

ORDINANCE 1998-1
WARRIORS MARK TOWNSHIP
ACT 167 STORM WATER MANAGEMENT ORDINANCE

ARTICLE I
GENERAL PROVISIONS

SECTION 101. STATEMENT OF FINDINGS

The governing body of the Municipality finds that:

- A. Inadequate management of accelerated storm water runoff resulting from development throughout a watershed increases flood flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of existing streams and storm sewers, greatly increases the cost of public facilities to convey and manage storm water, undermines floodplain management and flood reduction efforts in upstream and downstream communities, reduces groundwater recharge, and threatens public health and safety.
- B. A comprehensive program of storm water management, including reasonable regulation of development and activities causing accelerated erosion, is fundamental to the public health, safety, welfare, and the protection of the people of the Municipality and all the people of the Commonwealth, their resources, and the environment.

SECTION 102. PURPOSE

The purpose of this Ordinance is to promote public health, safety, and welfare within Warriors Mark Township by minimizing the damages described in Section 101.A of this Ordinance through provisions designed to:

- A. Manage accelerated runoff and erosion and sedimentation problems at their source by regulating activities that cause these problems.
- B. Utilize and preserve the existing natural drainage systems.
- C. Encourage recharge of groundwater where appropriate and prevent degradation of groundwater quality.
- D. Maintain existing flows and quality of streams and watercourses in the Municipality and the Commonwealth.
- E. Preserve and restore the flood-carrying capacity of streams.
- F. Provide proper maintenance of all permanent storm water management facilities that are constructed in the

Township.

- G. Provide performance standards and design criteria for township-wide storm water management and planning.

SECTION 103. STATUTORY AUTHORITY

The Township is empowered to regulate land use activities that affect runoff by the authority of the Act of October 4, 1978, P.L. 864 (Act 167), the "Storm Water Management Act," and the Municipal Planning Code, Act 247.

SECTION 104. APPLICABILITY

This Ordinance shall apply to permanent storm water management facilities constructed as part of any of the Regulated Activities listed in this Section. Storm water management and erosion and sedimentation control during construction activities are specifically not regulated by this Ordinance, but shall continue to be regulated under existing laws and ordinances.

This Ordinance contains the storm water management performance standards and design criteria that are necessary or desirable from a township-wide perspective. Local storm water management design criteria (e.g. inlet spacing, inlet type, collection system details, outlet structure design, etc.) shall continue to be regulated by the Municipal Planning Code, Act 247.

The following activities are defined as "Regulated Activities" and shall be regulated by this Ordinance:

- A. Land development.
- B. Subdivision.
- C. Construction of new or additional impervious or semi-pervious surfaces (driveways, parking lots, etc.).
- D. Construction of new buildings or additions to existing buildings.
- E. Diversion or piping of any natural or man-made stream channel.
- F. Installation of storm water management facilities or appurtenances thereto.
- G. Reconstruction.

SECTION 105. REPEALER

Any ordinance of the Township inconsistent with any of the provisions of this Ordinance is hereby repealed to the extent of the inconsistency only.

SECTION 106. SEVERABILITY

Should any section or provision of this Ordinance be declared invalid by a court of competent jurisdiction, such decision shall

not affect the validity of any of the remaining provisions of this Ordinance.

SECTION 107. COMPATIBILITY WITH OTHER ORDINANCE REQUIREMENTS.

Approvals issued pursuant to this Ordinance do not relieve the Applicant of the responsibility to secure required permits or approvals for activities regulated by any other applicable code, rule, act, or ordinance.

ARTICLE II
DEFINITIONS

For the purpose of this chapter, certain terms and words used herein shall be interpreted as follows:

- A. Words used in the present tense include the future tense; the singular number includes the plural, and the plural number includes the singular; words of masculine gender include feminine gender; and words of feminine gender include masculine gender.
- B. The word "includes" or "including" shall not limit the term to the specific example but is intended to extend its meaning to all other instances of like kind and character.
- C. The word "person" includes an individual, firm, association, organization, partnership, trust, company, corporation, or any other similar entity.
- D. The words "shall" and "must" are mandatory; the words "may" and "should" are permissive.
- E. The words "used or occupied" include the words "intended, designed, maintained, or arranged to be used or occupied."

Alteration - As applied to land, a change in topography as a result of the moving of soil and rock from one location or position to another; also the changing of surface conditions by causing the surface to be more or less impervious; land disturbance.

Applicant - A landowner or developer who has filed an application for approval to engage in any Regulated Activities as defined in Section 104. of this Ordinance.

Cistern - An underground reservoir or tank for storing rainwater.

Conservation District - The Huntingdon County Conservation District.

Culvert - A structure with appurtenant works which carries a stream under or through an embankment or fill.

Dam - An artificial barrier, together with its appurtenant works, constructed for the purpose of impounding or storing water or another fluid or semifluid, or a refuse bank, fill or structure for highway, railroad or other purposes which does or may impound water or another fluid or semifluid.

Design Storm - The magnitude and temporal distribution of precipitation from a storm event measured in probability of occurrence (e.g. a 5-year storm) and duration (e.g. 24-hours), used in the design and evaluation of storm water management systems.

Detention Basin - An impoundment structure designed to manage storm water runoff by temporarily storing the runoff and releasing it at a predetermined rate.

Developer - A person, partnership, association, corporation, or other entity, or any responsible person therein or agent thereof, that undertakes any Regulated Activity of this Ordinance.

Development Site - The specific tract of land for which a Regulated Activity is proposed.

Drainage Easement - A right granted by a landowner to a grantee, allowing the use of private land for storm water management purposes.

Drainage Plan - The documentation of the storm water management system, if any, to be used for a given development site, the contents of which are established in Section 403.

Erosion - The movement of soil particles by the action of water, wind, ice, or other natural forces.

Floodplain - Any land area susceptible to inundation by water from any natural source or delineated by applicable Department of Housing and Urban Development, Federal Insurance Administration Flood Hazard Boundary Maps as being a special flood hazard area. Also included are areas that comprise Group 13 Soils, as listed in Appendix A of the PA Department of Environmental Protection (PA DEP) Technical Manual for Sewage Enforcement Officers (as amended or replaced from time to time by PA DEP).

Groundwater Recharge - Replenishment of existing natural underground water supplies.

Impervious Surface - A surface that prevents the percolation of water into the ground.

Infiltration Structures - A structure designed to direct runoff into the ground (e.g. french drains, seepage pits, seepage trench.)

Land Development - (i) the improvement of one lot or two or more contiguous lots, tracts, or parcels of land for any purpose involving (a) a group of two or more buildings, or (b) the division

or allocation of land or space between or among two or more existing or prospective occupants by means of, or for the purpose of streets, common areas, leaseholds, condominiums, building groups, or other features; (ii) any subdivision of land; (iii) any lot improvements regulated under the Municipal Zoning Regulations.

Land Disturbance - Any activity involving grading, tilling, digging, or filling of ground or stripping of vegetation or any other activity that causes an alteration to the natural condition of the land.

Municipality/Township - Warriors Mark Township.

Open Channel - A drainage element in which storm water flows with an open surface. Open channels include, but shall not be limited to, natural and man-made drainageways, swales, streams, ditches, canals, and pipes flowing partly full.

Peak Discharge - The maximum rate of storm water runoff from a specified storm event.

Pipe - A culvert, closed conduit, or similar structure (including appurtenances) that conveys storm water.

Plan Administrator - The entity set up specifically to review Act 167 Drainage Plans, inspect storm water management structures, and otherwise enforce all regulations as outlined in the "Warriors Mark Township Act 167 Storm Water Management Ordinance." This entity may be an Engineer appointed by the Township.

PMF - Probable maximum flood - The flood that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonable possible in an area. The PMF is derived from the probable maximum precipitation (PMP) as determined on the basis of data obtained from the National Oceanographic and Atmospheric Administrator (NOAA).

Regulated Activities - Actions or proposed actions that have an impact on storm water runoff and that are specified in Section 104. of this Ordinance.

Retention Basin - An impoundment in which storm water is stored and not released during the storm event. Stored water may be released from the basin at some time after the end of the storm.

Return Period - The average interval, in years, within which a storm event of a given magnitude can be expected to recur. For example, the 25-year return period rainfall would be expected to recur on the average once every twenty-five years.

Runoff - Any part of precipitation that flows over the land surface.

SCS - U.S. Department of Agriculture, Soil Conservation Service.

