as part of the water quality analysis. Appendix E describes BMP suitability versus various site conditions.

2. Stormwater Benefits

The BMP must strive to also achieve the pre-development hydrology of the site as well as provide water quality enhancement. Through a combination of peak discharge control, volume control, groundwater recharge and stream bank erosion protection, these benefits can be achieved. Appendix F indicates the benefit provided by each BMP type.

Specifically, the design of a BMP facility should include detailed calculations for peak discharge control, volume control, and stream bank erosion control. Criteria for these items are listed in other parts of this chapter.

3. Pollutant Removal Benefits

In order to achieve improved water quality, the designer must design the BMP to provide pollutant removal.

The Capacity of a BMP to remove pollutants depends on:

- The type of pollutant to be removed
- Percent of runoff volume that is effectively treated
- Removal mechanisms utilized

Particulate pollutants, such as sediment and lead, are relatively easy to remove by common BMP removal mechanisms, including settling and filtering. Soluble

pollutants, such as nitrate, phosphate, and some trace metals, are much more difficult to remove since settling and filtering removal mechanisms have little or no effect. For soluble pollutants the biological mechanisms such as uptake by bacteria, algae, rooted aquatic plants or terrestrial vegetation, must be used.

The Technical Guide For 10% Rule Compliance (Reference No. 6, Appendix A) recommends using Total Phosphorus as a surrogate pollutant for all stormwater pollutants. This "keystone" pollutant is used as the basis for computing pre- and post-development pollutant loads at a site, and ultimately, the necessary pollutant removal requirement. The quantity of Total Phosphorus exported from a development site may be determined by using the Simple Method as described in Reference No. 6.

Appendix G compares the pollutant removal capabilities of various BMP options. Each rate shown is an estimate of performance based on past monitoring, experimentation, and theoretical considerations. The design of the BMP must include a listing of pollutants and the effectiveness of removal for each pollutant.

4. Environmental and Community Amenities

   In most cases the environmental and community amenities are not included as part of the design of a BMP facility. The BMP designer must present various options that address the amenity issues. Appendix H shows the various BMPs amenities that can be provided. Again, the advantages and/or disadvantages of each BMP must be considered and included in the report described in paragraph 5 below.

5. Report/Narrative

   Each project design submitted must include a narrative describing the analysis that was used to determine which BMP is chosen to address the water quality issue. Use of the appendices in support of the description is recommended. The report shall be on 8-1/2" x 11" sheets of paper, bound in a booklet, and signed and sealed by a professional engineer registered in the State of Maryland. All supporting maps and drawings shall be placed in pockets.

E. Critical Area Requirements

The County has enacted critical area legislation (Bill 61-93) that mandates developmental practices within a 1,000-foot distance measured from the landward boundaries of tidal wetlands, and the heads of tides. Each development's stormwater management facility in the defined critical area must also comply with the adopted critical area legislation, as well as requirements presented in this chapter. Stormwater management facilities for a proposed development in the critical area shall be installed to meet the minimum performance requirements for managing increased runoff so that:

1. Two-year and ten-year pre-development peak discharge rates are not exceeded and the pre-development volume is released over a 36-hour period;

2. Accelerated channel erosion will not occur as a result of the proposed development; and

3. The 10 percent rule requires that pollutant loadings from the development site shall be reduced to a level at least 10 percent below the level generated from the site prior to development.

4. Any development within resource conservation areas, limited development areas, or intensely developed areas of the critical area shall be undertaken only in accordance with the following:

   a) Development activity may not cause downstream property, watercourses, channels or conduits to receive stormwater runoff at a higher volume or rate than would have resulted from a 10-year storm were the land in its pre-development state; and

   b) All stormwater management facilities are designed with sufficient capacity to manage at a minimum the first 1/2" of runoff from impervious surfaces or extended detention of a 1-year storm for 24-hours in order to achieve water quality improvement.

F. Comprehensive Watershed Management Master Plan

PACE will prepare Watershed Master Plans for all 12 County watersheds. Once adopted, within these watersheds developers will be required to comply with additional or revised stormwater management goals as determined by the needs of the particular watershed. The design standards for stormwater management may also be modified for these priority watersheds to assist in the mitigation of known water quality, sedimentation, or flooding problems. Special requirements and modified design standards for the priority watersheds will be published by the County and made part of the Adopted County Comprehensive Watershed Management Master Plan.

G. Ownership, General Location, and Maintenance of Stormwater Management Devices.

1. Private Facilities

Individual stormwater management facilities for commercial, institutional, industrial, condominium, townhouse, and apartment developments are owned and maintained by the party or parties who own and develop a single parcel or contiguous parcels. Additionally, centralized stormwater management facilities owned and maintained by community associations or each property owner in the subdivision (in-lieu of associations), are also deemed private facilities. Private stormwater management facilities shall be noted as a responsibility of the Home

Owners Association (HOA) in the standard HOA documents. An inspection and maintenance agreement is required between the owner and the County.

The stormwater management device will manage only on-site runoff. Wherever practical, off-site runoff will be directed away from the proposed device. Private stormwater management facilities may not receive water directly from a public stormwater management facility unless permission is granted by the owner of the private facility.

2. Public Facilities

Public stormwater management facilities are owned, inspected and maintained by the County. Facilities may be constructed as a capital project or by a developer under a public works agreement. The public stormwater management facility will manage the runoff from the contributing drainage area. The Department of PACE will perform both construction and maintenance inspections for facilities and will advise the Department of Public Works if any routine maintenance is needed. The Department of Public Works will provide routine maintenance. Public stormwater management facilities shall be located on common ground/open space, expanded public right-of-way, or stormwater management easements.

H. Exemptions From On-Site Stormwater Management

1. List of Exemptions

The following activities are exempt from stormwater management:

a. Land developments that do not disturb over 5,000 square feet of land area.

b. Agricultural land management activities meeting all the following requirements:

1) The area is included in an active soil and water conservation plan.

2) The agricultural activity has been reviewed and approved by the Anne Arundel Soil Conservation District.

c. Additions or modifications to existing single-family detached residential structures.

d. Land development activities, which are regulated by the Maryland Water Resources Administration under specific state laws such as Federal and State government construction activities.

e. Residential developments consisting of single-family houses on lots of 2 acres or more located outside of the critical area.

I. Waivers and Modifications to On-Site Stormwater Management

1. Eligibility

Except in the critical area, the Department of PACE may grant a waiver to the water quantity requirements of the Stormwater Management Ordinance if the water quality requirements of the ordinance are met and the applicant can demonstrate that the proposed development:

a. Will not generate more than a 10 percent increase in the 2-year pre-development peak discharge rate and will not cause an adverse impact on the receiving wetland, watercourse or waterbody;

b. Is adjacent to existing developed areas that are served by an existing storm drainage system with sufficient capacity to accommodate ultimate upstream development runoff from the 10-year storm in a non-erosive manner, or

c. Provides for controlled storm drainage discharges to:

1) An adequately protected tidal outfall;

2) An approved storm drainage system that provides an adequately protected tidal outfall; or

3) The non-tidal main streams of the Upper Patuxent River, Little Patuxent River, or the Upper Patapsco River.

2. Stormwater Management Waiver Submission

a. Major Subdivision Submittal

1) Formal and informal pre-sketch; sketch submittal phase. At this review phase, waiver submittal will be reviewed for concept only.

a) Cover Letter

The cover letter shall state the nature of the proposed stormwater management waiver and reference the waiver provision in the Stormwater Management Ordinance. The cover letter shall also contain a statement as to why the waiver conditions apply. The letter shall be signed and sealed by a professional engineer, registered in the State of Maryland.

b) Bound Computations

All notes concerning the waiver shall appear on the formal and informal pre-sketch, and/or the sketch site plan under the heading, Stormwater Management Waiver. Engineering calculations shall be

signed and sealed by a professional engineer registered in the State of Maryland, and shall be submitted on bound 8-1/2" x 11" sheets. All supporting maps shall be folded in a pocket and color coded as required for clarity.

c) Number of Copies of Waiver

Three sets of computations and cover letter shall be submitted to the PACE Development Division.

d) Processing Procedure

A waiver number will be assigned to the proposed waiver. All subsequent submittals shall reference the stormwater management waiver number. Once all of the review comments have been received and evaluated, the following response will be made:

- The proposed waiver appears reasonable and feasible based upon the concepts presented.
- The proposed waiver has insufficient information for Anne Arundel County to make a determination on its feasibility.
- The proposed waiver has a major impact on the site and if not approved, a major redesign of the subdivision may result. Final design criteria is required to evaluate the feasibility of the waiver.
- The proposed waiver does not appear to meet any of the Stormwater Management Ordinance criteria or Anne Arundel County policies, and it is the opinion of the review staff that the waiver be withdrawn and stormwater management provisions provided on the plans.

2) Final Major Subdivision Submittal

a) Processing Fee

A fee of $100.00 shall be paid to Anne Arundel County for waiver review.

b) Submittal Package

Cover letter and computations shall be as required for the formal and informal pre-sketch and sketch submittal phases. Three sets shall be submitted to the Development Division.

c) Processing Procedure

Once all of the review comments have been received and evaluated, one of the following statements will be part of the final subdivision review comments:

- Waiver is recommended for approval.
- Waiver is acceptable in concept; however, additional information must be submitted for review and approval prior to waiver approval.
- Waiver is found unacceptable and review staff recommends denial.

b. Minor Subdivision Submittal

1) Final Subdivision Submittal

Since the initial waiver submittal is made at the final subdivision review stage, it shall be the developer's responsibility to make any inquiries on an informal basis.

a) Processing Fee

A fee of $100.00 shall be paid to Anne Arundel County for waiver review.

b) Cover Letter

The cover letter shall state the nature of the waiver request, reference the appropriate Stormwater Management Ordinance section, and be signed and sealed by a professional engineer registered in the State of Maryland.

c) Bound Computations

Engineering calculations shall be signed and sealed by a professional engineer registered in the State of Maryland, and shall be submitted on bound 8-1/2" x 11" sheets. All supporting maps shall be folded in a pocket and color coded as required for clarity.

d) Number of Copies of Waiver Submittal

Three sets of computations and cover letter shall be submitted to the Development Division.

e) Processing Procedure

A waiver number will be assigned to the proposed waiver. Once all of the review comments have been received and evaluated, the following response will be made:

- Waiver is recommended for approval
- Waiver is acceptable in concept; however, additional information must be submitted for review and approval prior to waiver approval.

- Waiver is found unacceptable and review staff recommends denial.

c. Capital Projects and Individual Sites, Industrial and Commercial Submittal

1) Grading and Building Permit Submittal

If the site development is part of a subdivision that has already obtained a waiver, it shall be the developer's responsibility to submit a copy of the waiver approval letter. If the development site is not part of a subdivision that has previously obtained a waiver, then a formal waiver package must be submitted.

a) Processing Fee

A fee of $100.00 shall be paid to Anne Arundel County for waiver review.

b) Cover Letter

The cover letter shall state the nature of the proposed stormwater management waiver and reference the waiver provision in the Stormwater Management Ordinance. The cover letter shall also contain a statement as to why the waiver conditions apply. The letter shall be signed and sealed by a professional engineer registered in the State of Maryland.

c) Bound Computations

Engineering calculations shall be signed and sealed by a professional engineer registered in the State of Maryland, and shall be submitted on bound 8-1/2" x 11" sheets. All supporting maps shall be folded in a pocket and color coded as required for clarity.

d) Number of Copies of Waiver Submittal

Three sets of computations and cover letter shall be submitted with the application package.

e) Processing Procedure

A waiver number will be assigned to the proposed waiver. All subsequent submittals shall reference the stormwater management waiver number. Once all of the review comments have been received and evaluated, the following response will be made:

- Waiver is recommended for approval.

- Waiver is acceptable in concept; however, additional information must be submitted for review and approval prior to waiver approval.
- Waiver is found unacceptable and review staff recommends denial.

II. DESIGN CRITERIA

A. General Requirements

1. Development Projects

The design of all development projects shall provide for the management of increased stormwater runoff and pollutants in accordance with the following requirements. All stormwater management designs, plans and waiver submissions shall be performed under the seal and signature of a professional engineer registered in the State of Maryland.

a. Minimum Performance Requirements

An applicant shall install or construct stormwater management facilities for control of stormwater runoff quantity and quality so that:

1) 2-year and 10-year pre-development peak discharge rates are not exceeded by the corresponding rates for developed conditions. For sites in the critical area, 2-year and 10-year pre-development peak rates are not exceeded and the pre-development volume is not exceeded in 36 hours.

2) Accelerated channel erosion will not occur as a result of the proposed development.

3) The first 1/2" of runoff from all impervious surfaces shall be controlled, or extended detention of a 1-year storm for 24-hours shall be provided in order to achieve water quality improvement.

4) In the critical area pollutant loadings from impervious surfaces shall be reduced by at least 10 percent.

5) Stormwater runoff from impervious surfaces may not cause downstream property, watercourses, channels or conduits, to receive stormwater runoff at a higher volume or rate than would have resulted from a 10-year storm were the land in pre-development state.

b. Investigation of Stormwater Management Practices

The following water quality practices shall be investigated in the following order of preference and, through the use of standard engineering practices, the designer shall justify the reason for the selection of the proposed practice.

1) Onsite infiltration of runoff.

2) Flow attenuation by use of open vegetated swales and natural depressions.

3) Stormwater retention structures.

4) Stormwater detention structures.

5) A combination of the practices listed above if used to achieve applicable minimum control requirements.

c. Computational Methodologies

Computational methodologies used to determine runoff and analyze stormwater management structures shall be those presented in this chapter.

d. Applicable Publications

In addition to the criteria presented in this design manual, the design criteria, standards, procedures, details, and requirements set forth in the following publications latest editions and addenda shall be included. If conflict becomes apparent, The Department of PACE shall determine which standards govern. In general, the more restrictive requirements shall govern.

1) The Anne Arundel County Design Manual.

2) The Anne Arundel County Standard Details and Specifications.

3) Standards and Specifications for Infiltration Practices, Maryland Department of Natural Resources, Water Resources Administration.

4) National Engineering Handbook Natural Resource Conservation Service, (NRCS) U.S. Department of Agriculture.

5) Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas, U.S. Department of Agriculture, NRCS.

6) Highway Drainage Manual, Maryland Department of Transportation, SHA.

7) Stormwater Management Pond Design Manual, Maryland Association of Soil Conservation Districts.

8) Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs, Metropolitan Washington Council of Governments.

9) Technical Release No. 55 (2nd Edition), Urban Hydrology For Small Watersheds, U.S. Department of Agriculture.

10) Technical Release No. 20, U.S. Department of Agriculture, NRCS.