Sedimentation - The process by which mineral or organic matter is accumulated or deposited by the movement of water.

Sediment Basin - A barrier, dam, retention, or detention basin located and designed to retain rock, sand, gravel, silt, or other material transported by water.

Seepage Pit/Seepage Trench - An area of excavated earth filled with loose stone or similar coarse material, into which surface water is directed for infiltration into the ground.

Soil-Cover Complex Method - A method of runoff computation developed by the SCS that is based on relating soil type and land use/cover to a runoff parameter called Curve Number (CN).

Storage Indication Method - A reservoir routing procedure based on solution of the continuity equation (inflow minus outflow equals the change in storage) with outflow defined as a function of storage volume and depth.

Storm Sewer - A system of pipes and/or open channels that convey intercepted runoff and storm water from other sources, but excludes domestic sewage and industrial wastes.

Storm Water - Drainage runoff from the surface of the land resulting from precipitation, snow, or icemelt.

Storm Water Management Facility - Any structure, natural or man-made, that, due to its condition, design, or construction, conveys, stores, or otherwise affects storm water runoff. Typical storm water management facilities include, but are not limited to, detention and retention basins, open channels, storm sewers, pipes, and infiltration structures.

Stream Enclosure - A bridge, culvert or other structure in excess of 100 feet in length upstream to downstream which encloses a regulated water of this Commonwealth.

Subdivision - The division or re-division of a lot, tract, or parcel of land by means into two or more lots, tracts, parcels or other divisions of land including changes in existing lot lines for the purpose, whether immediate or future, of lease, transfer of ownership, or building or lot development.

Wetland - Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions, including swamps, marshes, bogs, fens, and similar areas.

ARTICLE III
STORM WATER MANAGEMENT

SECTION 301. GENERAL REQUIREMENTS

- A. Storm water drainage systems shall be provided in order to permit unimpeded flow along natural watercourses, except as modified by storm water management facilities or open channels consistent with this Ordinance.
- B. The existing points of concentrated drainage that discharge onto adjacent property shall not be relocated and shall be subject to any applicable release rate criteria specified in this Ordinance.
- C. Areas of existing diffused drainage discharge shall be subject to any pre-development discharge pattern in the general direction of existing discharge or as proposed, whether proposed to be concentrated or maintained as diffused drainage areas.

If diffused flow is proposed to be concentrated and discharged onto adjacent property, the Developer must document that adequate downstream conveyance facilities exist to safely transport the concentrated discharge, or otherwise prove that no erosion, sedimentation, flooding, or other harm will result from the concentrated discharge.

- D. Where a Development Site is traversed by watercourses other than permanent streams, a drainage easement shall be provided conforming substantially to the line of such watercourse. The terms of the easement shall prohibit excavation, the placing of fill or structures, and any alterations that may adversely affect the flow or storm water within any portion of the easement. Also, maintenance and mowing of vegetation within the easement shall be required.
- E. Any storm water management facilities regulated by this Ordinance that would be located on State highway right-of-ways shall be subject to approval by the Pennsylvania Department of Transportation (PADOT).
- F. Any storm water management facilities regulated by this Ordinance that would be located in or adjacent to waters of the Commonwealth or potential wetlands shall be subject to approval by PA DEP through the Joint Permit Application process. When there is a question whether wetlands may be involved, it is the responsibility of the Developer or his agent to show that the land in question cannot be classified as wetlands, otherwise approval to work in the area must be obtained from PA DEP.

- G. When it can be shown that, due to topographic conditions, natural drainageways on the site cannot adequately provide for drainage, open channels may be constructed conforming substantially to the line and grade of such natural drainageways.
- H. Sinkholes shall be protected as follows:
1. Storm water from roadways, parking lots, storm sewers, roof drains, or other concentrated runoff paths shall not be discharged directly into sinkholes.
 2. Sinkholes with sufficient capacity to receive appreciable amounts of storm water, as determined by the Plan Administrator, shall be designated as such by posting on-site notices clearly visible at the sinkhole prohibiting any disposal of refuse, rubbish, hazardous wastes, organic matter, or soil into the sinkhole. Rock fill may be permitted in the sinkhole for the purpose of preventing dumping of said materials. The discharge of storm water runoff to the subsurface using sinkholes shall be considered as potential pollution and prohibited unless the disposal method is designed so that contaminants in the runoff will be absorbed/adsorbed in the soil mantle and be acted upon by the bacteria naturally present in the mantle before reaching the groundwater. Systems intended to meet this requirement shall be designed by a hydrogeologist.
 3. If increased or concentrated runoff is to be discharged into a sinkhole, including filtered discharge, a geologic assessment of the effects of such runoff on increased land subsidence and groundwater quality shall be prepared and the results submitted with the Drainage Plan. Such discharge shall be prohibited if the Plan Administrator determines that the discharge poses a hazard to life, property, or groundwater resources.

SECTION 302. STORM WATER MANAGEMENT PERFORMANCE STANDARDS

A. General

The following general standards shall be applied to all development within Warriors Mark Township to promote flow attenuation, erosion and sediment control, and flood control.

1. All site development in Warriors Mark Township
 - a) creating 15,000 square feet or more of

impervious cover; or

- b) traversed or bordered by a stream or open channel; or
- c) containing slopes in excess of 8%, shall submit a storm water management plan to the municipality for review, subject to the right of the Township to grant a variance or exemption for just cause.

This criteria shall apply to the total proposed development even if development is to take place in stages. Impervious cover shall include, but not be limited to, any roof, parking or driveway areas, and any new streets and sidewalks. Any area designed to initially be gravel or crushed stone shall be assumed to be impervious for the purposes of comparison to the waive criteria.

- 2. Runoff from impervious areas must be drained to pervious areas, subject to variances.
- 3. Roof drains must not be connected to streets, sanitary or storm sewers, or roadside ditches, controlled facilities, subject to variances.
- 4. Runoff from a site should not be concentrated or increased runoff discharged onto adjacent property without the written consent of the adjacent landowners and the Plan Administrator (Township Engineers assessment and approval).

B. Detention/infiltration Standards

- 1. Post-development rates of runoff from any regulated activity shall not exceed the peak rates of runoff prior to development for the 2 and 10 year design storms. That is, facilities for the control of storm water form a development site must be designed for both the 2 year and 10 year design storms.
- 2. Minimization of impervious surfaces and infiltration of runoff through seepage beds, infiltration trenches, etc. are encouraged, where soil conditions permit, to reduce the size or eliminate the need for detention facilities.

C. Stream Corridors and Sinkholes

- 1. Land uses which occur adjacent to streams and/or sinkholes shall require an undisturbed buffer or filter strip along the stream or sinkhole. This

shall include agriculture land use.

- a) The purpose of the buffer is to intercept sediment and pollutants from project runoff occurring overland before they reach the stream, and/or sinkhole, thereby protecting local water resources and the environment.
- b) The buffer width shall be a minimum of fifty (50) feet measured from the stream bank or sinkhole to the area of the proposed soil disturbance. This buffer shall apply to each side of the watercourse where soil disturbance is proposed. If the watercourse marks the project boundary, the buffer requirement shall apply to only one side of the stream.
- c) Where the subdivision and land development has a slope in excess of eight (8) percent, the following buffer widths shall apply to each applicable side of the watercourse.

<u>% Slope</u>	<u>buffer width</u>
0-8%	50'
8-15%	65'
15-25%	80'
25% +	100'

- d) The slopes of a site may not be averaged over the gross acreage. Only the area within two hundred (200) feet of the watercourse shall be considered for the purpose of the slope calculation.
- e) If the land on each side of the stream bank has different slope characteristics, a different buffer width would be required on each side of the stream.
- f) The buffer shall consist of existing or new vegetation or a combination thereof, as in the following order of preference:
 - 1. Existing hedgerow, woodlot, brush and/or uncultivated fields which are naturally occurring along the stream.
 - 2. A combination of existing vegetation (such as above) and newly-established vegetation.
 - 3. A newly established area of trees, bushes and grasses, where no vegetation existed prior to development.

- g) Stream encroachment work or any development within fifty (50) feet of a stream bank or wetlands must obtain a permit from DEP and the US Army Corps of Engineers. The Applicant shall provide written determination from the applicable regulatory body or a copy of the required permit prior to Final Plan approval.

SECTION 303. DESIGN CRITERIA FOR STORM WATER MANAGEMENT FACILITIES

- A. Any storm water management facilities required or regulated by this Ordinance shall be designed to meet the performance standards of this Ordinance. Compensatory storm water management facilities shall not be permitted.
- B. Any storm water management facility required or regulated by this Ordinance shall be designed to provide an emergency spillway to handle flow up to 100-year post-development conditions. The height of embankment must be set as to provide a minimum of 1.0 foot of free-board above the maximum pool elevation computed when the facility functions for 100-year post-development inflow. Should any storm water management facilities qualify as a dam under PA DEP Chapter 105, the facility shall be designed in accordance with Chapter 105 and meet the regulations of Chapter 105 concerning dam safety.
- C. Any hydraulic capacity analysis conducted in accordance with this Ordinance shall use the following criteria to determine if adequate hydraulic capacity exists:
1. Open channels must be able to convey post-development runoff from a 10-year design storm within their banks at velocities that would not erode the channel bed or banks. Acceptable velocities shall be based on criteria included in the PA DEP Soil Erosion and Sedimentation Control Manual (as amended or replaced from time to time by PA DEP) and presented in Table 1 in Appendix A of this Ordinance.
 2. Open channels must be able to convey post-development runoff from a 100-year design storm within their banks with a minimum 1.0 foot of freeboard and not create a hazard to any persons or property.
 3. Any facilities that constitute water obstructions (e.g., culverts, bridges, outfalls, or stream enclosures), and any work involving wetlands as described in PA DEP Chapter 105 regulations (as amended or replaced from time to time by PA DEP), shall be designed in accordance with Chapter 105 and will require a permit from PA DEP. Any other

drainage conveyance facility that doesn't fall under Chapter 105 regulations must be able to convey, without damage to the drainage structure or roadway, runoff from the 25-year design storm with a minimum 1.0 foot of freeboard measured below the lowest point along the top of the roadway. Roadway crossings located within designated floodplain areas must be able to convey runoff from a 100-year design storm with a minimum 1.0 foot of freeboard measured below the lowest point along the top of the roadway. Any facility that constitutes a dam as defined in PA DEP Chapter 105 regulations may require a permit under dam safety regulations. Any facility located within a PADOT right-of-way must meet PADOT minimum design standards and permit submission requirements.

- D. Adequate erosion protection shall be provided along all open channels, and at all points of discharge.
- E. Any storm water facility located on State highway rights-of-way shall be subject of approval by the Pennsylvania Department of Transportation.
- F. Any storm water facility that would be located in or adjacent to waters of the Commonwealth or potential wetlands shall be subject to approval by PA DEP through the joint Permit or General Permit process.
- G. Easements along open channels shall be provided. The minimum width of the required easement shall be equal to the width of the 100-year water surface (for post-development conditions), including a minimum 1.0 foot of freeboard. In addition, an undisturbed vegetated buffer of fifty (50) feet width shall be reserved and remain undeveloped along streams.
- H. Capacity Improvements - If the developer could prove that it would be feasible to provide capacity improvements to relieve the capacity deficiency in the existing drainage network, then adequate capacity improvements could be provided by the Developer in lieu of storm water management facilities on the development site. Any capacity improvements would be designed based on development of all areas tributary to the improvement and the capacity criteria specified in this Ordinance. The type and amount of development that the Developer must consider shall be either based on current zoning or established by the Plan Administrator, whichever results in a greater amount of imperviousness. It shall be assumed that all new development upstream of a proposed capacity improvement would implement applicable storm water management techniques, consistent with this Ordinance.

- I. Adequate erosion protection shall be provided along all open channels, and at all points of discharge.
- J. Ponds and other similar water features that are not designed as storm water management facilities shall be designed in accordance with U.S. Department of Agriculture, Soil Conservation Service (SCS), Ponds - Planning, Design, Construction (as amended or replaced from time to time by SCS), and shall be treated as impervious surfaces for storm water runoff computations.
- K. The design of all storm water management facilities shall incorporate sound engineering principles and practices. The Plan Administrator shall reserve the right to disapprove any design that would result in the occurrence or perpetuation of an adverse hydrologic or hydraulic condition within the watershed.

SECTION 304. CALCULATION METHODOLOGY

Storm water runoff from all development sites shall be calculated using either the rational method or a soil-cover-complex methodology.

- A. Runoff curve numbers listed in Appendix A are to be used in SCS methodologies such as TR-55.
- B. Rational "C" values listed in Appendix A are to be used for the Rational formula.
- C. The design of any storm water detention facilities intended to meet the performance standards of this Ordinance shall be verified by routing the design storm hydrograph through these facilities using the Storage - indication Method. For drainage areas greater than 20 acres in size, the design storm hydrograph shall be computed using a calculation method that produces a full hydrograph. The municipality may approve the use of any generally accepted full hydrograph approximation technique and shall use a total runoff volume that is consistent with the volume from a method that produces a full hydrograph.
- D. All calculations consistent with this Ordinance using the soil cover complex method shall use the appropriate design rainfall depths for the various return period storms presented in Appendix A of this Ordinance. If a hydrologic computer model such as PSRM or HEC-1 is used for storm water runoff calculations, then the duration of rainfall shall be 24 hours.
- E. All calculations, using the Rational Method shall use rainfall intensities consistent with appropriate times of concentration for overland flow and return periods.

Times of concentration for overland flow shall be calculated using the methodology presented in Chapter 3 of Urban Hydrology for Small Watersheds, SCS, TR-55 (as amended or replaced from time to time by SCS). Times of concentration for channel and pipe flow shall be computed using Manning's equation.

- F. Where uniform flow is anticipated, the Manning equation shall be used for hydraulic computations, and to determine the capacity of open channels, pipes, and storm sewers. Values for Manning's roughness coefficient (n) shall be consistent with Table 4 in Appendix A of this Ordinance.
- G. Outlet structures for storm water management facilities shall be designed to meet the performance standards of this Ordinance using any generally accepted hydraulic analysis technique or method.

SECTION 305. USE OF PERFORMANCE STANDARDS AND CRITERIA

The methodology for determining required storm water controls for a regulated activity is outlined below.

I. Compute:

- A. Pre-development hydrograph at the site discharge point for the 2 and 10 year, 24 hr. storm.
- B. Post-development hydrograph at the site discharge point incorporating any "non-detention" techniques such as pervious areas, swales, infiltration trenches, etc.

II. Compare:

Post-development hydrographs with pre-development hydrographs. If the peak rate of runoff and the shape of the hydrographs are nearly identical, storm water management has been achieved. Detention will not be required. If not, proceed to Item III.

III. Design:

Detention/retention facilities, in conjunction with any non-detention techniques, such that post-development peak rates from the site will not exceed pre-development levels for both the 2 and 10 year storms.

Storm water Control Determination Flow Chart

Compute Pre-Development Hydrograph and Post-Development Hydrograph incorporating any infiltration/non-Detention Techniques

Compare Hydrographs

Yes-----Does Post-Development Hydrograph-----No
Match Pre-Development Hydrograph?

Criteria Met!-----Design Detention Facilities so Post-Development Peak Rates are Less Than or Equal to Pre-Development Rates for 2 yr. and 10 year design storms.

ARTICLE IV DRAINAGE PLAN REQUIREMENTS

SECTION 401. GENERAL REQUIREMENTS

For any of the activities regulated by this Ordinance, the final approval of subdivision and/or land development plans, the issuance of any building or occupancy permit, or the commencement of any land disturbance activity may not proceed until the Property Owner or Developer or his/her agent has received written approval of a Drainage Plan from the Plan Administrator.

SECTION 402. EXEMPTIONS

- A. Any Regulated Activity that would create 15,000 square feet or less of impervious area is exempt from the Drainage Plan preparation provisions of this Ordinance. This criteria shall apply to the total development even if development is to take place in phases. Exemption shall not relieve the applicant from providing adequate storm water management to meet the purpose of this Ordinance.
- B. Land disturbance associated with existing one-and two-family dwellings.
- C. Use of land for gardening for home consumption.
- D. At the discretion of the Township, any activity, as part of an agricultural operation, which is regulated by this ordinance, may be exempt from submitting a full drainage plan. A modified plan may be required by the Township

which shall include, at a minimum, sketches of proposed work and plans for stormwater control facilities. Although this exemption may waive the need for a full drainage plan as normally required under this Ordinance, any regulated activity will still need to meet the general and technical requirements of this ordinance. Proof of no harm must be shown from the point of discharge through downstream reaches by methods acceptable to the Township.