11) Urban Stormwater Quality Guidance for the Maryland Chesapeake Bay Critical Area (Applicant's Guide, technical Guide, Plan Reviewer's Guide), Chesapeake Bay Critical Area Commission and the Department of Environmental Programs, Metropolitan Washington Council of Governments, May 1993.

12) Natural Resource Conservation Service, Maryland Standards and Specifications for Ponds, Code 378 (MD378), current version.

13) Technical Release No. 60, Earth Dams and Reservoirs, U.S. Department of Agriculture, NRCS.

14) Soil Mechanics Note No. 1, U.S. Department of Agriculture, NRCS.

e. Maintenance

Stormwater management facilities shall be designed to minimize the need for maintenance and provide access for maintenance purposes. A private stormwater maintenance agreement for County inspection must be provided for private stormwater management facilities.

f. Natural cover

Wherever possible, the applicant shall save all natural cover as well as wetlands, ponds, natural swales and depressions as they exist before development.

g. Use of Natural Topography

The applicant may incorporate the use of natural topography and land cover such as wetlands, ponds, natural swales and depressions as they exist before development to the extent that they are able to accommodate an additional flow of water; provided that 1/2-inch of runoff from all impervious areas is managed prior to reaching any natural features mentioned in this section according to infiltration standards and specifications promulgated by the Maryland Department of Natural Resources, Water Resources Administration.

h. Easements

If a stormwater management plan involves direction of any runoff to an offsite location, the applicant shall obtain any necessary easements from adjacent and other affected property owners or rights to discharge. Cases where easement and/or right to discharge are required shall be determined as follows:

1) Case I

When facility construction and change of flow characteristics is on an adjacent property, a permanent easement for the perpetual maintenance of the facility is required. A working strip around the facility should be included as required. A right to discharge from the downstream property owner is also required.

2) Case II

When facility construction is onsite and results in a change in flow character, a right to discharge will be required from the downstream property owner.

3) Case III

When facility construction is onsite and the engineer has shown that the flow across the downstream boundary is the same peak flow as existed prior to development, the facility shall be setback sufficiently to allow the transition of flow to return to its natural condition. The following table shall be used as a guide:

Peak Flow (cfs)	Distance between Outfall and Property Line
0 - 10	Minimum 10' clearance
10 – 20	20'
20 - 30	30’
> 30	The engineer shall demonstrate that the predicted discharge will return to a natural condition by appropriate evaluation.

4) Case IV

When a downstream sump condition exists with no apparent outfall other than evaporation and infiltration, the engineer shall design the discharge for peak and volume management so as not to load the natural sump more than is predicted under existing conditions.

2. Capital Projects

The Department of PACE may initiate a stormwater management capital project consisting of the design and construction of regional stormwater management facilities or retrofit site facilities. The design criteria and computational methodology for the design of these facilities shall be the same as those for development projects.

3. Downstream Impacts

Where deemed necessary by the Department of PACE, an analysis of the impact of stormwater flows downstream in the watershed shall be submitted. Analysis shall be based on the 2, 10, and 100-year storms, unless otherwise directed by the County. Analysis of the 100-year storm is intended to determine if an adequate floodway exists that will not cause structural damage to buildings or in anyway jeopardizes the public's health, safety or welfare. If applicable, a dam breach analysis may be required.

In all cases, the engineer shall investigate downstream conditions for predicted erosion. If found to be or predicted to be erosive, the downstream channel shall be repaired or action taken as noted in the following paragraph.

If the downstream property is erosive, there are no alternative means of discharge and the engineer demonstrates that offsite easements are not to be granted by the downstream owner to repair the condition, the new system shall be overdesigned to decrease the predicted pre-development flow by 20 percent so as to reduce the impact peak discharge on the downstream owner.

a. Basin-Wide Analysis

The analysis shall include, at a minimum, hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications. The proposed development impact, upon any dam, highway, structure, or natural point of restricted stream flow downstream of the first downstream tributary whose drainage area equals or exceeds the contributing area to the structure or whose peak 100-year discharge exceeds that of the structure, shall be analyzed.

The Department of PACE, with the recommendations of the Anne Arundel Soil Conservation District, may require additional downstream analysis to insure the safe and non-erosive conveyance of the discharge from the site. For development projects, the exact study limits will be determined by PACE in the subdivision review process.

b. Design Modifications

The designed release rate of the structure shall be modified if any increase in flooding or stream channel erosion would result at the downstream dam, highway, structure, or natural point of restricted stream flow. For areas where the base flow channel is non-eroding, the release rate of the structure shall:

1) Be reduced to a level that will prevent any increase in flooding or steam channel erosion at the downstream control point.

2) Be not more than the 1-year pre-development peak discharge rate. If the existing 1-year pre-development peak discharge rate is 1 cfs or less, the minimum allowable discharge rate shall be 1 cfs.

   For areas where the base flow channel is presently eroding, or slopes are greater than eight percent, corrective measures must be taken.

B. Stormwater Management Practices

1. Infiltration Devices

Infiltration devices are to be the first consideration in the designer's development of stormwater management design for a site. The following devices may be utilized:

- Infiltration Trench
- Infiltration Basin
- Dry Well

The Maryland Standards and Specifications for Infiltration Practices in Stormwater Management, published by the Maryland Department of Natural Resources, shall be used in conjunction with the Storm Drain Design Chapter of this manual to design infiltration devices. Infiltration devices used for peak management shall be constructed on soils with an infiltration rate of 2.41 in/hr or greater, and have a contributing drainage area of 5.0 acres or less. Soils with an infiltration rate greater than 0.52 in/hr but less than 2.41 in/hr are suitable for off-line devices utilized explicitly for water quality management. Soil infiltration rates shall be determined by a professional engineer who is registered in the State of Maryland and experienced in soils engineering. Additional County criteria and guidelines are as follows:

a. General

1) The infiltration facility will not be used as a sediment control feature at any time during construction.

2) The infiltration facility will not be traversed by construction vehicles at any time during the excavation of the 2 feet immediately above the facility invert.

3) No infiltration device will receive any runoff until the entire contributory drainage area to the infiltration system has received final stabilization and is accepted by the County.

4) Infiltration devices located uphill of any existing house or structure shall be evaluated for possible adverse effects to the existing house or structure.

5) A minimum distance of two feet shall be maintained between the bottom of any infiltration device and the seasonal high water table, as measured in the test-boring hole a minimum of 24 hours after drilling, bedrock or impermeable soil layer.

6) Infiltration devices shall not be placed in fill.

7) Vegetative buffers or other approved runoff filtering or sediment-trapping device should be provided for infiltration practice. The filtering strip should be a minimum of 20 feet wide around the infiltration system with sheet flow only over the strip. Water quality inlets, grass filter strips or sediment traps, shall be required for underground infiltration storage.

8) Infiltration devices shall not be utilized as an integral part of the main stormwater conveyance system. If the infiltration device receives runoff via a storm drainage system, the device must be located "off-line". An off-line infiltration device shall be connected to an inlet structure that has a sump chamber with minimum depth of three feet below the infiltration device inlet pipe.

9) An observation well shall be installed in every infiltration trench and drywell. The observation well shall consist of a perforated schedule 40 PVC, SDR-35 PVC or other pipe with a minimum of 3,000 pounds crush strength, 4- to 6-inches in diameter. It shall be located in the center of the structure. A footplate shall be provided under the observation well (pipe) to keep it from settling into the earth. Observation wells constructed in residential lots shall project 4- to 6-inches above grade and be constructed in such a way that they will not be damaged by lawn mowing. The top of the observation well shall be capped to discourage vandalism and tampering. When observation wells are constructed in driveways, parking lots, etc., Anne Arundel County Standard Detail S-10 must be used. Geogrid shall be included in the bottom of trenches located within paved areas.

10) Setbacks

    a) The setback from structures on slabs is 10 feet.

    b) Infiltration devices uphill from buildings and structures with basements shall be located a minimum of 20 feet from the structure, or the intersection of the structure foundation footing with the phreatic line from the overflow depth of the device, whichever is greater.

    c) Infiltration devices downhill from buildings and structures with basements shall be located at least 10 feet from the structure foundation or the intersection of the foundation footing with the phreatic line from the overflow depth of the device whichever is greater.

d) Infiltration devices shall be located a minimum of 10 feet from property lines.

e) No infiltration devices shall be located within 100 feet of any water supply well for commercial and industrial development.

f) No infiltration devices shall be located within 50 feet of any water supply well for residential development.

g) All infiltration devices shall be located a minimum of 20 feet horizontally from the 100-year floodplain.

h) Infiltration systems shall be located a minimum of 25 feet or in accordance with the latest Health Department criteria, whichever is greater, from a septic system and alternate septic systems. The clearance shall be maintained at the perimeter of the 10,000 square feet septic system area.

i) All infiltration devices shall be located a minimum of 25 feet from the top of slopes 25% or greater and retaining walls. In no case shall the phreatic line from the overflow depth of the device intersect existing and/or final ground line of the slope or the retaining wall.

j) Infiltration devices, including individual lot devices, shall be located a minimum of 10 feet horizontally from any public sanitary sewer or house connection.

k) Where "O" ring or glue weld schedule 40 connections are not used for sanitary sewer or house connections, infiltration devices shall be located a minimum of 50 feet horizontally from any public sanitary sewer or house connection.

b. Infiltration Basins

Infiltration basins used for peak management will generally be considered for drainage areas of 5 acres or less. Infiltration basins with contributory drainage areas of 5 to 50 acres shall be considered for water quality improvement only. All infiltration basins shall be designed with gravity outlet structures with a valve or cap on the discharge pipe. Infiltration basins shall not be used as an outfall. All infiltration basins shall meet the current MD378 standards and basin requirements of this chapter.

c. Infiltration Trench

Infiltration trenches will generally be considered for drainage areas less than 5 acres.

d. Dry Well

Dry wells may be used to capture and store runoff from rooftop areas with less than 1-acre of surface area.

2. Attenuation Devices

Attenuation devices are to be the second method considered in the designer's development of stormwater management for a site. The use of ditches, swales and depressions are not applicable in R-2 and denser zoned properties. The following attenuation devices may be used:

- Attenuation Ditch
- Attenuation Swale
- Natural Depressions
- Attenuation Trench - Only to be utilized when no other acceptable alternative is feasible.

The Storm Drains Chapter of the Anne Arundel County Design Manual shall be used in conjunction with the following criteria to design attenuation devices.

a. Attenuation Ditch and Swale

1) Minimum grade for attenuation ditches and swales shall be 0.5 percent. Grades of less than 0.5 percent necessitated by topographic conditions of the site may be used with the approval of the Department of PACE.

2) Lot grading in areas discharging to attenuation ditches shall provide a minimum of 15 feet at 2 percent minimum grade around the house to insure positive drainage. The design water surface elevation of the attenuation device shall be a minimum one-foot below the ground line at the house.

3) Underdrain systems shall be provided under the invert of swales and ditches, as may be necessary, to drain areas of possible ponding. The underdrains shall discharge to an adequate outfall. The requirement for underdrain systems shall be reviewed on a case-by-case basis by the Department of PACE.

4) Location of attenuation ditch and swale devices shall be no closer than 20 feet to any property line and 100 feet from any existing or proposed structures.

b. Natural Depressions

Natural depressions shall be located on common ground in a stormwater management easement. Natural depressions may be incorporated into the overall stormwater management design system if the following criteria are met:

1) Subsurface investigation to determine infiltration rate for areas without a positive outfall.

2) Topographic survey to determine the capacity of the depression.

3) The overflow shall be conveyed to an adequate outfall.

4) Shall be located no closer than 20 feet from any property line or 100 feet from any existing or proposed structure.

5) Natural depressions shall be hydraulically designed.

c. Attenuation Trench

1) Attenuation trenches for water quality shall be sized to filter the first 1/2-inch of runoff from all impervious surfaces of a development site.

2) Attenuation trenches will be allowed for peak management for watersheds of less than 5 acres.

3) The attenuation trench will not be used as a sediment control feature at any time during construction.

4) An attenuation trench will not receive any runoff until the entire contributory drainage area to the attenuation trench has received final stabilization and is accepted by the County.

5) A drainage structure, such as a water quality inlet or sediment trap, shall be located upstream of the attenuation trench to provide runoff filtering. Filter cloth shall be provided over the ends of the attenuation trench distribution and dewatering pipes at the drainage structure to prevent clogging.

6) The top of the attenuation trench shall be located a minimum of 12-inches below finished grade.

7) An observation well shall be installed in every attenuation trench. Design and construction of the observation well shall be as described previously for infiltration devices.

8) A gravity outfall pipe shall be located in the trench a minimum of 2 feet separation from the distribution pipe and 6-inches above the bottom of the trench. All piping located within the trench shall be perforated.

9) Permeable filter cloth shall be placed on the sides and on top of the trench.

10) Attenuation trench shall be backfilled with washed No. 2 stone.

11) Location of attenuation trench devices shall be the same as for infiltration trenches contained in IIB.1.(10).

3. Retention and Detention Devices

Retention devices are to be the third design consideration and detention devices are to be the fourth design consideration in the designer's evaluation of stormwater management devices. The following devices may be used:

- Retention Device (Wet Pond)
- Extended Detention Device (Dry Pond) - Shall only be used when criteria for a retention device cannot be met.
- Detention Device (Dry Pond) - Shall be considered only as a last alternative because they provide very little pollutant removal.

Computational Methodology: All retention and detention devices shall be designed in accordance with the "urban" criteria of the current version of Maryland Standards and Specifications for Ponds, Code 378 (MD378). Additional County criteria and guidelines follow:

a. General Guidelines for Water Quality Control

1) Retention Device (wet ponds) - The permanent pool storage shall be sized to hold a minimum of 1/2-inch of runoff from all impervious areas within the development site. For regional facilities, ultimate development of the total drainage area according to zoning maps shall be used. For all ponds an additional 1-foot depth shall be provided for sedimentation.

2) Extended Detention Device - The 1-year, 24-hour frequency storm shall be detained temporarily for an additional 12 hours. This interval shall be measured by determining the time interval between the time of mass inflow centroid and the time of the mass outflow centroid. The extended detention volume may not be incorporated within the 2-year pool volume requirement.

3) The most preferred extended detention design includes a plunge pool at the entrance to the control structure. By designing a facility with a plunge pool, the pollutant removal is enhanced by allowing greater settling time. The criteria for sizing the plunge pool shall be as determined by PACE.

4) In order to ensure the expected settling, the design of the facility should be such that the flow length from the inflow point to the discharge point is maximized.