No exemption shall be provided for Regulated Activities as defined in Section 104.E and 104.F of this Ordinance.

SECTION 403. DRAINAGE PLAN CONTENTS

The Drainage Plan shall consist of all applicable calculations, maps, and plans. A note on the maps shall refer to the associated computations and erosion and sedimentation control plan by title and date. The cover sheet of the computations and erosion and sedimentation control plan shall refer to the associated maps by title and date. All Drainage Plan materials shall be submitted to the Plan administrator in a format that is clear, concise, legible, neat, and well organized; otherwise, the Drainage Plan shall be disapproved and returned to the Applicant.

The following items shall be included in the Drainage Plan:

A. General

1. General description of project.
2. General description of permanent storm water management techniques, including construction specifications of the materials to be used for storm water management facilities.
3. Complete hydrologic, hydraulic, and structural computations for all storm water management facilities.

B. Maps(s), of the project area, shall be submitted on 24-inch X 36-inch or 30-inch X 42-inch sheets and shall be prepared in a form that meets the requirements for recording in the offices of the Recorder of Deeds of Huntingdon County. The contents of the map(s) shall include, but not be limited to:

1. The location of the project relative to highways, municipalities or other identifiable landmarks.
2. Existing contours at intervals of two feet. In areas of steep slopes (greater than 15 percent), five-foot contour intervals may be used.

3. Existing streams, lakes, ponds, or other bodies of water within the project area. A fifty (50) foot wide undisturbed vegetated buffer area shall be shown along existing streams.
4. Other physical features including flood hazard boundaries, sinkholes, streams, existing drainage courses, area of natural vegetation to be preserved, and the total extent of the upstream area draining through the site.
5. The locations of all existing and proposed utilities, sanitary sewers, and water lines within 50 feet of property lines.
6. An overlay showing soil names and boundaries.
7. Proposed changes to the land surface and vegetative cover, including the type and amount of impervious area that would be added.
8. Proposed structures, roads, paved areas, and buildings.
9. Final contours at intervals of two feet. In areas of steep slopes (greater than 15 percent), five-foot contour intervals may be used.
10. The name of the development, the name and address of the owner of the property, and the name of the individual or firm preparing the plan.
11. The date of submission.
12. A graphic and written scale of one (1) inch equals no more than fifty (50) feet; for tracts of twenty (20) acres or more, the scale shall be one (1) inch equals no more than one hundred (100) feet.
13. A North arrow.
14. The total tract boundary and size with distances marked to the nearest foot and bearings to the nearest degree.
15. Existing and proposed land uses(s).
16. A key map showing all existing man-made features beyond the property boundary that would be affected by the project, with a 500' limitation.
17. Horizontal plan and vertical profiles of all open channels, including hydraulic capacity.

18. Overland drainage paths.
19. A twenty-foot wide access easement around all storm water management facilities that would provide ingress from and egress to a public right-of-way.
20. A note on the plan indicating the location and responsibility for maintenance of storm water management facilities that would be located off-site. All off-site facilities shall meet the performance standards and design criteria specified in this Ordinance.
21. A construction detail of any improvements made to sinkholes and the location of all notices to be posted, as specified in this Ordinance.
22. A statement, signed by the landowner, acknowledging the storm water management system to be a permanent fixture that can be altered or removed only after approval of a revised plan by the Plan Administrator.
23. The following signature block for the Plan Administrator:

"I, (Plan Administrator), on this date (date of signature), have reviewed and hereby certify that the Drainage Plan meets all design standards and criteria of the Warriors Mark Township Act 167 Storm Water Management Ordinance."
24. The location of all erosion and sedimentation control facilities.

C. Supplemental Information

1. A written description of the following information shall be submitted.
 - a. The overall storm water management concept for the project.
 - b. Storm water runoff computations as specified in this Ordinance.
 - c. Storm water management techniques to be applied both during and after development.
 - d. Expected project time schedule.
2. A soil erosion and sedimentation control plan, including all reviews and approvals, as required by the Huntingdon County Conservation District.

3. A geologic assessment of the effects of runoff on sinkholes as specified in this Ordinance.
4. The effect of the project (in terms of runoff volumes and peak flows) on adjacent properties and on any existing municipal storm water collection system that may receive runoff from the project site.
5. A Declaration of Adequacy and Highway Occupancy Permit from the PADOT District Office when utilization of a PA storm drainage system is proposed.

D. Storm Water Management Facilities

1. All storm water management facilities must be located on a map and described in detail.
2. When groundwater recharge methods such as seepage pits, beds or trenches are used, the locations of existing and proposed septic tank infiltration areas and wells must be shown.
3. All calculations, assumptions, and criteria used in the design of the storm water management facilities must be shown.

SECTION 404. PLAN SUBMISSION

For all activities regulated by this Ordinance, the steps below shall be followed for submission. For any activities that require a PA DEP Joint Permit Application and are regulated under Chapter 105 (Dam Safety and Waterway Management) or Chapter 106 (Floodplain Management) of PA DEP's Rules and Regulations, require a PADOT Highway Occupancy Permit, or require any other permit under applicable state or federal regulations, the permit(s) shall be part of the plan.

1. The Drainage Plan shall be submitted by the Developer as part of the Preliminary Plan submission for the Regulated Activity.
2. Four (4) copies of the Drainage Plan shall be submitted.
3. Distribution of the Drainage Plan will be as follows:
 - a) One (1) copy to the Municipality accompanied by the requisite Municipal Review Fee, as specified in this Ordinance.
 - b) One (1) copy to the Municipal Engineers.

- c) Two (2) copies to the Plan Administrator accompanied by the requisite Plan Administrator Review Fee as specified in this Ordinance.

SECTION 405. DRAINAGE PLAN REVIEW

- A. The Plan Administrator shall review the Drainage Plan for consistency with this Ordinance.
- B. The Plan Administrator shall review the Drainage Plan for any subdivision or land development against the municipal subdivision and land development ordinance provisions not superseded by this Ordinance.
- C. For activities regulated by this Ordinance, the Plan Administrator shall notify the Municipality in writing, within 30 calendar days, whether the Drainage Plan is consistent with the Storm Water Management Plan. Should the Drainage Plan be determined to be consistent with the Storm Water Management Plan, the Plan Administrator will forward an approval letter to the Municipal Secretary with a copy to the Developer.

Should the Drainage Plan be determined to be inconsistent with the Storm Water Management Plan, the Plan Administrator will forward a disapproval letter to the Municipal Secretary and Developer citing the reason(s) for the disapproval. Any disapproved Drainage Plans may be revised by the Developer and resubmitted consistent with this Ordinance.

- D. For Regulated Activities specified in Sections 104.C and 104.D of this Ordinance, the Plan Administrator shall notify the Municipal Building Permit Officer in writing, within a time frame consistent with the Municipal Building Code, whether the Drainage Plan is consistent with the Storm Water Management Plan and forward a copy of the approval/disapproval letter to the Developer. Any disapproved drainage plan may be revised by the Developer and resubmitted consistent with this Ordinance.
- E. For Regulated Activities requiring a PA DEP Joint Permit Application, the Plan Administrator shall notify PA DEP whether the Drainage Plan is consistent with this Ordinance and forward a copy the review letter to the Municipality and the Developer. PA DEP may consider the Plan Administrator's review comments in determining whether to issue a permit.
- F. The Municipality shall not approve any subdivision or land development for Regulated Activities specified in Sections 104.A and 104.B of this Ordinance if the Drainage Plan has been found to be inconsistent with this

Ordinance, as determined by the Plan Administrator, or without considering the comments of the Municipal Engineer. All required permits from PA DEP must be obtained prior to approval.