5) All water quality devices shall have a gravity outlet structure with a valve or cap on the discharge pipe to allow draining of the device for maintenance purposes.

b. General Stormwater Management Quantity Control Guidelines

1) Drainage Area Size Limit

Stormwater management ponds with a contributory drainage area greater than 400 acres must be approved by the Maryland Water Resources Administration (WRA) and County Department of PACE. Stormwater management retention ponds shall have a minimum contributory drainage area of 10-acres.

2) Attenuation must be provided to maintain the post-development peak discharges for a 2-year and 10-year frequency storm event at a level that is equal to or less than the respective 2- and 10-year pre-development peak discharge rate.

3) When required by the results of the downstream impact analysis, the attenuation of the 100-year frequency storm event is necessary to control flooding downstream.

4) Trout Streams

These structures may not be sited so as to discharge to a Class III or IV Natural Trout Waters identified in COMAR 10.50.01.021 except as authorized by the WRA in permits issued pursuant to Natural Resources Article 8-803.

Proposed utilities are to be located away from the embankment. Existing utilities shall be relocated around the stormwater management facility embankment. Minimum clearance for utilities from the toe of the embankment shall be 20 feet.

c. General Design Guidelines

1) Hydraulics

Detailed hydraulic design calculations will be required for all facilities. The stage discharge data must be presented in tabular and graphical form with all supporting computations. Orifice, pipe and weir flows should be clearly indicated. The storage elevation data must also be presented in both tabular and graphical forms.

2) Flood Routings

The level pool routing method shall be used in all cases. The use of the TR-20 and TR-55 computer programs will be permitted as noted in this chapter. The wet storage volume of a retention pond, water quality volumes of infiltration basins and detention ponds shall not be included in the storage computation for the pond.

3) Pond Construction

All pond construction (wet or dry) shall, as a minimum, meet the current version of the Natural Resource Conservation Service design standard (MD378). Excavated ponds will have the same free board requirements as embankment structures, as outlined in MD378. Small pond approval shall be obtained from the Anne Arundel Soil Conservation District or the WRA pursuant to Natural Resources Article 8-903(b).

4) Cut-Off Trench

All dams require a cut-off trench. The cut-off trench shall extend below the existing ground as necessary to cut-off permeable layers in the foundation; however, in no case shall the depth be less than 4 feet below the existing ground. Design of the cut-off trench shall be in accordance with the current MD 378.

5) Supplemental Spillway

A supplemental spillway shall be provided for all impoundments. The spillway outlet shall be uniform for the required control section length. The supplemental spillway shall discharge to an adequate outfall determined by the design flow. Supplemental spillways are not required if the principal spillway fulfills the requirements of the emergency spillway in accordance with current MD378.

6) Phreatic Line

For all ponds, the assumed phreatic line shall be drawn at a four horizontal to one vertical slope from the intersection of the 10-year water surface elevation and the embankment to the invert of the outflow pipe. For ponds designed to attenuate the 100-year storm, the 100-year water surface elevation shall be used.

7) Outflow Piping and Seepage Control

Outflow pipes shall be round reinforced concrete pipe with rubber gasket joints as specified in the current MD378. Outflow pipes require a low concrete cradle within the embankment area (see Standard Detail CC-1).

Seepage along outflow piping extending through the embankment shall be controlled by use of filter and drainage diaphragms. Seepage control will not be required on pipes 6-inches and less in diameter. Filter and drainage diaphragms shall be designed in accordance with NRCS TR-60 and Soil Mechanics Note No. 1.

8) Outlet

Principal outlet structures shall discharge to an adequate outfall. The outfall shall be protected as per SCS outfall protection charts and riprap shall be sized accordingly. Outfall protection shall be based on the 10-year discharge from the facility. Filter cloth shall be placed under all riprap. Filter cloth and riprap shall be as specified in the current version of MD378. When the outfall discharges into a County storm drain, the engineer shall show that the discharge was computed based on a TR 20/55 criteria. In addition, the engineer shall adjust the flow rate to be compatible with the "Rational Method" by adjusting the runoff coefficient and the intensity value. Further, the engineer shall show the overflow route and its impact for the 100-year storm.

9) Fence, Gates and Access Ramps

Dry ponds with 3:1 side slopes are not required to be fenced. Retention and detention devices located within a residential area or within 500 feet of a residential area, or in the proximity of an elementary school playground or other areas where small children may congregate without adult supervision and that meet any one of the following criteria shall be fenced:

a) Retention devices with design wet storage depth greater than twenty-four inches.

b) Retention and detention devices designed to retain the 10-year storm for more than 24 hours at depth greater than twenty-four inches.

Fence shall meet the following criteria:

a) Fence height shall be a minimum of 42 inches.

b) Gates shall have minimum width of 12 feet and be equipped with a suitable weatherproof lock.

c) Fence shall be constructed so as not to impede flow through the supplemental spillway.

d) Galvanized chain-link fence is not permitted in residential areas. In industrial parks with outside storage or an utilitarian character, chain-link fence is permissible if of the black vinyl coated variety. In

commercial or residential applications, fencing is to be of vinyl, pressure treated or rot resistant wood or a material consistent with neighboring buildings. The infill gaps shall consist of black vinyl mesh material.

Access ramp shall meet the following minimum requirements:

a) All access ramps shall be at least 12 feet in width.

b) The maximum acceptable slope for access ramps is 15 percent. Slopes greater than 8 percent shall be stabilized with a 4-inch minimum layer of No. 2 stone underlaid with filter cloth. Flatter slopes may be stabilized with approved grasses.

10) Embankment

a) Wet Ponds - All slopes (inside and outside) including the dam itself must be on a slope not steeper than 3:1.

b) Dry Basins - Embankment slopes (inside and outside) and all excavated slopes may be no steeper than 3:1. Natural slopes, if left vegetated, may be greater than 3:1.

c) Embankment material, placement, compaction and compaction testing, shall be as specified in the current MD378.

11) Riser

The riser shall be a reinforced concrete structure (see Standard Detail D/88). For the required size of access opening see Standard Detail D/17. The riser/barrel connection shall be watertight and sealed by grout or rubber gasket. Riser structure openings shall be protected from clogging by trash racks, which meet the following requirements:

a) The dimensions of the trash rack openings shall be no larger than three-quarters the dimension of the opening to be protected. The minimum dimension will be not less than 6 inches.

b) The trash rack on the primary outflow shall have 3 times the cross-sectional area of the protected outflow opening. Computations must indicate that the criteria is met.

c) Vertical bars shall be located outside of horizontal bars and spaced 9-inches maximum on center.

d) The trash rack shall project out a minimum of 8-inches from the riser wall and extend a minimum of 8 inches below the invert of the opening being protected.

e) The reinforcing bars used in the fabrication of a trash rack shall be sized according to the design. However, in no case shall bars less than 1/2" in diameter (#4) be utilized. All trash racks shall be hot dipped galvanized or epoxy coated to prevent corrosion.

12) Pilot Channel and Cross-Slopes

The minimum bottom slope for pilot channels in dry ponds shall be 0.5 percent and the minimum cross slope toward the pilot channel shall be 2.0 percent. Riprap and filter cloth shall be placed in the pilot channel to prevent erosion of the facility. Under special circumstances, and with the approval of Anne Arundel County, a concrete pilot channel having a slope greater than 0.5 percent may be used.

13) Set Back

The minimum distance from the pond embankment toe of fill or top of cut shall be 50 feet to any adjacent property and when the device serves the property on which it is located, a minimum set back of 50 feet shall be provided to any structure on that property.

14) Safety Bench

In lieu of fencing, a safety bench may be provided. Wet ponds, which are not fenced, shall be provided with a 10 feet wide safety bench that extends around the entire shoreline. The bench shall be located such that the permanent pool elevation is located at the mid-point of the bench. The maximum slope of the bench shall be 10:1. The bench and other pond areas shallower than 12-inches shall be planted with a variety of aquatic and emergent plants. Aggressive colonizing species, excluding cattails, may be appropriate.

15) Landscaping

Wet and dry stormwater management ponds, including infiltration basins, shall be landscaped in a manner, which preserves the functional aspects of the facility while embracing the feature from an aesthetic standpoint. Such features shall not create an eyesore, but shall harmonize with other site and development features. Natural curvilinear designs with required plantings, as addressed herein, are to be utilized to soften the visual impact of the pond and create a park like setting.

a) A stormwater management pond buffer shall be created encompassing the land area surrounding the outside toe of slope for the pond. The buffer is to be at least 25 feet in depth and shall not contain any stormwater management devices with the exception of outfall structures and access drives for maintenance.

b) Within the buffer area planting shall be provided at a rate of one deciduous tree and one evergreen tree for every 50 linear feet of the outside buffer perimeter. For variety, woody shrubs may be substituted for up to 30% of the trees at a rate of 10 shrubs per tree. Deciduous trees may include trees of at least 2 1/2 inch caliper and smaller ornamental species appropriate to site conditions. The placement of the plant material shall be governed by site conditions and the nature of the facility to maximize public benefits.

c) Existing woodland should be retained around the pond and augmented with new material to provide buffering and reduce thermal pollution. The amount of new plant material provided may be reduced proportionate to the amount of perimeter woodland maintained.

d) No woody plants shall be planted on the dam embankment. Only herbaceous plants such as low maintenance ground covers and required stabilization grasses/legumes are permitted on the dam. Any trees or woody shrubs that are planted should be set back from the toe of the embankment a distance equal to the mature canopy of the tree (plant). Areas around pipes and structures must be kept clear of plantings. Species chosen for planting should be native to the Mid-Atlantic coastal plain and/or be well adapted to growing conditions on the site.

16) Pond Drain

If the design includes a permanent pool, a pond drain capable of draining the pond within a 24-hour time period shall be provided.

4. Water Quality Inlets (Oil-grit separators)

Oil-grit separators may be used if approved by the Department of PACE to enhance water quality from small commercial areas when more preferred water quality measures have been proven infeasible. Oil-grit separators are applicable in areas where heavy automobile traffic and/or parking lots contribute large loads of oil, grit and trash to runoff water. Oil-grit separators shall be located off-line to prevent the device from being flushed during heavy storms.

a. General Design Guidelines

1) Size the structure horizontally by computing the volume of storage need for the oil. Provide 200-cubic-feet of storage per acre of impervious parking area directed to the structure. The depth of the oil storage shall be a minimum of 3-feet measured from the normal pool surface down to the intake end of the 90-degree elbow pipe (see Standard Detail D/89). The minimum depth of grit storage shall be as shown on Standard Detail D/89.

2) The first two chambers are for storage and the third chamber is for controlling the discharge and does not contribute to the storage volume.

3) The minimum acceptable width of the chambers shall be as shown on Standard Detail D/89.

4) Oil storage volume should be calculated as the total length of the first and second chambers x width of chambers x length of drawdown pipe.

5) The minimum depth from the normal pool surface to the bottom of the structure shall be 4.5-feet.

6) Size the structure vertically by first establishing the inverts of the inflow and outflow pipes. The invert of the inflow pipe shall not be lower than the normal pool elevation. The invert of the outflow pipe should allow enough head to pass the 10-year storm discharge.

7) The trash rack protecting the orifices shall have an area three times the combined area of the orifices.

8) Determine the size of 90-degree elbow pipe that could pass the 10-year storm discharge through the structure allowing for 1-foot of freeboard.

9) Walls shall be constructed of cast-in-place or pre-cast concrete. Wall thickness shall be a minimum of 6-inches for the first 8'-0" of depth, 12-inches between 8'-0" and 12'-0" of depth and 16-inches for depths greater than 12'-0".

10) For cast-in-place structure, concrete shall have a 28-day strength of 4,000 psi. For pre-cast structures, concrete shall have a 28-day strength of 5,000 psi.

11) All pre-cast structures must have shop drawings approved prior to fabrication.

12) For details concerning throat openings, refer to Anne Arundel County standard inlets.

13) When inside width of structure is greater than 4'-0", reinforcing shall be revised as needed and structural computations must be provided.

14) When the structure is subject to traffic loading, reinforcing shall be designed for the appropriate traffic loads and manhole frames and covers shall be traffic bearing.

15) Manhole covers shall be provided with adequate locking device.

16) Silt and debris shall not be allowed to enter the structure until contributing drainage area has been permanently stabilized.

III. DRAWINGS AND DOCUMENTS

A. Reports

1. Stormwater Management Design Report

A design report signed and sealed by a licensed professional engineer registered in the State of Maryland shall be prepared and submitted presenting all supporting computations, including those for hydrology, hydraulics, and design of any stormwater management device. A subsurface investigation report, signed and sealed by a professional engineer registered in the State of Maryland, shall be submitted with the Stormwater Management Design Report. A downstream impact analysis, if required, shall be included in the report.

2. Outfall Statement

Accompanying the final design computations, the design engineer shall provide a written or computational analysis of the impact of the stormwater management device outfall on the receiving drainage course. This analysis will show the existing cross-section, slope, soil type, vegetation, and pre-developed and developed design flow velocities of the existing outfall channel or swale. A comparison of existing and ultimate flow quantities and velocities is to be provided. The design of energy dissipators (riprap outfall, stilling basins, or other devices) may be necessary to provide suitable, non-erosive outfall velocities.

3. Construction Completion Form

The Maryland Department of the Environment Stormwater Management Construction Completion Form shall be completed by the developer/builder and forwarded to the Department of PACE. The Construction Inspection Checklist (see Section D.1.C) shall be submitted with the Construction Completion Form.

B. Subsurface Investigation

1. Number of Borings

A minimum of two "representative" borings, within the limits of the device per infiltration device, shall be taken. For devices using more than 10,000 square feet of infiltration area, one additional boring, per 10,000 square feet of area, shall be taken, at equally spaced locations on the device. Maximum spacing of 150' between borings shall be provided throughout the area of the infiltration device.

2. Boring Depth

   The minimum boring depth shall be five feet below the invert of the proposed device. Except for single lot development, boring logs shall be sufficiently clear to show suitable soils layers.

3. Boring Information

   Boring data shall include the following information, determined and certified by a professional engineer registered in the State of Maryland:

   - Unified soil classification for each strata
   - Groundwater elevation
   - U.S.D.A. soil textural classification

4. Percolation Tests

   The Department of PACE will accept a passing percolation test in lieu of boring information in the area of the infiltration device, for single lot building permits, if the following requirements are met:

   Percolation tests must be taken during the "wet season" in areas designated by the Health Department.

   A description of the soil strata shall be provided in accordance with the Unified System Classification of Soils.

   The depth of the percolation test shall be two feet below the invert of the proposed device.

   The results of any percolation test not performed by the Health Department shall be certified by a professional engineer registered in the State of Maryland.

5. Subsurface Investigation Report

   Information obtained as a result of the subsurface investigation shall be shown on the Construction Plans. A subsurface investigation report, including a recommendation on the adequacy of the subsurface soils for stormwater infiltration shall be included with the Design Computation Booklet. The subsurface investigation report shall be signed and sealed by a professional engineer registered in the State of Maryland.