- G. The Municipal Building Permit Officer shall not issue a building permit for any Regulated Activity specified in Section 104.C and 104.D of this Ordinance if the Drainage Plan has been found to be inconsistent with this Ordinance, as determined by the Plan Administrator, or without considering the comments of the Municipal Engineer. All required permits from PA DEP must be obtained prior to issuance of a building permit.
- H. The Developer shall be responsible for completing an "As-Built Survey" of all storm water management facilities included in the approved Drainage Plan. The As-Built Survey and an explanation of any discrepancies with the design plans shall be submitted to the Plan Administrator for final approval. In no case shall the Plan Administrator approve the As-Built Survey until the Plan Administrator receives a copy of an approved Declaration of Adequacy, Highway Occupancy Permit from the PADOT District Office, and any applicable permits from PA DEP.
- I. The Plan Administrator's approval of a Drainage Plan shall be valid for a period not to exceed one (1) year. This one-year time period shall commence on the date that the Plan Administrator signs the approved Drainage Plan. If storm water management facilities included in the approved Drainage Plan have not been constructed, or if an As-Built Survey of these facilities has not been approved within this one-year time period, then the Plan Administrator may consider the Drainage Plan disapproved and may recommend that the Municipality revoke any and all permits. Drainage Plans that are considered disapproved by the Plan Administrator shall be resubmitted in accordance with Section 407 of this Ordinance.

SECTION 406. MODIFICATION OF PLANS

A modification to a submitted Drainage Plan for a development site that involves a change in storm water management facilities or techniques, or that involves the relocation or re-design of storm water management facilities, or that is necessary because soil or other conditions are not as stated on the Drainage Plan (as determined by the Plan Administrator or the Municipal Engineer), shall require a resubmission of the modified Drainage Plan consistent with Section 404 of this Ordinance and be subject to review as specified in Section 405 of this Ordinance.

A modification to an already approved or disapproved Drainage Plan shall be submitted to the Plan Administrator, accompanied by the

applicable Plan Administrator Review Fee. A modification to a Drainage Plan for which a formal action has not been taken by the Plan Administrator shall be submitted to the Plan Administrator, accompanied by the applicable Plan Administrator Review Fee.

SECTION 407. RESUBMISSION OF DISAPPROVED DRAINAGE PLANS

A disapproved Drainage Plan may be resubmitted, with the revisions addressing the Plan Administrator's concerns documented in writing, to the Plan Administrator in accordance with Section 404 of this Ordinance and be subject to review as specified in Section 405 of this Ordinance. The applicable Plan Administrator Review Fee must accompany a resubmission of a disapproved Drainage Plan.

ARTICLE V INSPECTIONS

SECTION 501. SCHEDULE OF INSPECTIONS

- A. The Plan Administrator or his assignee shall have the option to inspect all phases of the installation of the permanent storm water management facilities.
- B. During any stage of the work, if the Plan Administrator determines that the permanent storm water management facilities are not being installed in accordance with the approved Storm Water Management Plan, the Municipality shall revoke any existing permits until a revised Drainage Plan is submitted and approved, as specified in this Ordinance.

ARTICLE VI FEES AND EXPENSES

SECTION 601. GENERAL

The fees required by this Ordinance are the Municipal Review Fee and the Plan Administrator Review Fee. The Municipal Review Fee shall be established by the Municipality to defray review costs incurred by the Municipality and the Municipal Engineer. The Plan Administrator Review Fee shall be established by the Plan Administrator to defray the Plan Administrator's review costs. All fees shall be paid by the Applicant.

SECTION 602. PLAN ADMINISTRATOR DRAINAGE PLAN REVIEW FEE

The Plan Administrator shall establish a Review Fee Schedule based on the size of the Regulated Activity and based on the Plan Administrator's costs for reviewing Drainage Plans. The Plan Administrator shall periodically update the Review Fee Schedule to ensure that review costs are adequately reimbursed.

SECTION 603. EXPENSES COVERED BY FEES

The fees required by this Ordinance shall at a minimum cover:

- A. The review of the Drainage Plan by the Plan Administrator and the Municipal Engineer.
- B. The site inspection.
- C. The inspection of storm water management facilities and drainage improvements during construction.
- D. The final inspection upon completion of the storm water management facilities and drainage improvements presented in the Drainage Plan.
- E. Any additional work required to enforce any permit provisions regulated by this Ordinance, correct violations, and assure proper completion of stipulated remedial actions.

SECTION 604. FEE EXCEPTIONS

The fees required by this Section for review costs incurred by the Municipal Engineer shall be waived by the Municipality upon certification by the Registered Engineer of the Developer and Applicant that the Drainage Plans are in compliance with this Ordinance; and that prior to Final Approval under Sec 405(H), the Engineer for the Developer shall submit a certificate of completion to the Plan Administrator.

ARTICLE VII MAINTENANCE RESPONSIBILITIES

SECTION 701. MAINTENANCE RESPONSIBILITIES

- A. The storm water management plan for the development site shall contain an operation and maintenance plan prepared by the developer and approved by the Municipal Engineer. The operation and maintenance plan shall outline required routine maintenance actions and schedules necessary to insure proper operation of the facility (ies).
- B. The storm water management plan for the development site shall establish responsibilities for the continuing operating and maintenance of all proposed storm water control facilities, consistent with the following principals:
 - 1. If a development consists of structures or lots which are to be separately owned and in which streets, sewers and other public improvements are to be dedicated to the municipality, storm water control facilities may also be dedicated to and maintained by the municipality.

2. If a development site is to be maintained as a single ownership or if sewers and other public improvements are to be privately owned and maintained, then the ownership and maintenance of storm water control facilities should be the responsibility of the owner or private management entity.
- C. The governing body, upon recommendation of the Municipal Engineer, will make the final determination on the continuing maintenance responsibilities prior to final approval of the storm water management plan. The governing body reserves the right to accept the ownership and operating responsibility for any or all of the storm water management controls.

SECTION 702. MAINTENANCE AGREEMENT FOR PRIVATELY OWNED STORM WATER FACILITIES

- A. Prior to final approval of the site's storm water management plan, the property owner shall sign and record a maintenance agreement covering all storm water control facilities which are to be privately owned. The agreement shall stipulate that:
1. The owner shall maintain all facilities in accordance with the approved maintenance schedule and shall keep all facilities in a safe and attractive manner.
 2. The owner shall convey to the municipality easements and/or rights-of-way to assure access for periodic inspections by the municipality and maintenance, if required.
 3. The owner shall keep on file with the municipality the name, address and telephone number of the person or company responsible for maintenance activities; in the event of a change, new information will be submitted to the municipality within ten (10) days of the change.
 4. If the owner fails to maintain the storm water control facilities following due notice by the municipality to correct the problem(s), the municipality may perform the necessary maintenance work or corrective work and the owner shall reimburse the municipality for all costs.
- B. Other items may be included in the agreement where determined necessary to guarantee the satisfactory maintenance of all facilities. The maintenance agreement shall be subject to the review and approval of the municipal solicitor and governing body.

SECTION 703. MUNICIPAL STORM WATER MAINTENANCE FUND

- A. Persons installing storm water storage facilities shall be required to pay a specified amount to the Municipal Storm Water Maintenance Fund to help defray costs of periodic inspections and maintenance expenses. The amount of the deposit shall be determined as follows:
1. If the storage facility is to be privately owned and maintained, the deposit shall cover the cost of periodic inspections performed by the municipality for a period of ten (10) years, as estimated by the Municipal Engineer. After that period of time, inspections will be performed at the expense of the municipality.
 2. If the storage facility is to be owned and maintained by the municipality, the deposit shall cover the estimated costs for maintenance and inspections for ten (10) years. The municipal engineer will establish the estimated costs utilizing information submitted by the applicant.
 3. The amount of the deposit to the fund shall be converted to present worth of the annual series values. The municipal engineer shall determine the present worth equivalents which shall be subject to the approval of the governing body.
- B. If a storage facility is proposed that also serves as a recreation facility (e.g., ballfield, lake), the municipality may reduce or waive the amount of the maintenance fund deposit based upon the value of the land for public recreation purposes.
- C. If at some future time a storage facility (whether publicly or privately owned) is eliminated due to the installation of storm sewers or other storage facility, the unused portion of the maintenance fund deposit will be applied to the cost of abandoning the facility and connecting to the storm sewer system or other facility. Any amount of the deposit remaining after the costs of abandonment are paid will be returned to the depositor.

ARTICLE VIII
ENFORCEMENT AND PENALTIES

SECTION 801. RIGHT-OF-ENTRY

Upon presentation of proper credentials, duly authorized

representatives of the municipality may enter at reasonable times upon any property within the municipality to investigate or ascertain the condition of the subject property in regard to any aspect regulated by this Ordinance.

SECTION 802. NOTIFICATION

In the event that a person fails to comply with the requirements of this Ordinance, or fails to conform to the requirements of any permit issued hereunder, the municipality shall provide written notification of the violation. Such notification shall set forth the nature of the violation(s) and establish a time limit for correction of these violation(s). Failure to comply within the time specified shall subject such person to the penalty provisions of this Ordinance. All such penalties shall be deemed cumulative and resort by the municipality from pursuing any and all other remedies. It shall be the responsibility of the owner of the real property on which any Regulated Activity is proposed to occur, is occurring, or has occurred, to comply with the terms and conditions of this Ordinance.

SECTION 803. PENALTIES

- A. Any person who or which has violated any provisions of this Ordinance, shall, upon a judicial determination thereof, be subject to civil judgment for each such violation of not more than Six Hundred and 00/100 Dollars \$600.00, plus costs of suit. Each day that a violation occurs shall constitute a separate offense. All fines shall be paid to the Township of Warriors Mark for its use.
- B. In addition, the Township of Warriors Mark may institute injunctive, mandamus or any other appropriate action or proceeding at law or in equity for the enforcement of this Ordinance. Any court of competent jurisdiction shall have the right to issue restraining orders, temporary or permanent injunctions, mandamus or other appropriate forms of remedy or relief.

SECTION 804. REPEAL

All Ordinances or resolutions or parts of Ordinances or resolutions, insofar as they are inconsistent herewith, be and the same are hereby repealed.

SECTION 805. SEVERABILITY

If any sentence, clause, section or part of this Ordinance is for any reason found to be unconstitutional, illegal or invalid, such unconstitutionality, illegality or invalidity shall not affect or impair any of the remaining provisions, sentences, clauses,

sections, or parts of this Ordinance. It is hereby declared as the intent of the Board of Supervisors of the Township, that this Ordinance would have been adopted had such constitutional, illegal or invalid sentence, clause, section or part thereof not been included therein.

SECTION 806. EFFECTIVE DATE

This Ordinance shall become effective five (5) days after its adoption.

ENACTED AND ORDAINED into an Ordinance this ^{14th} day of ^{OCTOBER} 1998, by the Supervisors of the Township of Warriors Mark, Huntingdon County, in Lawful Session duly assembled.

SUPERVISORS OF THE
TOWNSHIP OF WARRIORS MARK

L. Stewart Neff
William N Hoover
Donald E Bickle

ATTEST:

Mark E Brown
Secretary

APPENDIX A
GENERAL HYDROLOGIC AND HYDRAULIC
DATA

Table A-1
Permissible Velocities for Channels

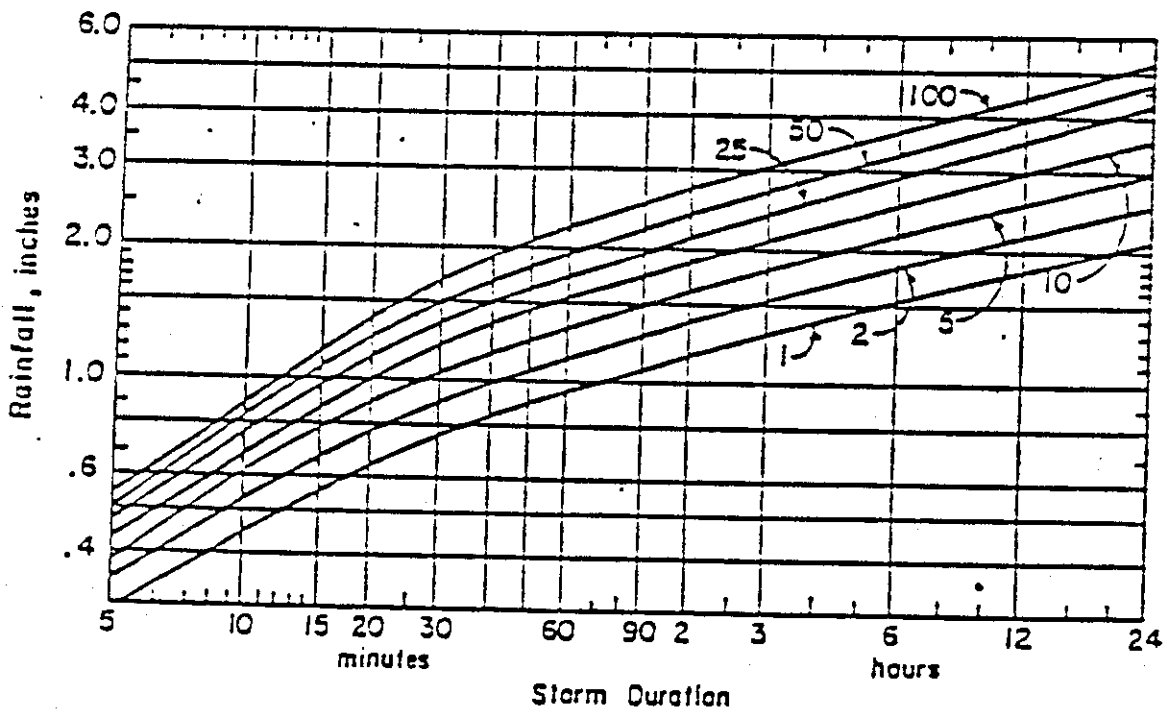
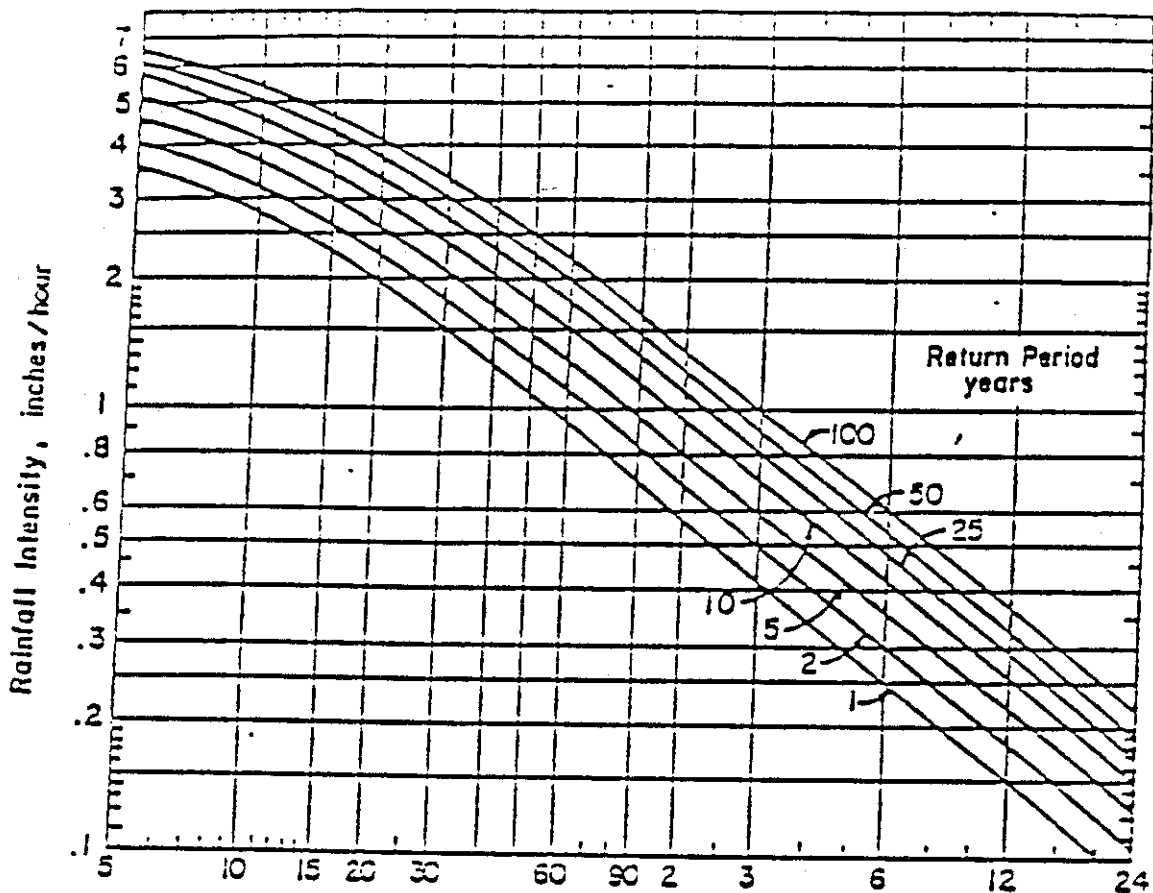
Channel Lining	n	Permissible Velocity (fps)
Bare Earth^a		
Fine sand, noncolloidal	.020	1.50 to 2.50
Sandy loam, noncolloidal	.020	1.75 to 2.50
Silt loam, noncolloidal	.020	2.00 to 3.00
Alluvial silts, noncolloidal	.020	2.00 to 3.50
Ordinary firm loam	.020	2.50 to 3.50
Stiff clay, very colloidal	.025	3.75 to 5.00
Alluvial silts, colloidal	.025	3.75 to 5.00
Shales and hardpan	.025	6.00 to 6.00
Fine gravel	.020	2.50 to 3.00
Graded loam-cobbles (when noncolloidal)	.030	3.75 to 5.00
Graded silt-cobbles (when noncolloidal)	.030	4.00 to 5.50
Coarse gravel, noncolloidal	.025	4.00 to 6.00
Cobbles and shingles	.035	5.00 to 5.50
Vegetation^b		
Kentucky Bluegrass		3 to 7
Tall Fescue		3 to 7
Grass Mixture		3 to 5
Reed Canarygrass		3 to 5
Sericea Lespedeza		2.5 to 3.5
Weeping Lovegrass		2.5 to 3.5
Redtop		2.5 to 3.5
Red Fescue		2.5 to 3.5
Annuals, temporary cover only		2.5 to 3.5
Sudangrass		2.5 to 3.5
Rock and Riprap^c		
R-1 (D ₅₀ = 0.75 inches)		2.5
R-2 (D ₅₀ = 1.50 inches)		4.5
R-3 (D ₅₀ = 3 inches)		6.5
R-4 (D ₅₀ = 6 inches)		9.0
R-5 (D ₅₀ = 9 inches)		11.5
R-6 (D ₅₀ = 12 inches)		13.0
R-7 (D ₅₀ = 15 inches)		14.5
Reno Mattress and Gabions^d		
Reno mattress, 6" thickness, rock 3-6"	.025	13.5
Reno mattress, 9" thickness, rock 3-6"	.025	16.0
Reno mattress, 12" thickness, rock 4-6"	.025	18.0
Gabion, 18" thickness, rock 5-9"	.027	22.0