C. Design Methods

1. Hydrologic Modeling Methods

A hydrologic model of the entire drainage area contributing runoff to any proposed device or design point shall be prepared by one of the methods described below.

a. Natural Resources Conservation Service TR-55

The runoff computational methods, as described in Technical Release No. 55 (TR55), "Urban Hydrology for Small Watersheds," (1986 revision or later) shall be used to model small drainage areas, generally less than 400 acres. Computerized versions of this method may be used with the prior approval of the Department of PACE.

b. Natural Resources Conservation Service TR-20

The NRCS Technical Release No. 20 (TR-20), "Computer Program for Project Formulation-Hydrology", should be used to model drainage areas when any of the following conditions exist:

1) There are several subareas with heterogeneous land-use characteristics.

2) There is a need to model the routing hydrographs through stream reaches and reservoirs.

3) There is a need for historical storm analysis.

c. Other Models

Other modeling methods may be used with the prior approval of the Department of PACE. PACE may request that the design engineer submit calculations using benchmark data provided by PACE. Approval of the computer program will be subject to successful completion of the benchmark tests.

2. Conditions to be Modeled

Pre-development runoff conditions shall be calculated according to land use at the time of submittal or the predominant land covering during the previous five years, whichever results in the lower curve number. This information may be obtained from field investigations, aerial photographs, topographic maps, or other sources.

Proposed runoff conditions (after development) shall be calculated according to ultimate development as zoned, except where it can be shown that actual future runoff conditions would differ from ultimate zoning conditions.

3. Input Parameters

   a. Drainage Areas

      The boundaries of the entire drainage area and sub-areas shall be shown on a topographic map of appropriate scale. Sub-areas shall be homogeneous in runoff characteristics.

   b. Soils

      The Soil Survey of Anne Arundel County, Maryland (1:20,000 scale) shall be used to determine soil types within the drainage area. The current version of the Water Features Table for Anne Arundel County from the Natural Resources Conservation Service Field Office Tech. Guide (see Appendix M), shall be used to classify the soils into hydrologic soil groups A, B, C, and D. Copies of the most current version of the Water Features Table may be obtained from the Anne Arundel Soil Conservation District Office upon request.

      On sites where substantial grading (cuts and fills greater than two feet) will occur, the soil classifications shall be adjusted as follows:

Existing Soil Group	Post Grading Soil Group
A	B
B	C
C	C
D	D

      The adjustment for large off-site graded areas may be no larger than 50 percent based on zoning, grading and probable land use.

      The above classifications may be modified if the Engineer can substantiate that field conditions are different from those obtained by the above method.

      A map showing the soil groups and the drainage area and sub-area boundaries shall be included in the storm water management design report.

   c. Land Uses

      Existing and ultimate land uses shall be determined as described above. For each condition, a map shall be included showing land uses and the drainage area and sub-area boundaries.

   d. Runoff Curve Number (RCN)

      The runoff curve number for each sub-area shall be calculated as in TR-55. Good hydrologic condition should be assumed unless field conditions indicate otherwise. Refer to Appendix B and Appendix C for RCN values.

e. Time of Concentration

The methods described in the latest version of TR-55 shall be used to compute time of concentration in each sub-area. The maximum length of overland flow shall be 200 feet.

f. Reach Routing

Reach routing shall be computed in accordance with procedures found in the latest TR-20 manual. Rating curves for representative cross-sections shall be derived using Manning's Equation for normal depth, or backwater computations from HEC-2.

g. Structure Routing

The TR-20 storage-indication routing shall be used for structure routing. Provide a schematic diagram for the TR-20 run. A sketch of the device's controls shall be included in the design computations with performance curves plotted.

h. Rainfall

The following rainfall depths shall be used in hydrologic computations:

Frequency	24 Hour - Type II Storm Rainfall
1 year	2.7”
2 year	3.3”
5 year	4.3”
10 year	5.2”
25 year	5.9”
50 year	6.5”
100 year	7.4”

Free Board Hydrograph Storm (NRCS National Engineering Handbook)

Antecedent Moisture Condition (AMC) II and the NRCS Type II Rainfall Distribution shall be used for all design analysis.

D. Construction Drawings

1. Stormwater Management Plans

a. Review Submittals

The owner shall make the following submittals to PACE for review:

1) Conceptual and schematic stormwater management plans (or preliminary stormwater management plans if exempt from submitting conceptual stormwater management plans), for proposed on-site and off-site stormwater management controls. Plans, specifications, and computations for stormwater management facilities that are submitted for review by the Department of PACE shall be sealed and signed by a licensed professional engineer registered in the State of Maryland.

2) Final stormwater management plans, specifications, computations and supporting data which provide sufficient information to evaluate the effectiveness and acceptability of measures proposed, for managing stormwater runoff. If the design is for a major subdivision, the final submittal major subdivision checklist (Appendix K) shall also be submitted. Both the stormwater management/structural data sheet (Appendix I) and the storm drain outfall data sheet (Appendix J) are to be submitted as part of the grading permit application.

b. Stormwater Management Plans

1) Stormwater management plans shall be prepared separately from any other design drawings to allow for record keeping and filing purposes. The minimum information to be submitted for support of a stormwater management plan is:

a) Topography showing existing and proposed contours, including area necessary to determine downstream analysis for proposed stormwater management facility;

b) Soils investigation including borings or percolation tests for construction of small ponds and borings or test pits for infiltration practices;

c) Location of all watercourses, impoundments and wetlands on, or adjacent to, the site or into which stormwater flows;

d) Delineation of 100-year flood plains, if applicable;

e) Structure classification (NRCS Pond Standard MD378, current version);

f) Dam Breach Analysis if required. The following flood routing procedures may be used:

- DAMBRK - The NWS Dam-Break Flood Forecasting Model, The Hydrologic Engineering Center, U.S. Army Corps of Engineers, February, 1984.

- HEC-1 Flood Hydrograph Package, Computer Program 723-X6-L2010, The Hydrologic Engineering Center, U.S. Army Corps of Engineers, September 1981 (Revised January, 1985).
- Natural Resource Conservation Service Technical Release No. 66, Simplified Dam-Breach Routing Procedure (Revised December, 1981.)

g) Critical Area Boundary

h) Design Computation Booklet

All Engineering calculations shall be signed and sealed by a professional engineer registered in the State of Maryland and shall be submitted on bound 8-1/2" x 11" sheets. All supporting maps shall be folded in a pocket and color coded as required for clarity. Calculations that are to be included in the Design Computation Booklet include:

- Hydrology;
- Hydraulic;
- Structural; and
- Subsurface investigation report

2) In addition to the information listed above, stormwater management plans must include:

a) vicinity map;

b) drainage area map showing the watershed boundaries, drainage area, and stormwater flow paths;

c) proposed improvements, including location of buildings or other structure, impervious surfaces, and storm drainage facilities.

d) location of utilities;

e) structural details for all components for the proposed stormwater management facilities;

f) sequence of development clearing, including stripping, rough grading, construction, final grading, and vegetative stabilization;

g) maintenance schedule including the maintenance to be performed, the time period for completion and the party who will perform the maintenance;

h) location of easements;

i) certifications;

j) label the proposed stormwater management facilities public or private; and

c. As-Built Plans

1) As-built plans shall be submitted, by the owner, indicating any field deviations from the approved construction drawings. The most current approved grading permit plans shall be redlined to reflect the as-built information for the project. The certifying engineer must sign, seal and date the as-builts along with the owner's certification. Three sets are to be submitted to PACE Environmental Programs.

2) The certifying engineer shall submit the appropriate completed Construction Inspection Checklist included in Appendix L. Where the construction inspection checklist is not appropriate for the stormwater management device, PACE will determine what certifications will be required.

3) If the stormwater management device is a registered MD378 pond, two sets of interim as-builts that meet the conditions of the Small Pond Letter must be submitted to PACE within 30 days of completion of the principle spillway, outfall, and embankment. Supporting geotechnical reports, compaction tests, concrete testing reports, etc., must be submitted with these interim as-builts. These interim as-builts are for pond information only and will be forwarded to the Anne Arundel Soil Conservation District for review for compliance with the current MD378.

At the end of construction, as-builts will be submitted that reflect all as built grading and stormwater management information, signatures and certifications as in item 1 and 2.

E. Inspection of Facilities

The owner shall procure the services of a registered professional engineer to inspect each stormwater management facility during construction, as stated below. The inspection schedule and appropriate inspection checklist shall appear on the plans. The engineer must inspect the construction of the facility so that the key elements of construction as indicated on the Construction Inspection Checklist can be certified. The Department of PACE will inspect the stormwater management facility during construction and during the first year of operation and at least once every three years thereafter.

1. Infiltration Trench and Drywell Inspection Schedule

   Inspection of infiltration facility construction shall take place, as a minimum, at the following stages:

   a. Completion of subgrade excavation and geotextile placement.

   b. Installation of observation well and surface inlet.

   c. Installation of distribution pipes.

   d. Upon completion of final grading and establishment of permanent stabilization.

2. Flow Attenuation Devices Inspection Schedule

   Flow attenuation devices such as open vegetated swales, shall be inspected at the following stages:

   a. Completion of subgrade excavation.

   b. Installation of distribution pipes.

   c. Installation of underdrain, if required.

   d. Upon completion of final grading and establishment of permanent stabilization.

3. Retention and Detention and Infiltration Basin Inspection Schedule

   a. Detention and retention structures and infiltration basins shall be inspected upon completion of excavation to subfoundation and upon installation of structural supports or reinforcement for structures, including but not limited to:

      1) Cut-off trenches for structural embankments.

      2) Inlet-outlet structures, seepage control structures and watertight connectors on pipes.

      3) Trenches for enclosed storm drainage facilities.

   b. Inspection shall be made during placement of structural fill, concrete, and installation of piping and catch basins.

   c. Inspection shall be made during backfill of foundations and trenches.

   d. Inspection shall be made during embankment construction.

e. Inspection shall be made upon completion of final grading and establishment of permanent stabilization.

4. Oil-Grit Separator Inspection Schedule

   Inspection of oil-grit separator construction shall take place, as a minimum, at the following stages:

   a. Completion of subgrade excavation.

   b. Footings formed and steel set prior to concrete pouring.

   c. Structure sides formed and steel set prior to concrete pouring.

   d. Prior to top slab and manholes being set after all debris and soil in structure have been removed.

   e. When site has been permanently stabilized and sediment control measures to protect the structure are to be removed.

5. County Inspection

   No work shall proceed until a PACE inspector inspects and approves the work previously completed.

6. Correction of Deficient Work

   Any portion of the work which does not comply with the stormwater management facility plans and specifications approved by the Department of PACE shall be promptly corrected by the owner after written notice from PACE. The notice shall set forth the nature of corrections required and the time within which corrections shall be made.

7. Start of Work Notification

   The owner shall notify the Department of PACE by telephone 48-hours before commencing any work in conjunction with the stormwater management plan to schedule a pre-construction meeting. PACE shall also be notified upon completion of the work when a final inspection will be conducted.

8. Final Inspection

   Upon completion of construction of a stormwater management facility, the PACE inspector shall perform a final inspection to determine if the work is constructed in accordance with the approved plans. As-built drawings, certification letters and construction inspection checklists, shall be submitted and approved by the Department of PACE prior to final acceptance and within 30 days of completion

of the facility. Prior to final acceptance of the facility all outstanding items must be completed.

9. Stop Work Order

Upon notice from the Department of PACE that any work or activity at a property is being undertaken in an unsafe and dangerous manner or contrary to the requirements of the County Stormwater Management Ordinance, that work or activity shall immediately cease. It is a violation of the Stormwater Management Ordinance for any person to work at a property after a stop work order has been served, except for work required to be undertaken by the order.

F. Security

1. Public Stormwater Management Devices

a. Grading Permit Security

The construction of any stormwater management device must be secured under grading permit in accordance with Section 2-209 of the County grading ordinance. The security shall be in an amount of $200 plus $0.10 for each square foot of total site disturbance.

1) A performance bond executed by the owner and a corporate surety authorized to do business in the State as a security

2) A cash deposit, certified check or cashier's check from a local bank or other local accredited institution

3) An irrevocable letter of credit approved by the Controller and acceptable to the County Attorney

The County shall apply the proceeds of a forfeited construction security to completion of the required device and placing the site in an environmentally secure condition. In the event that the proceeds exceed the costs of completion, including engineering, inspection, overhead, and other administrative costs, including attorneys' fees, the excess funds shall be returned.

The grading permit security may not be returned until:

1) As-built plans have been submitted and approved;

2) A certification has been submitted by the Developer and a registered professional engineer that the construction and required testing for the stormwater management facilities have been completed and comply with the approved plans and the Stormwater Management Ordinance; and

3) For sensitive area permits, a post sensitive area study is submitted and approved.

4) The site has passed a final inspection by the DPW Inspector.

2. Public Storm Drains

a. Performance (Completion) Security

The construction of public storm drains is to be secured by a bond, irrevocable letter of credit, certified check, cash deposit or certificate of deposit as part of a properly executed public works agreement executed through the Department of PACE. Security shall be in an amount equal to the estimated cost of construction and incidental costs to cover processing, administration and inflation over the period of construction. The security shall be in a form acceptable to the Office of Law and the Financial Officer, and if provided in a form other than cash from a bonding company or financial institution acceptable to the Financial Officer. The County shall apply the proceeds of a forfeited construction security to completion of the required stormwater management facility. In the event that the proceeds exceed the costs of completion, which shall include the County's cost for engineering, inspection, overhead, and other administrative costs, including attorneys' fees, the excess funds shall be returned.

The performance security may not be returned until:

1) As-built plans are submitted and approved

2) The maintenance security required in the Public Works Agreement is posted

3) The work passes a final inspection by the DPW inspector

4) Monuments and markers are set, certified by the engineer and verified by DPW

5) The developer certifies in writing that in accordance with contractual arrangements, all contractors, subcontractors, and suppliers have been paid

b. Labor and Materials Security

In addition to the performance security, the developer shall provide a security payable to the County that meets the requirements of Section 17-104 of the State Finance and Procurement Article of the State Code in an amount equal to 50 percent of the performance security. Contractors, subcontractors and suppliers have the right to bring claim on the payment security provided by the developer as if they were bringing claim under Title 17, Subtitle 1 of the State Finance and Procurement Article of the State Code. The Labor and

Materials security shall be returned along with the performance security when all applicable conditions are satisfied.

3. Private Stormwater Management Devices and Storm Drains

   a. Grading Permit Security

   The construction of private stormwater management devices and storm drains must be secured under a grading permit in accordance with Section 2-209 of the County Grading Ordinance. The security shall be in an amount of $200 plus $0.10 for each square foot of total site disturbance plus the estimated cost of the stormwater management devices and storm drains. The security shall meet the following criteria:

   1) A performance bond executed by the owner and a corporate surety authorized to do business in the State as a security

   2) A cash deposit, certified check or cashier's check from a local bank or other local accredited institution

   3) An irrevocable letter of credit approved by the Controller and acceptable to the County Attorney

   The County shall apply the proceeds of a forfeited grading permit security to completion of the required device and placing the site in an environmentally secure condition. In the event the proceeds exceed the costs of completion, including engineering, inspection, overhead and other administrative costs, the excess funds will be returned.

   The grading permit security shall not be returned until:

   1) As-built plans are submitted and approved

   2) A certification has been submitted by the Developer and a registered professional engineer that the construction and required testing for the stormwater management facilities have been completed and comply with the approved plans and the Stormwater Management Ordinance; and

   3) For sensitive area permits, a post sensitive area study is submitted and approved

   4) The site has passed a final inspection by the PACE inspector

G. Public Works Agreement Inspection Fees

General inspection fees in the amount of six percent of construction cost, shall be deposited with the County as required in the public works agreement. The inspection fees are to be based on the construction cost of all public improvements including

stormwater management devices and storm drains. After completion of the work, additional County costs incurred in the course of completing the work over and above the estimate, including County costs for engineering, inspection, overhead, and other administrative costs, shall be paid by the developer or, in the case of a performance bond, by the surety within 30 days after demand by the County for the additional amount.

H. Private Inspection and Maintenance Agreement

Prior to the issuance of any building permit or grading permit for property, which has a private stormwater management facility, the applicant or the applicant and the owner of the property, if other than the applicant, shall execute an inspection and maintenance agreement with the County, which shall:

1. Provide that the applicant shall be responsible for installation of the stormwater management facilities in accordance with the Stormwater Management Ordinance.

2. Bind all subsequent owners of the property served by the on-site stormwater management facility to the agreement.

3. Provide for access to the facility at reasonable times for inspection by the County or its agents or contractor. Provide for regular or special assessments to insure that the facility is properly maintained in accordance with its design standards.

4. Be recorded among the Land Records of Anne Arundel County.

5. Provide that if the applicant and the owner of the property, if other than the applicant, after reasonable notice by the Department of PACE, fails to correct a violation of the Stormwater Management Ordinance, the Department of Public Works may perform the necessary work to correct the violation and return the facility to a proper working condition.

6. Provide that the cost of work performed by the Department of Public Works shall be levied and collected from the owner of the property, in the same manner as County real property taxes are levied and collected, and shall have the same priority, bear the same interest and penalties, and in every respect be treated as County real property taxes.

I. Specifications

The following construction specifications shall be used for the construction of stormwater management facilities:

"Anne Arundel County Standard Specifications for Construction". Maryland Water Resources Administration, "Standards and Specifications for Infiltration Practices".

J. Maintenance Inspection Reports

Maintenance inspection reports shall be maintained by Anne Arundel County in accordance with the current Maryland 378 Small Pond Inspection form and the Stormwater Management Ordinance on all stormwater management structures and shall include the following:

1. The date of inspection;

2. Name of inspector;

3. The condition of:

   a. vegetation
   b. fences
   c. spillways
   d. embankments
   e. reservoir area
   f. outlet channels
   g. underground drainage
   h. sediment load
   i. Any other item that could affect the proper function of the stormwater management system;

4. Description of required maintenance.

IV. APPENDICES

A. References

B. NRCS Runoff Curve Numbers - "RCN".

C. NRCS Runoff Curve Numbers by Zoning Classifications.

D. Watershed Area and Soil Permeability Restrictions for BMPs.

E. Restrictions on BMPs.

F. Comparative Stormwater Benefit Provided By Urban BMPs.

G. Comparative Pollutant Removal of Urban BMP Designs.

H. Environmental and Community Amenities Provided by BMPs.

I. Stormwater Management/Structural Data Sheet

J. Storm Drain Outfall Data Sheet

K. Final Submittal Major Subdivision Checklist

L. Construction Inspection Checklists.

M. Water Features Table For Anne Arundel County

APPENDIX A

REFERENCES

1. Maryland Association of Soil Conservation Districts, College Park, Maryland, Stormwater Management Pond Design Manual, June 1975.

2. Maryland Department of the Environment, Water Management Administration, 2500 Broening Highway, Building 30, 1st Floor, Baltimore, Maryland 21224.

   a. Standards and Specifications for Infiltration Practices, February 1984.

   b. 1991 Maryland Standards and Specifications for Soil Erosion and Sediment Control, 1991.

3. Maryland Department of Transportation, State Highway Administration, 707 North Calvert Street, Baltimore, Maryland 21202, Highway Drainage Manual, December 1981.

4. Metropolitan Washington Council of Governments, Department of Environmental Programs, 777 North Capital Street, N.E., Suite 300, Washington, D.C. 20002-4226, Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMP's, July 1987.

5. U.S. Department of Agriculture, Natural Resources Conservation Service, P.O. Box 2890, Washington, D.C. 20013:

   a. Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds, June 1986.

   b. Technical Release 20 (TR-20), Project Formulation - Hydrology, May 1983.

   c. Technical Release 60 (TR-60), Earth Dams and Reservoirs

   d. National Engineering Handbook, Section 4, Hydrology, (NEH-4), August 1972

6. Chesapeake Bay Critical Area Commission and the Department of Environmental Programs, Metropolitan Washington Council of Governments, Urban Stormwater Quality Guidance for the Maryland Chesapeake Bay Critical Area (Applicants Guide, Technical Guide, Plan Reviewers Guide), May 1993

APPENDIX B

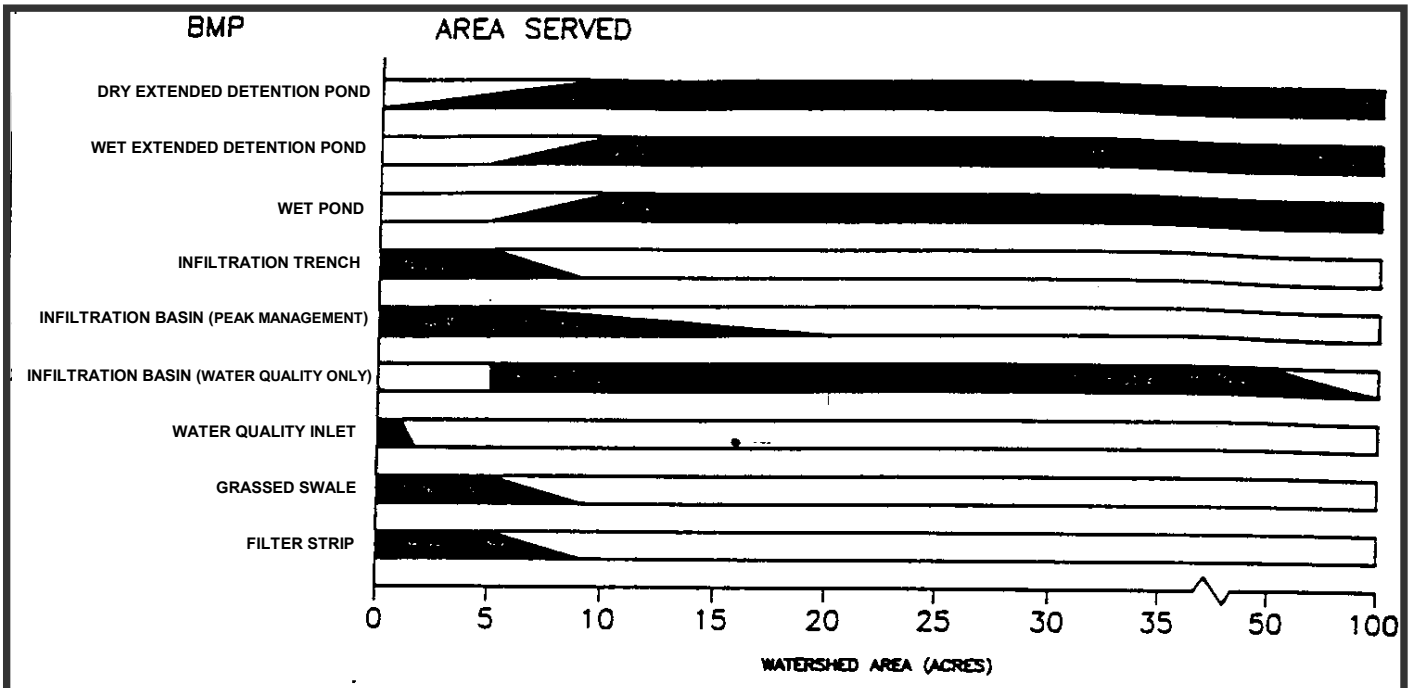
NRCS RUNOFF CURVE NUMBERS – "RCN"

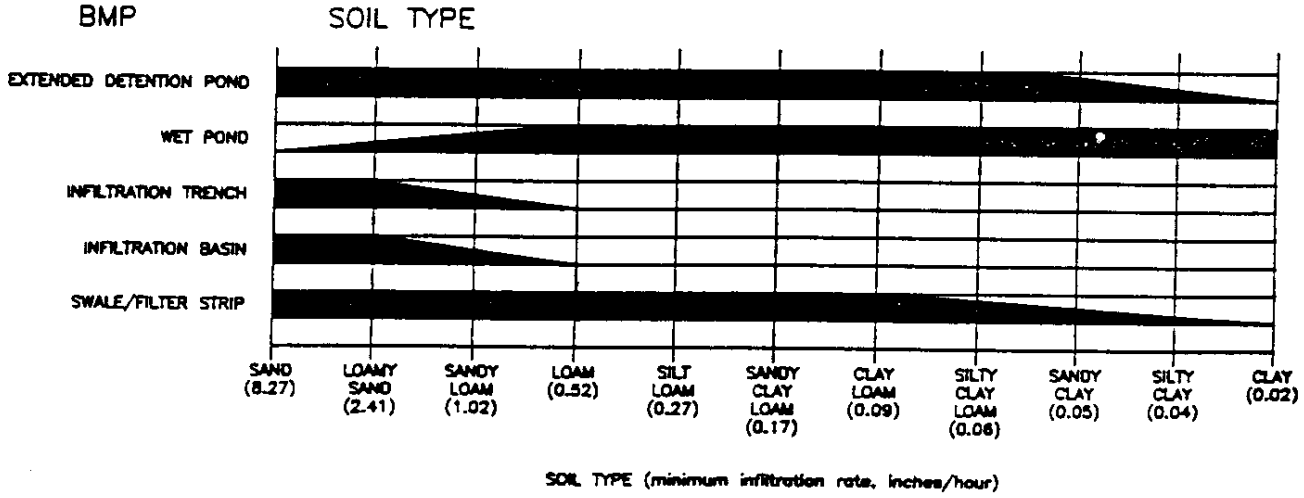
LAND DESCRIPTION	HYDROLOGICAL SOIL GROUP			
	A	B	C	D
Surface				
Pavement (Bituminous and Concrete)	98	98	98	98
Roofs	98	98	98	98
Water	100	100	100	100
Gravel Roads	76	85	89	91
Undeveloped Land				
Wooded:				
Poor - No mulch, small trees or brush	45	66	77	83
Fair - Grazed, some mulch	36	60	73	79
Good - Protected from grazing, Heavy mulch and shrubs cover soil	25	55	70	77
Pasture: (Native or improved grassland reserved for grazing)				
Poor - Heavily grazed, Plant cover on less than 50% of area	68	79	86	89
Fair - Not heavily grazed, Plant cover on 50% to 75% of area	49	69	79	84
Good - Lightly grazed, Plant cover on more than 75% of area	39	61	74	80
Meadow: (Grass grown for hay crop)	30	58	71	78
Cultivated				
Fallow: (Plowed, no crop planted etc.)	77	86	91	94
Row Crop: (Corn, soybeans, tomatoes, spaced about 3-1/2" apart)	72	81	88	91
Small Grain: (Wheat, oats, barley, etc.)	65	76	84	88

APPENDIX C

NRCS RUNOFF CURVE NUMBERS BY ZONING CLASSIFICATION

	HYDROLOGICAL SOIL GROUP			
	A	**B**	**C**	**D**
Developed Land Commercial - All C Zones	89	92	94	95
Industrial - W2 and W3 Zones	81	88	91	94
Industrial Parks - W1 Zone	80	85	90	93
Apartments/High Density Residential R44, R22, and R15 Zones	80	85	90	93
Single Family - R10 and R5 Zones	69	80	87	90
Single Family - R2 Zone	54	70	80	85
Single Family - R1 Zone	51	68	79	84
Single Family - RLD Zone	47	66	77	81
Single Family Agricultural - RA Zone	Use Undeveloped Land			