- Notes:
- Listed n values assume good to excellent construction techniques which provide uniform channel dimensions. Values should be adjusted using SCS Engineering Handbook #5, Supplement 2, for other conditions. Velocities are for straight channels where slope < 0.02 ft/ft. Lower velocities are for clear water; higher velocities are for water transporting colloidal silts.
 - Lowest values are for easily eroded soils at > 10 percent slope; highest values are for erosion resistant soils at < 5 percent slope. Velocities > 5 fps are for use only where good cover and proper maintenance are obtained. 3.0 fps is the maximum velocity for sparse cover conditions. When supplemented by stone centers or erosion resistant materials, velocities may be increased by 2.0 fps. When base flow exists, a rock lined low flow channel should be incorporated into the vegetative lined channel section.
 - Permissible velocities based on rock at 165 lbs. per cubic foot. Adjust velocities for other rock weights in accordance with PA DER Erosion and Sediment Pollution Control Program Manual, 1990, Figure 4.6.
 - Permissible velocities may be increased by the introduction of sand mastic grout in accordance with manufacturers' specifications.

For other materials not listed in this table, refer to PA DER Erosion and Sediment Pollution Control Program Manual, 1990.

Source: PA DER Bureau of Soil and Water Conservation, 1990, Erosion and Sediment Pollution Control Program Manual, Chapter 4.

Figure A
Design Storm Curves
Warriors Mark Township



Source: Aron, G. et al., 1986, Field Manual of Pennsylvania Department of Transportation Storm Intensity-Duration-Frequency Charts, Department of Civil Engineering and Institute for Research on Land and Water Resources, Pennsylvania State University, University Park, PA.

Table 1-1
 Runoff Curve Numbers and Average Imperviousness
 For Various Land Uses by Hydrologic Soil Group

Cover Description Land Use/Cover Type	Average Imperviousness (%)	Curve Numbers For Hydrologic Soil Group			
		A	B	C	D
Open Space (lawns, parks, golf courses, cemeteries, etc.):					
Good condition (grass cover greater than 75%)	n/a ^a	39	61	74	80
Impervious Areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)	n/a	98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)	n/a	98	98	98	98
Paved; open ditches (including right-of-way)	n/a	98	98	98	98
Urban Districts:					
Commercial and business	95	89	92	94	95
Industrial	72	81	88	91	93
Residential Districts by Average Lot Size:					
1/8 acre or less (town houses)	65	77	89	90	93
1/4 acre	53	61	75	81	87
1/3 acre	39	57	72	81	88
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	48	65	77	82
Woods:	n/a	30	55	70	77

^a Not applicable.

Source: U.S. Department of Agriculture, Soil Conservation Service, Engineering Division, 1986, "Urban Hydrology for Small Watersheds," Technical Release 55, Washington, DC.

Table A-3

Runoff Coefficients for the National Formula
By Hydrologic Soil Group and Overland Slope (%)

Land Use	A			B			C			D		
	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+	0-2%	2-6%	6%+
Cultivated Land	0.00 ^a 0.14 ^b	0.13 0.18	0.18 0.22	0.11 0.16	0.15 0.21	0.21 0.28	0.14 0.20	0.19 0.25	0.26 0.34	0.18 0.24	0.23 0.29	0.31 0.41
Pasture	0.12 0.15	0.20 0.25	0.30 0.37	0.10 0.23	0.20 0.34	0.37 0.45	0.24 0.30	0.34 0.42	0.44 0.52	0.30 0.37	0.40 0.50	0.50 0.62
Forest	0.10 0.14	0.16 0.22	0.25 0.30	0.14 0.20	0.22 0.28	0.30 0.37	0.20 0.28	0.28 0.35	0.36 0.44	0.24 0.30	0.30 0.40	0.40 0.50
Residential	0.05 0.08	0.08 0.11	0.11 0.14	0.09 0.10	0.11 0.14	0.14 0.18	0.10 0.12	0.13 0.16	0.16 0.20	0.16 0.15	0.16 0.20	0.20 0.25
Lot Size 1/8 Acre	0.25 0.33	0.28 0.37	0.31 0.40	0.27 0.35	0.30 0.39	0.35 0.44	0.30 0.30	0.33 0.42	0.38 0.49	0.33 0.41	0.36 0.45	0.42 0.54
Lot Size 1/4 Acre	0.22 0.30	0.29 0.34	0.29 0.37	0.24 0.33	0.29 0.37	0.33 0.42	0.27 0.36	0.31 0.40	0.36 0.47	0.30 0.38	0.34 0.42	0.39 0.52
Lot Size 1/3 Acre	0.19 0.28	0.23 0.32	0.26 0.35	0.22 0.30	0.26 0.35	0.30 0.39	0.25 0.33	0.29 0.38	0.34 0.45	0.28 0.36	0.32 0.40	0.39 0.50
Lot Size 1/2 Acre	0.16 0.25	0.20 0.29	0.24 0.32	0.19 0.28	0.23 0.32	0.28 0.36	0.22 0.31	0.25 0.35	0.31 0.42	0.26 0.34	0.30 0.38	0.37 0.48
Lot Size 1 Acre	0.14 0.22	0.19 0.28	0.22 0.29	0.17 0.24	0.21 0.28	0.26 0.34	0.20 0.28	0.25 0.32	0.31 0.40	0.24 0.31	0.29 0.35	0.35 0.46
Industrial	0.07 0.05	0.09 0.05	0.08 0.06	0.05 0.05	0.06 0.06	0.09 0.08	0.09 0.06	0.09 0.08	0.09 0.08	0.09 0.08	0.09 0.06	0.09 0.06
Commercial	0.07 0.05	0.09 0.05	0.08 0.06	0.05 0.05	0.06 0.06	0.09 0.08	0.09 0.06	0.09 0.08	0.09 0.08	0.09 0.08	0.09 0.06	0.09 0.06
Streets	0.71 0.08	0.71 0.08	0.72 0.09	0.71 0.09	0.72 0.09	0.72 0.09	0.72 0.09	0.72 0.09	0.72 0.09	0.72 0.09	0.72 0.09	0.72 0.09
Down Slope	0.70 0.76	0.71 0.77	0.72 0.79	0.71 0.80	0.72 0.82	0.74 0.84	0.72 0.84	0.73 0.85	0.76 0.89	0.73 0.89	0.75 0.91	0.78 0.95
Parking	0.05 0.11	0.10 0.16	0.14 0.20	0.08 0.14	0.13 0.19	0.19 0.28	0.12 0.18	0.17 0.23	0.24 0.32	0.18 0.22	0.21 0.27	0.28 0.39
	0.85 0.95	0.88 0.98	0.87 0.97	0.85 0.95	0.88 0.98	0.87 0.97	0.85 0.95	0.88 0.98	0.87 0.97	0.85 0.95	0.88 0.98	0.87 0.97

^a Runoff coefficients for storm recurrence intervals less than 25 years.
^b Runoff coefficients for storm recurrence intervals of 25 years or more.
 Source: Gaillard, W.J., S.L. Wong and R.H. McCorn, 1981, "Comparison of Urban Flood Frequency Procedures," Preliminary Draft, U.S. Department of Agriculture, Soil Conservation Service, Beltsville, MD.