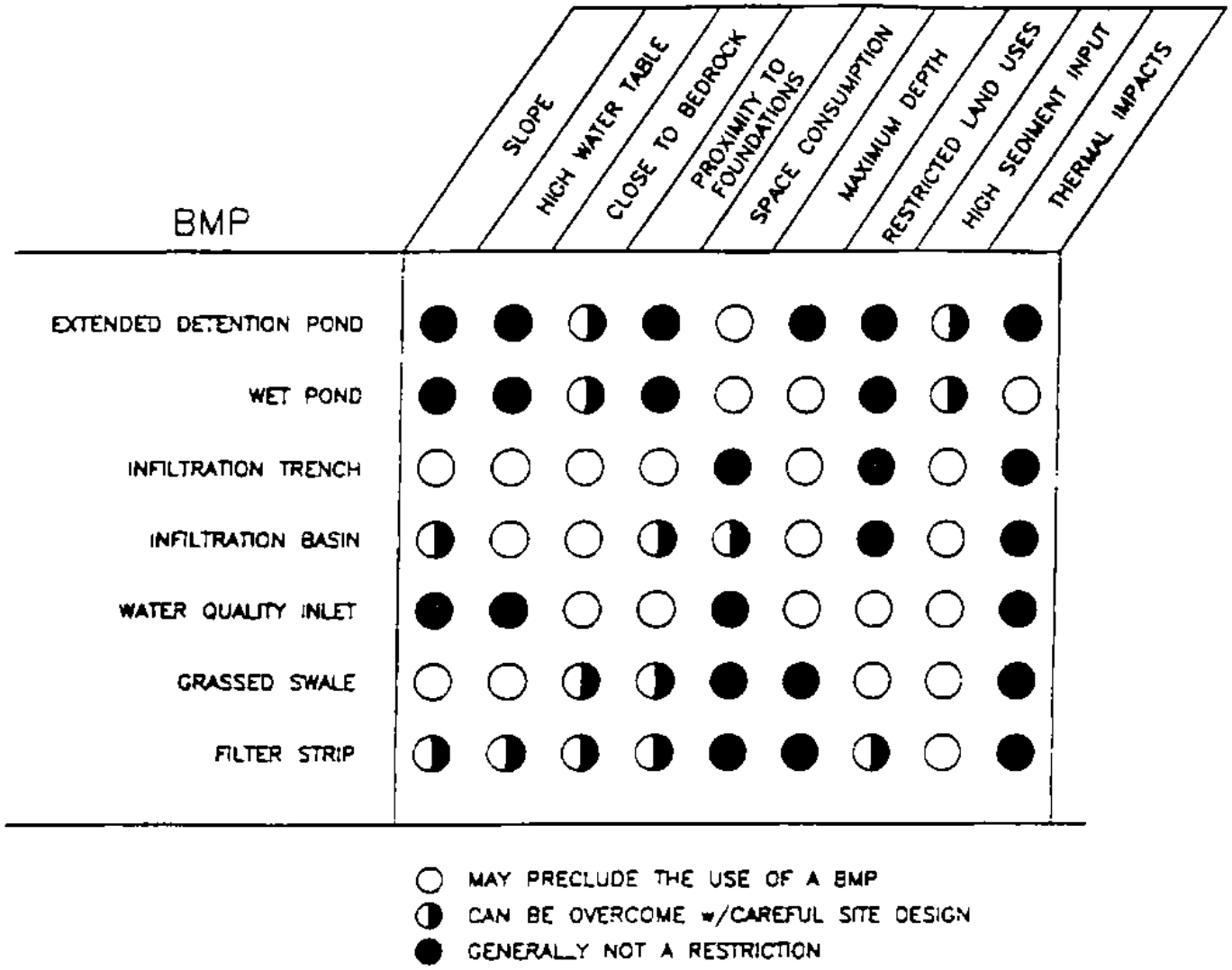


STORMWATER MANAGEMENT

WATERSHED AREA AND SOIL PERMEABILITY RESTRICTIONS FOR BMPs

REF: CONTROLLING URBAN RUNOFF, WASH COG

APPENDIX D

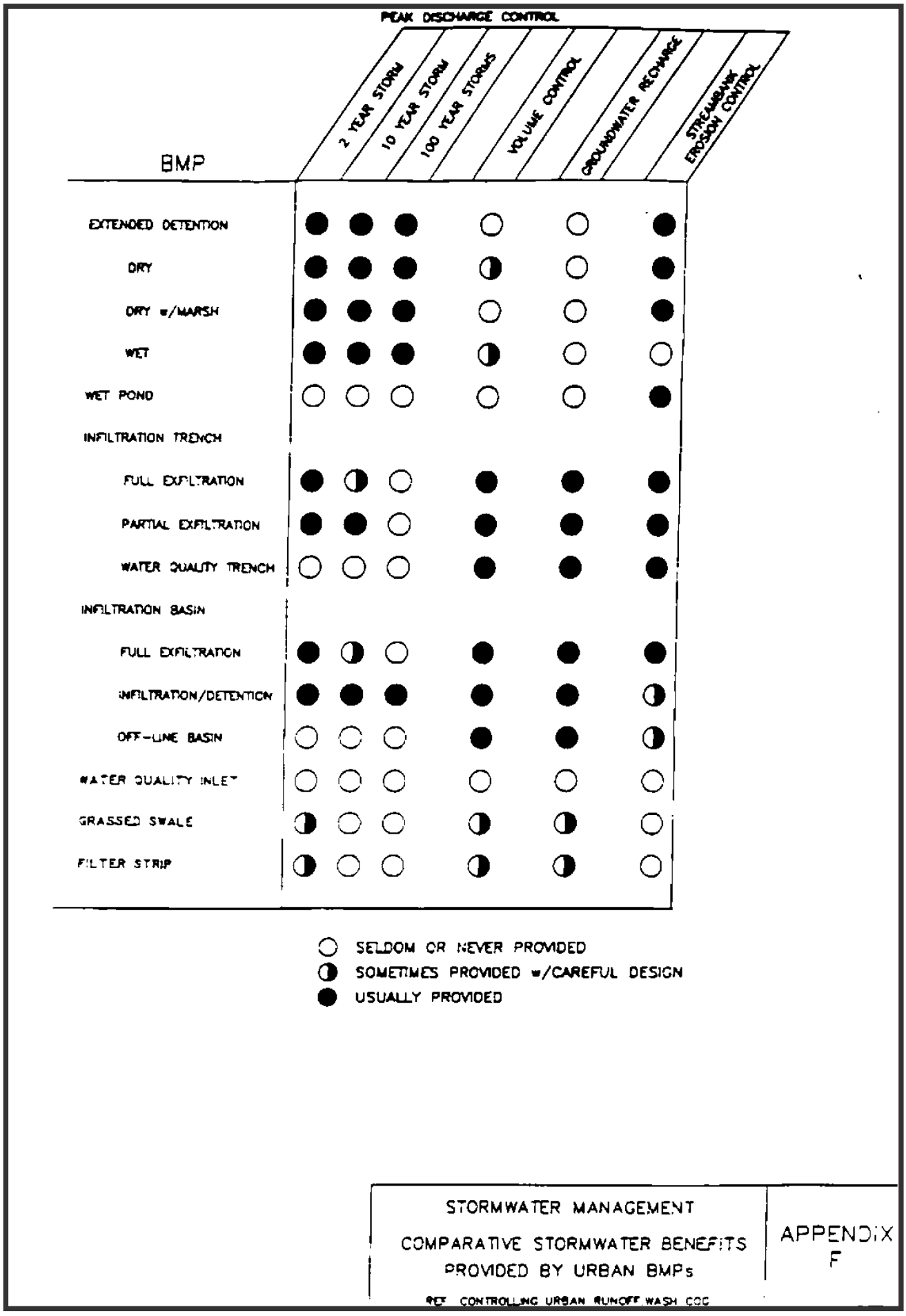


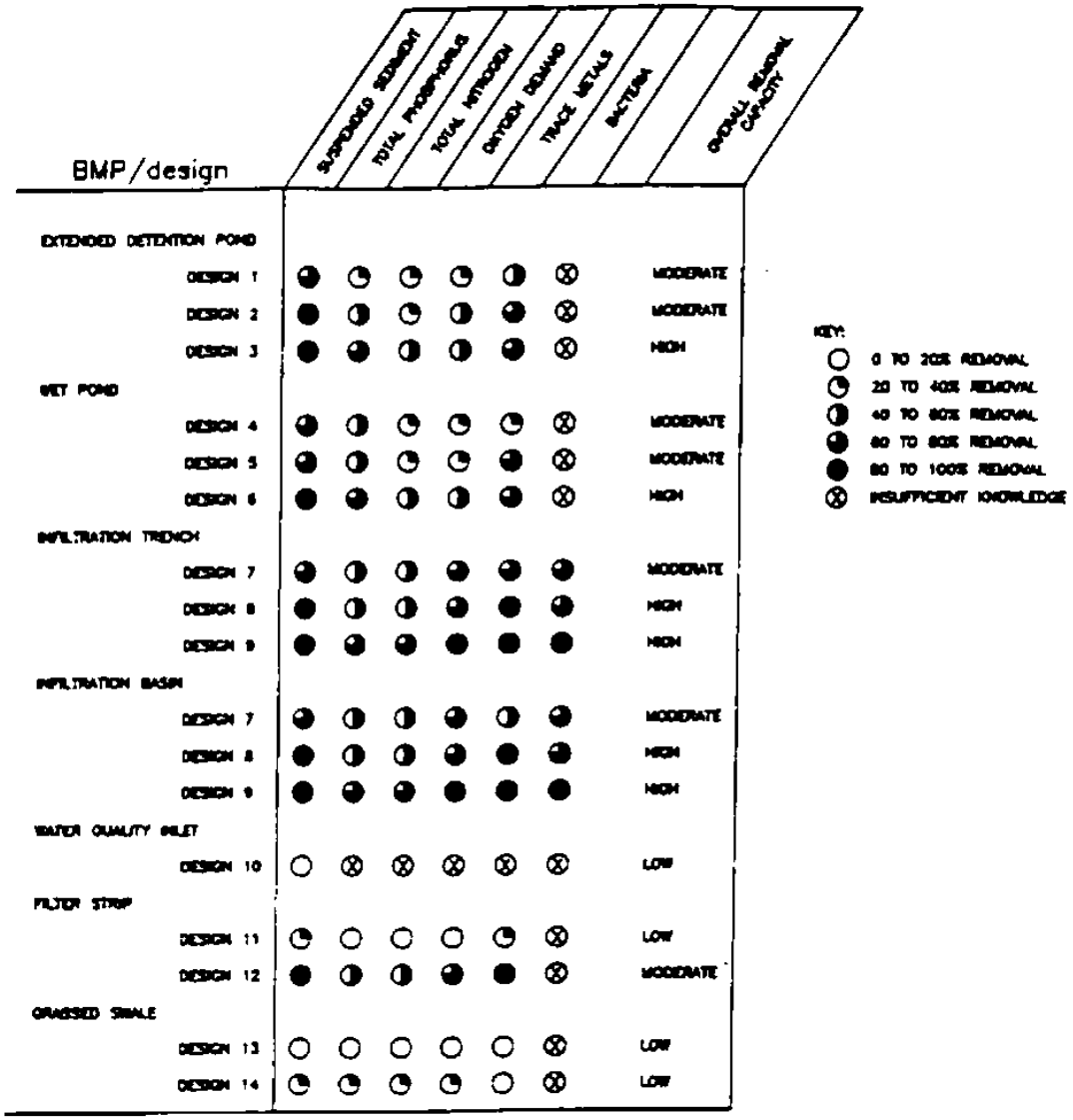
STORMWATER MANAGEMENT

RESTRICTIONS ON BMPs

APPENDIX E

REF: CONTROLLING URBAN RUNOFF, WASH. COG


PEAK DISCHARGE CONTROL
2 YEAR STORM
10 YEAR STORM
100 YEAR STORMS
VOLUME CONTROL
GROUNDWATER RECHARGE
STREAMBANK EROSION CONTROL
BMP
EXTENDED DETENTION
DRY
DRY w/MARSH
WET
WET POND
INFILTRATION TRENCH
FULL EXFILTRATION
PARTIAL EXFILTRATION
WATER QUALITY TRENCH
INFILTRATION BASIN
FULL EXFILTRATION
INFILTRATION/DETENTION
OFF-LINE BASIN
WATER QUALITY INLET
GRASSED SWALE
FILTER STRIP
SELDOM OR NEVER PROVIDED
SOMETIMES PROVIDED w/CAREFUL DESIGN
USUALLY PROVIDED
STORMWATER MANAGEMENT
COMPARATIVE STORMWATER BENEFITS PROVIDED BY URBAN BMPs
REF CONTROLLING URBAN RUNOFF WASH COG
APPENDIX F



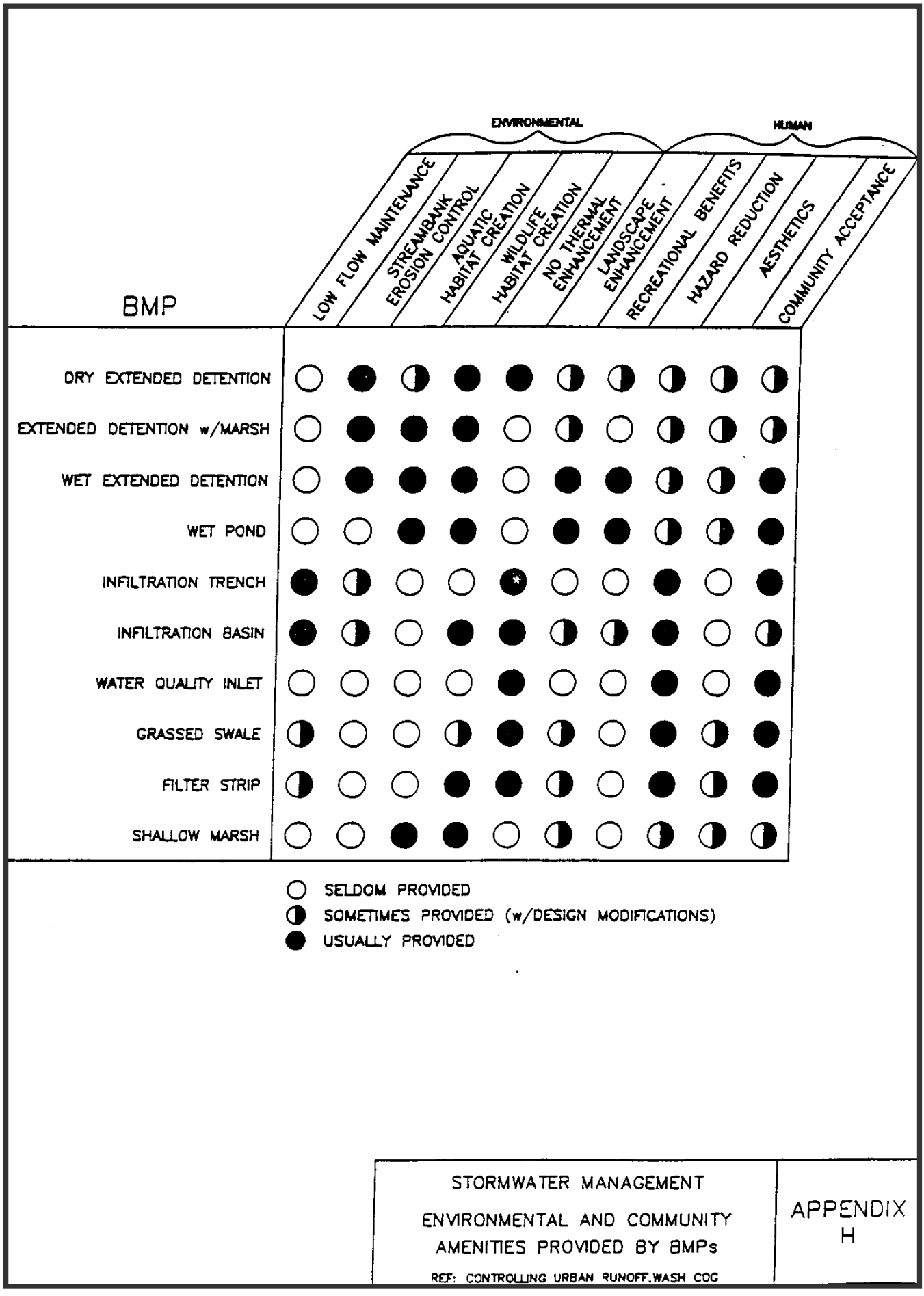
Design 1: First-flush runoff volume detained for 6-12 hours.
Design 2: Runoff volume produced by 1.0 inch, detained 24 hours.
Design 3: As in Design 2, but with shallow marsh in bottom stage.
Design 4: Permanent pool equal to 0.5 inch storage per impervious acre.
Design 5: Permanent pool equal to 2.5 (Vr); where Vr=mean storm runoff.
Design 6: Permanent pool equal to 4.0 (Vr); approx. 2 weeks retention.
Design 7: Facility exfiltrates first-flush; 0.5 inch runoff/imper. acre.
Design 8: Facility exfiltrates one inch runoff volume per imper. acre.
Design 9: Facility exfiltrates all runoff, up to the 2 year design storm.
Design 10: 400 cubic feet wet storage per impervious acre.
Design 11: 20 foot wide turf strip.
Design 12: 100 foot wide forested strip, with level spreader.
Design 13: High slope swales, with no check dams.
Design 14: Low gradient swales with check dams.

STORMWATER MANAGEMENT

COMPARATIVE POLLUTANT REMOVAL OF URBAN BMP DESIGNS

REF: CONTROLLING URBAN RUNOFF WASH COG

APPENDIX G


ENVIRONMENTAL
HUMAN
BMP
LOW FLOW MAINTENANCE
STREAMBANK EROSION CONTROL
AQUATIC HABITAT CREATION
WILDLIFE HABITAT CREATION
NO THERMAL ENHANCEMENT
LANDSCAPE ENHANCEMENT
RECREATIONAL BENEFITS
HAZARD REDUCTION
AESTHETICS
COMMUNITY ACCEPTANCE
DRY EXTENDED DETENTION
EXTENDED DETENTION w/MARSH
WET EXTENDED DETENTION
WET POND
INFILTRATION TRENCH
INFILTRATION BASIN
WATER QUALITY INLET
GRASSED SWALE
FILTER STRIP
SHALLOW MARSH
SELDOM PROVIDED
SOMETIMES PROVIDED (w/DESIGN MODIFICATIONS)
USUALLY PROVIDED
STORMWATER MANAGEMENT
ENVIRONMENTAL AND COMMUNITY AMENITIES PROVIDED BY BMPs
REF: CONTROLLING URBAN RUNOFF, WASH COG
APPENDIX H

ANNE ARUNDEL COUNTY DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
ENVIRONMENTAL PROGRAMS
STORMWATER MANAGEMENT/STRUCTURAL DATA SHEET

Date: _____
Design Professional: _____
Grading Permit: _____

A. To be completed by County:

1. Watershed Name _____
2. Watershed Number _____
3. Structure Number _____ • _____
4. Is this a Major Outfall? (Y/N) _____
5. Storm Drain Operating Map Number _____
6. County 1"=600' Topographic/Tax Map Number _____

B. To be completed by Design Professional:

7. Coordinates (State Grid) N _____
   E _____
8. ADC Map Book Reference _____
9. Address _____
10. Subdivision/Project Name _____
11. Outfall Dimensions (in.) _____
12. Distance from outfall to stream (ft.) _____
13. Zoning Category _____
14. Specific Land Use _____
15. Drainage Area (Acres) _____ • _____
16. Runoff Curve Number _____
17. Device Type _____

Published: 01/01 Revised:

ANNE ARUNDEL COUNTY DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
ENVIRONMENTAL PROGRAMS
STORM DRAIN OUTFALL DATA SHEET

Date: _____
Design Professional: _____
Grading Permit: _____

A. To be completed by County:

1. Watershed Name _____
2. Watershed Number _____
3. Outfall Number _____ • _____
4. Is this a Major Outfall? (Y/N) _____
5. Storm Drain Operating Map Number _____
6. County 1"=600' Topographic/Tax Map Number _____

B. To be completed by Design Professional:

7. Coordinates (State Grid) N _____
   E _____
8. ADC Map Book Reference _____
9. Address _____
10. Subdivision/Project Name _____
11. Outfall Dimensions (in.) _____
12. Outfall Cross-section Area ($ft.^2$) _____
13. Outfall Shape _____
    Round (R) Oval (O) Box (B) V-ditch (VD) Trapezoidal Ditch (TD) Other Ditch (OD)
14. Outfall Type _____
    CMP (CMP) RCP (RCP) PVC (PVC) Other (O)
15. Distance from outfall to stream (ft.) _____
16. Zoning Category _____
17. Specific Land Use _____
18. Drainage Area (Acres) _____ • _____

APPENDIX K

DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
SUBDIVISION APPLICATION CENTER
SUBMITTAL CHECKLIST

Final Submittal Major Subdivision

Project Name _____

Subdivision Number _____

Location (Street Address) _____

Name and Address of Engineering Firm:

_____
_____
_____
_____
_____

Tax Map: _____
Parcel _____
200 Scale Topo Map _____
Road Index Map _____
Page No ____ Coordinates: _____

Contact Person: _____

Telephone Number: _____

Name and Address of Developer:

_____
_____
_____
_____
_____

Contact Person: _____

Telephone Number: _____

I hereby certify that I have personally reviewed the materials submitted with this checklist and to the best of my ability have insured that the submittal is complete and accurate.

_____ _____ SEAL
Signature Date
(Design Professional Responsible for the work)

Published: 01/01 Revised:

8. Professional Engineer
    a. Signature and seal
    b. Name and number
    c. Name, address and phone number of professional organization making the submittal.

C. PLANS (1” = 40’)
1. North Arrow, Scale
2. Property Lines, Property Owners
3. Applicable Record Plats
4. Easements (Structure, Pond, Outfall, Access)
5. Existing Right-of-Way
6. Existing and Proposed Topography
7. Existing Conditions and Proposed Improvements
8. Test Boring and Bench Mark Locations
9. Swales, Channels, Low-Flow Channels, Drains
10. Outfall, Outfall Protection
11. Soil Erosion and Sediment Control Plans Requires AASCD Approval
12. Delineation of Disturbed Areas
13. Vegetative Stabilization
14. Delineation of 100 Yr. Water Surface Elevation
15. Access Road
    a. Approved Plan and Profile of Public Row from which Access will be obtained
    b. Proposed Plan and Profile of Access Road
16. Access Ramp
17. 42-inch Fence and Gate
18. References to Standard Specifications or Detail Design
19. Coordinate ticks (250' intervals and bracket work) ,

D. PROFILE (1” = 4' Vertical and 1" = 40' Horizontal)
1. Storm drainage system entering device
2. Low flow channel in basins

3. Profiles of all devices
   a. Existing ground
   b. Proposed Grade
   c. Pipes and Other Utilities
   d. Proposed Construction

E. DEVICE INFORMATION

1. Infiltration Device
   a. Soils investigation Data
      (1) Soil borings locations
      (2) Soil classification (Unified Classification System)
      (3) Strata profile
      (4) Water tab1e elevation
      (5) Elevations of strata
   b. Plan View
      (l) Location and easements
      (2) Dimensions #1 #2
      (3) Label system
         (a) Type of system
         (b) Public/private
      (3) Label system
         (a) Type of system
         (b) Public/private _____ _____
      (4) Inundation area of 10, 100 year in flows
   c. Profile
      (1) Existing ground
      (2) Proposed grades
      (3) Existing/proposed store drainage and utilities
      (4) Phreatic line
      (5) Depth of design storms 2, 10, and 100
   d. Details and notes
      (1) Construction specifications

(2) Inspection notes and schedule

(3) Maintenance notes

(4) Special structure details drawn to scale

(5) Profiles and sections for embankment structures as required by MD-378

2. Attenuation Devices

a. Plan

(1) Location and Easements

(2) Dimensions

(3) Label devices

(4) Show existing and new topo features

(5) Existing and proposed grading

(6) Design flow inundation areas

b. Profile

(1) Proposed system

(2) System dimensioned

(3) Label devices

(4) Show existing and proposed ground lines

(5) Show existing and proposed storm drainage and utilities

c. Details and Notes

(1) Construction and materials specifications

(2) Inspection schedule

(3) Maintenance schedule

(4) All special items detailed

3. Detention and Retention Devices

a. Plan View

(1) Proposed device shown and labeled

(a) Existing and proposed contours

(b) Access from public road

(c) Maintenance access

(d) Pipes and structures labeled

(e) Easements

(2) Location

(3) Device labeled as to public/private

(4) Topographic features existing and proposed Profile

b. Profile View

(1) Existing and proposed ground lines

(2) Existing and proposed storm drainage and uti1ities

(3) All information (sections and profiles) required by MD-378 Standards

c. Details and Notes

(1) Materials and construction specifications

(2) Inspection requirements and schedule

(3) Maintenance schedules and requirements

(4) All special items (items detailed to scale)

4. Miscellaneous Items

a. Fence to be shown

(1) Gate (width and swing)

(2) Height of fence

(3) Location of fence

(4) Fence material and specifications

b. Access

(1) Site access

(a) Easements

(b) Aprons

(c) Pavement materials

(d) Dimensions and location

(2) Maintenance access

(a) Grades

(b) Materials

(c) Width and dimensions

(d) Typical Section

c. Details

(1) All permanent materials to be equal to standard inlets and structures quality and materials

(2) Scaled drawing and plan, profiles, and sections as required

(3) Material specification or plans

(4) Construction specification or plans

F. DESIGN BOOKLET

1. To be presented in bound 8 1/2" x 11" booklet
2. Drainage area maps for existing and proposed condition folded and tucked in pocket (no fold outs)
   a. Color coded as required
   b. 1" = 200' scale
   c. Land use
   d. Soils
   e. Drainage flows
   f. Streets named
   g. Proposed and existing topo conditions
3. Narrative
   a. Explanation of method used
   b. Findings of existing conditions
   c. Proposed development
   d. Best management investigation
      (1) Alternatives considered
      (2) Why chosen or abandoned
   e. Water quality benefits of design
   f. Peak management benefits of design
4. Signature and Seal of Professional Engineer
   a. Name
   b. Seal and Number
   c. Address (including zip code)
   d. Telephone Number (including area code)

5. Design Data
    a. Formulas and source of information
    b. Input determination for all computer programs
    c. TR-55 and TR-20 computer runs
    d. HEC-2 computer runs
    e. Details, nomographs, formulas determination
        (1) Existing peaks - 2 and 10 year storms
        (2) Proposed peaks - 2 and 10 year storms
        (3) Performance curve of device (elevation vs. discharge)
        (4) Hydrograph plot for proposed conditions 2 and 10 year storms
        (5) Water quality computations
    f. Conclusions and summary of results
    g. Design factors considered in design
        (1) Best management device
        (2) Clearances - vertical and horizontal
        (3) Benefits of design water quality and peak management
    h. Outfall Study
        (1) Existing condition statement
            (a) Recommendations
            (b) Hydraulic analysis
        (2) Proposed condition statement
            (a) Proposed fl ows
            (b) Proposed devices
            (c) Erosion prediction and measures taken to prevent erosion

IV. FLOOD PLAIN

A. DETERMINATION OF 100 YEAR FLOOD PLAIN

1. Ultimate condition (as zoned) 10 year storm
    a. No credit for upstream management
    b. No credit for upstream constrictions

_____ _____ c. Assume developed channel condition

_____ _____ 2. Determine existing natural channel grade in development

_____ _____ a. Profile along natural flow line boundary to boundary

_____ _____ b. Average grade line

_____ _____ 3. Capacity of 48" R.C.P.

_____ _____ a. n = 0.015

_____ _____ b. Natural grade

_____ _____ c. Capacity more than predicted in flow not a flood plain

_____ _____ d. Capacity less than predicted flow a flood plain

_____ _____ 4. Inundation area for 100 year storm event

_____ _____ a. Hydraulic sections

_____ _____ b. HEC-II run or step method determination

_____ _____ c. Chow Handbook Open Channel Flow determination of "n" factors

_____ _____ d. Inundation area

_____ _____ (1) Dedicated under subdivision

_____ _____ (2) Not graded under building permit

_____ _____ e. Waivers to grading in flood plain are sought through the Office of Planning and Zoning

RECOMMENDATION

Department of Public Works Review Engineer

I have reviewed the referenced plans, specifications and computations and found them:

_____ Acceptable

_____ Not Acceptable – revise as noted for resubmittal

_____ See attached letter of explanation.

ANNE ARUNDEL COUNTY DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
DETENTION/RETENTION AND INFILTRATION BASINS
CONSTRUCTION INSPECTION CHECKLIST

AASCD NAME:_____ LOCATION:_____

PERMIT/.CAPITAL PROJECT #:_____

PHASE	DATE	INITIALS	REMARKS DESCRIPTION OF ACTION TAKEN
1. EXCAVATION: A. SIZE AND LOCATION B. SIDE SLOPE STABILITY C. SOILS PERMEABILITY D. GROUNDWATER/BEDROCK			
2. EMBANKMENT: A. CUT-OFF/CORE TRENCH B. APPROPRIATE FILL MATERIAL C. ,MATERIAL PLACEMENT (COMPACTION)			
3. FINAL EXCAVATION: A. STORAGE VOLUME/DRAINAGE AREA B. SEDIMENT REMOVAL C. TILLING (BOTTOM) D. LINING (BOTTOM) E. STABILIZATION (PERMANENT)			
4. STRUCTURE/PIPES: A. INLET-OUTLET STRUCTURES B. BARREL, CRADLE, ANTI-SEEP COLLARS C. FILTER DIAPHRAGM D. PRINCIPAL SPILLWAY/RISER E. CONCRETE TEST RESULTS F. INVERTS/ELEVATIONS			
5. FINAL INSPECTION: A. EMERGENCY SPILLWAY/ACCESS ROAD B. FENCE AND GATE C. REDLINED ASBUILTS			

I HEREBY CERTIFY THAT I PERSONALLY REVIEWED THE INFORMATION REPORTED ON THIS CHECKLIST AND TO THE BEST OF MY KNOWLEDGE DO HEREBY INSURE THAT THE SUBMITTAL IS COMPLETE AND ACCURATE.