Table A-4

Manning Roughness Coefficients

	Manning's n range		Manning's n range
I. Closed Conduits:			
A. Concrete pipe	0.011-0.013	B. Earth, fairly uniform section:	
B. Corrugated-metal pipe or pipe arch:		1. No vegetation	0.022-0.025
1. 2-2/3 by 1/2 in. corrugation		2. Grass, some weeds	0.025-0.030
(riveted) pipe):		3. Dense weeds or aquatic plants	
a. Plain or fully coated	0.024	in deep channels	0.030-0.035
b. Paved Invert (range values		4. Sides clean, gravel bottom ...	0.025-0.030
are for 25 and 50 percent		5. Sides clean, cobbles bottom ...	0.030-0.040
of circumference paved):		C. Dragline excavated or dredged:	
(1) Flow full depth	0.021-0.018	1. No vegetation	0.028-0.033
(2) Flow 0.8 depth	0.021-0.016	2. Light brush on banks	0.035-0.050
(3) Flow 0.6 depth	0.019-0.013	D. Rock:	
2. 8 by 2-in. corrugation		1. Based on design section	0.035
(field bolted)	0.030	2. Based on actual, mean section:	
C. Cast-iron pipe, uncoated	0.013	a. Smooth and uniform	0.035-0.040
D. Steel pipe	0.009-0.011	b. Jagged and irregular	0.040-0.045
E. Monolithic concrete:		E. Channels not maintained, weeds	
1. Wood forms, rough	0.015-0.017	and brush uncut:	
2. Wood forms, smooth	0.012-0.014	1. Dense weeds, high as flow depth	0.030-0.120
3. Steel forms	0.012-0.013	2. Clean bottom, brush on sides .	0.050-0.060
F. Cemented rubble masonry walls:		3. Clean bottom, brush on sides,	
1. Concrete floor and top	0.017-0.022	highest stage of flow	0.070-0.110
2. Natural floor	0.019-0.025	4. Dense brush, high stage	0.100-0.140
II. Open Channels, Lined (straight alignment):			
A. Concrete, with surfaces as		IV. Channels & Swales w/Maintained	
indicated:		Vegetation (Values shown are for	
1. Formed, no finish	0.013-0.017	velocities of 2 & 8 f.p.s.):	
2. Trowel finish	0.012-0.014	A. Depth of flow up to 0.7 feet:	
3. Float finish	0.013-0.015	1. Bermudagrass, Kentucky	
4. Float finish, some gravel on		bluegrass, buffalograss	
bottom	0.015-0.017	a. Mowed to 2 inches	0.045-0.070
5. Granite, good section	0.018-0.019	b. Length 4-6 inches	0.050-0.090
6. Granite, wavy section	0.018-0.022	2. Good stand, any grass:	
B. Concrete, bottom float finished,		a. Length about 12 inches	0.090-0.150
sides as indicated:		b. Length about 24 inches	0.150-0.300
1. Dressed stone in mortar	0.015-0.017	3. Fair stand, any grass:	
2. Random stone in mortar	0.017-0.020	a. Length about 12 inches	0.080-0.140
3. Cement rubble masonry	0.020-0.025	b. Length about 24 inches	0.130-0.250
4. Cement rubble masonry,		B. Depth of flow 0.7-1.5 feet:	
plastered	0.015-0.020	1. Bermudagrass, Kentucky	
5. Dry rubble (riprap)	0.020-0.030	bluegrass, buffalograss:	
C. Gravel bottom, sides as indicated:		a. Mowed to 2 inches	0.035-0.050
1. Formed concrete	0.017-0.020	b. Length 4 to 8 inches	0.040-0.050
2. Random stone in mortar	0.020-0.023	2. Good stand, any grass:	
3. Dry rubble (riprap)	0.023-0.033	a. Length about 12 inches	0.070-0.120
D. Asphalt:		b. Length about 24 inches	0.100-0.200
1. Smooth	0.013	3. Fair stand, any grass:	
2. Rough	0.018	a. Length about 12 inches	0.050-0.100
E. Concrete-lined excavated rock:		b. Length about 24 inches	0.090-0.170
1. Good section	0.017-0.020	V. Street and Expressway Gutters:	
2. Irregular section	0.022-0.027	A. Concrete gutter, troweled finish	0.012
III. Open Channels, Excavated (straight alignment, natural lining):			
A. Earth, uniform sections:		B. Asphalt pavement:	
1. Clean, recently completed	0.016-0.018	1. Smooth texture	0.013
2. Clean, after weathering	0.018-0.020	2. Rough texture	0.016
3. With short grass, few weeds ..	0.022-0.027	C. Concrete gutter with asphalt	
4. In gravelly soil, uniform		pavement:	
section, clean	0.022-0.025	1. Smooth	0.013
		2. Rough	0.015
		D. Concrete pavement:	
		1. Float finish	0.014
		2. Broom finish	0.016
		E. For gutters with small slope,	
		where sediment may accumulate,	
		increase above values of x by ...	0.002

Source: Chow, V.T., 1959, "Open Channel Hydraulics," McGraw Hill, New York.

Table A-4 (continued)

Manning Roughness Coefficients

	Manning's n range	Manning's n range
VI. Natural Stream Channels:		
A. Minor streams (surface width at flood stage less than 100 feet):		
1. Fairly regular sections:		
a. Some grass & weeds, little or no brush	0.030-0.035	
b. Dense growth of weeds, depth of flow materially greater than weed height ..	0.035-0.050	
c. Some weeds, light brush on banks	0.035-0.050	
d. Some weeds, heavy brush on banks	0.050-0.070	
e. Some weeds, dense willows on banks	0.050-0.080	
f. For trees within channel with branches submerged at high stage, increase all above values by	0.010-0.020	
2. Irregular sections, with pools, slight channel meander; increase values given in 1a-f about	0.010-0.020	
3. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stage		
a. Bottom of gravel, cobbles and few boulders	0.040-0.050	
b. Bottom of cobbles, with large boulders	0.050-0.070	
3. Flood plains (adjacent to natural streams):		
1. Pastures, no brush:		
a. Short grass	0.030-0.035	
b. High grass	0.035-0.050	
2. Cultivated areas:		
a. No crop	0.030-0.040	
b. Mature row crops	0.035-0.045	
c. Mature field crops	0.040-0.050	
3. Heavy weeds, scattered brush ..	0.050-0.070	
4. Light brush and trees:		
a. Winter	0.050-0.060	
b. Summer	0.060-0.080	
5. Medium to dense brush:		
a. Winter	0.070-0.110	
b. Summer	0.100-0.160	
6. Dense willows, summer, not bent over by current		
	0.150-0.200	
7. Cleared land w/tree stumps, 100-150 per acre:		
a. No sprouts	0.040-0.050	
b. With heavy growth of sprouts	0.060-0.090	
8. Heavy stand of timber, a few down trees, little undergrowth:		
a. Flood depth below branches	0.100-0.120	
b. Flood depth reaches branches	0.120-0.160	
C. Major streams (surface width at flood stage more than 100 ft.): Roughness coefficient is usually less than for minor streams of similar description on account of less effective resistance offered by irregular banks or vegetation on banks. Values of n may be somewhat reduced. Follow recommendation in publication cited if possible. The value of n for larger streams of most regular section, with no boulders or brush, may be in the range of....		
	0.025-0.033	

Source: Chow, V.T., 1959, "Open Channel Hydraulics," McGraw Hill, New York.