SEAL

_____

(PROFESSIONAL ENGINEER SIGNATURE AND DATE)

ANNE ARUNDEL COUNTY DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
INFILTRATION/ATTENUATION TRENCHES
CONSTRUCTION INSPECTION CHECKLIST

AASCD NAME:_____ LOCATION:_____

PERMIT/.CAPITAL PROJECT #:_____

PHASE	DATE	INITIALS	REMARKS DESCRIPTION OF ACTION TAKEN
1. EXCAVATION: A. SIZE AND LOCATION B. SIDE SLOPE STABILITY C. SOILS PERMEABILITY D. GROUNDWATER/BEDROCK E. SETBACKS PER DESIGN MANUAL			
2. FILTER FABRIC: A. FABRIC SPECIFICATIONS B. SIDES & TOP (INFILTRATION) C. SIDES, TOP, BOTTOM (ATTENUATION)			
3. AGGREGATE MATERIAL: A. SIZE B. PLACEMENT			
4. OBSERVATION WELL/ROOF LEADERS: A. ROOF LEADERS B. SURCHARGE PIPE(S) C. PIPE SIZE AND TYPE D. MINIMUM COVER (1 FOOT)			
5. SURFACE LAYER: A. AGGREGATE SURFACE B. VEGETATIVE SURFACE C. PAVED SURFACE			
6. INLET STRUCTURE: A. INVERTS AND ELEVATIONS B. RECEIVES DESIGNED DRAINAGE AREA			

I HEREBY CERTIFY THAT I PERSONALLY REVIEWED THE INFORMATION REPORTED ON THIS CHECKLIST AND TO THE BEST OF MY KNOWLEDGE DO HEREBY INSURE THAT THE SUBMITTAL IS COMPLETE AND ACCURATE.

SEAL

_____

(PROFESSIONAL ENGINEER SIGNATURE AND DATE)

ANNE ARUNDEL COUNTY DEPARTMENT OF PLANNING AND CODE ENFORCEMENT
DETENTION/RETENTION AND INFILTRATION BASINS
CONSTRUCTION INSPECTION CHECKLIST

AASCD NAME:_____ LOCATION:_____

PERMIT/.CAPITAL PROJECT #:_____

PHASE	DATE	INITIALS	REMARKS DESCRIPTION OF ACTION TAKEN
1. EXCAVATION: A. SIZE AND LOCATION B. SHAPE, SIDE SLOPE STABILITY C. SOIL PERMEABILITY D. GROUNDWATER/BEDROCK			
2. VEGETATIVE SWALE: A. STABILIZATION (PERMANENT) B. GRADIENT & INVERTS C. DRAINAGE AREA D. ,OUTLET (NON-EROSIVE)			
3. CHECK DAMS: A. NUMBER/DIMENSION B. TYPE C. COMPACTION (EARTH TYPE) D. AGGREGATE TYPE AND SIZE E. INVERTS/ELEVATIONS			

I HEREBY CERTIFY THAT I PERSONALLY REVIEWED THE INFORMATION REPORTED ON THIS CHECKLIST AND TO THE BEST OF MY KNOWLEDGE DO HEREBY INSURE THAT THE SUBMITTAL IS COMPLETE AND ACCURATE.

SEAL

_____
(PROFESSIONAL ENGINEER SIGNATURE AND DATE)

Published: 01/01 Revised:

U.S. Department of Agriculture
Soil Conservation Service

APPENDIX M

WATER FEATURES

Survey Area- ANNE ARUNDEL COUNTY, MARYLAND

Map symbol and soil name		Hydrologic group	Flooding			High water table		
			Freq	Duration	Months	Depth (Ft)	Kind	Months
AdA	ADELPHIA	B/C	NONE		-	1.5- 4.0	APPAR	JAN-APR
AdB	ADELPHIA	B/C	NONE		-	1.5- 4.0	APPAR	JAN-APR
AsA	ADELPHIA	B/C	NONE		-	1.5- 4.0	APPAR	JAN-APR
AsB	ADELPHIA SILT LOAM	B/C	NONE		-	1.5- 4.0	APPAR	JAN-APR
BeB2	BELTSVILLE	C	NONE		-	1.5- 2.5	PERCH	NOV-APR
BlB	BELTSVILLE	C	NONE		-	1.5- 2.5	PERCH	NOV-APR
	URBAN LAND		NONE		-	2.0- 2.0		-
Bm	BIBB	D	FREQ	LONG	DEC-MAY	0.5- 1.5	APPAR	DEC-APR
BuA	BUTLERTOWN	C	NONE		-	2.0- 4.0	PERCH	FEB-MAR
BuB2	BUTLERTOWN	C	NONE		-	2.0- 4.0	PERCH	FEB-MAR
BuC2	BUTLERTOWN	C	NONE		-	2.0- 4.0	PERCH	FEB-MAR
BuC3	BUTLERTOWN	C	NONE		-	2.0- 4.0	PERCH	FEB-MAR
BuD3	BUTLERTOWN	C	NONE		-	2.0- 4.0	PERCH	FEB-MAR
CW	CENSUS WATER > 40 Ac.				-	-		-
CaB2	CHILLUM	B	NONE		-	6.0- 6.0		-
CaC2	CHILLUM	B	NONE		-	6.0- 6.0		-
CbB	CHILLUM	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
CcB2	CHRISTIANA	C	NONE		-	6.0- 6.0		-
CcC2	CHRISTIANA	C	NONE		-	6.0- 6.0		-
CdC3	CHRISTIANA	C	NONE		-	6.0- 6.0		-
Ce	COASTAL BEACHES	D	FREQ	LONG	JAN-DEC	0- 6.0	APPAR	JAN-DEC
Ch	CODORUS	C	OCCA		DEC-APR	1.0- 2.0	APPAR	NOV-APR
Ck	COLEMANTOWN	C/D	OCCA		SEP-APR	0- 1.0	PERCH	OCT-JUN
Cm	COLEMANTOWN	C/D	OCCA		SEP-APR	0- 1.0	PERCH	OCT-JUN
CnB2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CnC2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoA	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoB2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoC2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoC3	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoD2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoD3	COLLINGTON	B	NONE		-	6.0- 6.0		-
CoE	COLLINGTON	B	NONE		-	6.0- 6.0		-
CpA	COLLINGTON	B	NONE		-	6.0- 6.0		-
CpB2	COLLINGTON	B	NONE		-	6.0- 6.0		-
CpuB	COLLINGTON	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
CpuD	COLLINGTON	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
Cr	CONUS	B	RARE		-	6.0- 6.0		-
CsC2	CROOM	C	NONE		-	6.0- 6.0		-
CsD2	CROOM	C	NONE		-	6.0- 6.0		-
CsE	CROOM	C	NONE		-	6.0- 6.0		-

WATER FEATURES

Survey Area- ANNE ARUNDEL COUNTY, MARYLAND

Map symbol and soil name		Hydrologic group	Flooding Freq	Flooding Duration	Flooding Months	High water table Depth (Ft)	High water table Kind	High water table Months
CtD	CROOM	C	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
CuB	CUT AND FILL LAND		NONE		-	2.0- 2.0		-
CuD	CUT AND FILL LAND		NONE		-	2.0- 2.0		-
CuE	CUT AND FILL LAND		NONE		-	2.0- 2.0		-
DnA	DONLONTON	C	NONE		-	1.5- 2.0	APPAR	NOV-MAY
DnB2	DONLONTON	C	NONE		-	1.5- 2.0	APPAR	NOV-MAY
DuB	DONLONTON	C	NONE		-	1.5- 2.0	APPAR	NOV-MAY
	URBAN LAND		NONE		-	2.0- 2.0		-
Ek	ELKTON	C/D	NONE		-	0- 1.0	APPAR	NOV-MAY
	ELKTON	C/D	NONE		-	0- 1.0	APPAR	NOV-MAY
En	ELKTON	C/D	NONE		-	0- 1.0	APPAR	NOV-MAY
	ELKTON	C/D	NONE		-	0- 1.0	APPAR	NOV-MAY
EoB	EVESBORO	A	NONE		-	6.0- 6.0		-
ErB	EVESBORO	A	NONE		-	6.0- 6.0		-
ErC	EVESBORO	A	NONE		-	6.0- 6.0		-
EsC	EVESBORO	A	NONE		-	6.0- 6.0		-
	GALESTOWN	A	NONE		-	6.0- 6.0		-
EsE	EVESBORO	A	NONE		-	6.0- 6.0		-
	GALESTOWN	A	NONE		-	6.0- 6.0		-
EuC	EVESBORO	A	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
FTM	FORT GEORGE G MEADE				-	-		-
Fa	FALLSINGTON	B/D	NONE		-	0- 1.0	APPAR	DEC-MAY
	FALLSINGTON	B/D	NONE		-	0- 1.0	APPAR	DEC-MAY
GaB	GALESTOWN	A	NONE		-	6.0- 6.0		-
Gp	GRAVEL AND BORROW PI	A	NONE		-	6.0- 6.0		-
Ha	HATBORO	D	FREQ		NOV-MAY	0- 0.5	APPAR	OCT-MAY
HfB2	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HgB2	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HsB2	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HtB2	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HyC3	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HyD3	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HyE3	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
HzC3	HOWELL	C	NONE		-	3.0- 3.0	APPAR	NOV-MAY
KeA	KEYPORT	C	NONE		-	1.5- 4.0	PERCH	NOV-MAY
KeB	KEYPORT	C	NONE		-	1.5- 4.0	PERCH	NOV-MAY
KpA	KEYPORT	C	NONE		-	1.5- 4.0	PERCH	NOV-MAY
KpB2	KEYPORT	C	NONE		-	1.5- 4.0	PERCH	NOV-MAY
KrB	KEYPORT	C	NONE		-	1.5- 4.0	PERCH	NOV-MAY
	URBAN LAND		NONE		-	2.0- 2.0		-
Ks	KLEJ	B/D	NONE		-	1.0- 2.0	APPAR	DEC-APR
LoB	LOAMY AND CLAYEY LAN	B	NONE		-	6.0- 6.0		-
LoC	LOAMY AND CLAYEY LAN	B	NONE		-	6.0- 6.0		-
LoD	LOAMY AND CLAYEY LAN	B	NONE		-	6.0- 6.0		-

U.S. Department of Agriculture
Soil Conservation Service

APPENDIX M

WATER FEATURES

Survey Area- ANNE ARUNDEL COUNTY, MARYLAND

Map symbol and soil name		Hydrologic group	Flooding			High water table		
			Freq	Duration	Months	Depth (Ft)	Kind	Months
Ma	MADE LAND		NONE		-	2.0- 2.0		-
MfB2	MARR	B	NONE		-	6.0- 6.0		-
MfC2	MARR	B	NONE		-	6.0- 6.0		-
MfC3	MARR	B	NONE		-	6.0- 6.0		-
MfD2	MARR	B	NONE		-	6.0- 6.0		-
MfD3	MARR	B	NONE		-	6.0- 6.0		-
MfE3	MARR	B	NONE		-	6.0- 6.0		-
MkA	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MkB2	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MmA	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MmB2	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MmC2	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MmC3	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MmD3	MATAPEAKE	B	NONE		-	6.0- 6.0		-
MnA	MATAWAN	C	NONE		-	2.0- 3.0	APPAR	JAN-APR
MnB	MATAWAN	C	NONE		-	2.0- 3.0	APPAR	JAN-APR
MpA	MATTAPEX	C	NONE		-	1.5- 3.0	APPAR	JAN-APR
MpB2	MATTAPEX	C	NONE		-	1.5- 3.0	APPAR	JAN-APR
MrA	MATTAPEX	C	NONE		-	1.5- 3.0	APPAR	JAN-APR
MrB2	MATTAPEX	C	NONE		-	1.5- 3.0	APPAR	JAN-APR
MrC2	MATTAPEX	C	NONE		-	1.5- 3.0	APPAR	JAN-APR
Mt	MIXED ALLUVIAL LAND	D	FREQ	LONG	DEC-MAY	0.5- 1.5	APPAR	DEC-APR
MuA	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MuB2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MuC2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MuC3	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MuD2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MuD3	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MvA	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MvB2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MvC2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MvD2	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MvE	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MwC3	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MwD3	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
MxB	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
	URBAN LAND		NONE		-	2.0- 2.0		-
MxD	MONMOUTH	C	NONE		-	2.0- 5.0	PERCH	NOV-MAY
	URBAN LAND		NONE		-	2.0- 2.0		-
MyB	MUIRKIRK	B	NONE		-	6.0- 6.0		-
MyC	MUIRKIRK	B	NONE		-	6.0- 6.0		-
MyD	MUIRKIRK	B	NONE		-	6.0- 6.0		-
MyE	MUIRKIRK	B	NONE		-	6.0- 6.0		-

WATER FEATURES

Survey Area- ANNE ARUNDEL COUNTY, MARYLAND

Map symbol and soil name		Hydrologic group	Flooding			High water table		
			Freq	Duration	Months	Depth (Ft)	Kind	Months
MzB	MUIRKIRK	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
MzD	MUIRKIRK	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
Os	OSIER	A/D	NONE		-	0- 1.0	APPAR	NOV-MAR
Ot	OTHELLO	C/D	NONE		-	0- 1.0	APPAR	JAN-MAY
RuA	RUMFORD	B	NONE		-	6.0- 6.0		-
RuB2	RUMFORD	B	NONE		-	6.0- 6.0		-
RuC2	RUMFORD	B	NONE		-	6.0- 6.0		-
RuC3	RUMFORD	B	NONE		-	6.0- 6.0		-
RuD2	RUMFORD	B	NONE		-	6.0- 6.0		-
RyB	RUMFORD	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
RyD	RUMFORD	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
SaA	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaB2	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaC2	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaC3	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaD2	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaD3	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SaE	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SfA	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SfB2	SASSAFRAS	B	NONE		-	6.0- 6.0		-
SnB	SASSAFRAS	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
SnD	SASSAFRAS	B	NONE		-	6.0- 6.0		-
	URBAN LAND		NONE		-	2.0- 2.0		-
Sr	SHREWSBURY	C/D	NONE		-	0- 1.0	APPAR	OCT-JUN
Ss	SHREWSBURY	C/D	NONE		-	0- 1.0	APPAR	OCT-JUN
Sw	SWAMP	D	FREQ		JAN-MAR	-	APPAR	-
Tm	TIDAL MARSH	D	FREQ		JAN-DEC	-	APPAR	-
Ur	URBAN LAND		NONE		-	2.0- 2.0		-
WaB2	WESTPHALIA	B	NONE		-	6.0- 6.0		-
WaC2	WESTPHALIA	B	NONE		-	6.0- 6.0		-
WaC3	WESTPHALIA	B	NONE		-	6.0- 6.0		-
WaD3	WESTPHALIA	B	NONE		-	6.0- 6.0		-
WaE3	WESTPHALIA	B	NONE		-	6.0- 6.0		-
WdA	WOODSTOWN	C	NONE		-	1.5- 3.5	APPAR	JAN-APR
WdB	WOODSTOWN	C	NONE		-	1.5- 3.5	APPAR	JAN-APR
WoA	WOODSTOWN	C	NONE		-	1.5- 3.5	APPAR	JAN-APR
WoB	WOODSTOWN	C	NONE		-	1.5- 3.5	APPAR	JAN-APR