

This version of the Bethel Township Stormwater Management Ordinance of 2006, is provided for your convenience.

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Bethel Township

Berks County

Pennsylvania

STORMWATER MANAGEMENT ORDINANCE

ORDINANCE NO. 2006-04, 2006

AN ORDINANCE OF THE TOWNSHIP OF BETHEL, BERKS COUNTY, PENNSYLVANIA, SETTING FORTH A PLAN FOR STORMWATER MANAGEMENT IN THE TOWNSHIP; SETTING FORTH GENERAL PROVISIONS, DEFINITIONS, REQUIREMENTS FOR STORMWATER MANAGEMENT AND PROCEDURES, INSPECTION REQUIREMENTS, PROVISIONS FOR FEES AND EXPENSES, ENFORCEMENT AND PENALTIES

BE IT ENACTED AND ORDAINED by the Board of Supervisors of the Township of Bethel, Berks County, Pennsylvania, and it is hereby enacted and ordained by the authority of the same as follows:

Section 1. Title. This Ordinance shall be known as the Bethel Township Stormwater Management Ordinance.

Section 2. Statement of Findings. The governing body of the Township of Bethel (the "Township") finds that:

(a) Inadequate management of accelerated runoff of stormwater resulting from development throughout a watershed increases flood flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of streams and storm sewers, greatly increases the cost of public facilities to carry and control stormwater, undermines flood plain management and flood control efforts in downstream communities, reduces groundwater recharge and threatens public health and safety.

(b) A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated erosion, is fundamental to the public health, safety and welfare and the protection of the people of the Township and all of the people of the Commonwealth of Pennsylvania, their resources and the environment.

Section 3. Purposes. The purpose of this Ordinance is to promote public health, safety and welfare by minimizing the damages described in Section 2 of this Ordinance by provisions designed to:

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- (a) Control accelerated runoff and erosion and sedimentation problems at their source by regulating activities which cause such problems.
- (b) Utilize and preserve the desirable existing natural drainage systems.
- (c) Maintain the existing flow and quality of streams and water courses in the Township and in the Commonwealth of Pennsylvania.
- (d) Preserve and restore the flood carrying capacity of streams.
- (e) Provide for proper maintenance of all permanent stormwater management structures which are constructed in the Township.
- (f) Insure adequate drainage of all low points along the line of streets.
- (g) Intercept stormwater runoff along streets at intervals related to the extent and grade of the area drained.
- (h) Establish criteria for computing stormwater runoff.
- (i) Provide positive drainage away from on-site sewage disposal facilities and buildings.

Section 4. Statutory Authority. The Township is empowered to regulate these activities by the authority of the Act of October 4, 1978, P.L. 864, No. 167, known as the "Stormwater Management Act", and pursuant to the express and implied powers granted under the Second Class Township Code and the Municipalities Planning Code, as amended.

Section 5. Applicability. The following activities are included within the scope of this ordinance:

- (a) Land development.
- (b) Subdivision.
- (c) Construction of new or additional impervious or semi-pervious areas which total ten thousand (10,000) square feet or more from the effective date of this Ordinance.
- (d) Diversion or piping of any natural or man-made stream channel.
- (e) Installation, alteration, modification or removal of stormwater systems or appurtenances thereto.
- (f) Any other activity where the Township determines that said activity may adversely affect any existing watercourses, stormwater management facilities or stormwater runoff patterns.

Section 6. Modifications.

(a) **Modification of These Provisions by the Township Supervisors.** The provisions of this Ordinance are intended as minimum standards for the protection of the public health, safety and welfare. The Township Supervisors may modify or extend said provisions in individual cases as may be deemed necessary in the public interest as set forth hereinafter; provided, however, that such variation shall not have the effect of nullifying the intent and purpose of this Ordinance. If the literal compliance with any mandatory provisions of these regulations is shown to be unreasonable as applied to a specific property, the Township Supervisors may grant a waiver, which is defined herein.

(b) **Modification to Approved Plans.** No changes, erasures, modifications or revisions shall be made in any documentation after approval has been made by the Township Supervisors, unless said documentation is first resubmitted to and approved by the Township Supervisors. In all cases "as built" plans must be provided prior to final release of security during the improvements phase.

Section 7. Warning and Disclaimer of Liability. The degree of stormwater protection sought by the provisions of this Ordinance is considered reasonable for regulatory purposes and is based on acceptable engineering methods of study. THIS ORDINANCE DOES NOT IMPLY THAT AREAS SUBJECT TO THE STORMWATER MANAGEMENT REQUIREMENTS OF THIS ORDINANCE WILL BE FREE FROM FLOODING OR FLOOD DAMAGES. The making of an administrative decision shall not constitute a representation, guarantee or warranty of any kind by the Township, or by any official, employee or agent thereof, of the practicability or safety of any proposed structure or use with respect to damage from erosion, sedimentation, stormwater runoff or floods, and shall not create liability upon, or cause of action against, the Township, its officials, employees or agents.

Section 8. Definitions and General Statement. Words used in the present tense shall include the future tense. Words in the singular shall include the plural and words in the plural shall include the singular. The word "shall" and "will" are mandatory; the word "should" and "may" are permissive. Terms not defined in this Ordinance shall have the meaning customarily assigned to them.

Unless otherwise expressly stated, the following words shall, for the purpose of this Ordinance, have the meaning herein indicated:

(a) **Accelerated Erosion.** The removal of the surface of the land thorough the combined action of man's activities and natural processes at a rate greater than would occur because of the natural process alone.

(b) **Conservation District.** The Berks County Conservation District.

(c) **County.** The County of Berks, Commonwealth of Pennsylvania.

(d) **Culvert.** A pipe, conduit or similar structure including appurtenant works which carries surface water under or through an embankment or fill.

(e) **Design Storm.** The magnitude of precipitation from a storm event measured in probability of occurrence (e.g., 50-year storm) and duration (e.g. 24-hour), and used in computing stormwater management control systems.

(f) **Detention Basin.** A basin designed to retard stormwater runoff by temporarily storing

the runoff and releasing it at a predetermined rate.

- (g) **Developer and/or Subdivider.** A person or persons, partnership, association, corporation or other entity, or any responsible person therein or agent thereof, that undertakes the activities covered by this Ordinance. In this Ordinance a developer and subdivider are used interchangeably.
- (h) **Drainage Easement.** A right granted by a landowner to a grantee, allowing the use of private land for stormwater management purposes.
- (i) **Erosion.** The removal of soil particles by the action of water, wind, ice or other agents.
- (j) **Grade.** The inclination, with the horizontal, of a road, unimproved land, etc., which is generally expressed by stating the vertical rise or fall as a percentage of the horizontal distance.
- (k) **Impervious Surface.** A surface which prevents the percolation of water into the ground.
- (l) **Improvements.** Those physical additions and changes to the land that may be necessary to produce usable and desirable lots.
- (m) **Infiltration Structures.** A structure designed to direct runoff into the ground, e.g. french drains, seepage pits and seepage trenches.
- (n) **Land Disturbance.** Any activity involving grading, tilling, digging or filling of ground, or stripping of vegetation, or any other activity which causes land to be exposed to the danger of erosion.
- (o) **Lot.** A designated parcel, tract or area of land established by a plan or otherwise as permitted by law and to be used, developed or built upon as a unit.
- (p) **Owner.** Any person, firm, association, syndicate, co-partnership or corporation having proprietary interest in any land sought to be subdivided or developed pursuant to this Ordinance.
- (q) **Parcel.** See Lot above.
- (r) **Peak Discharge.** The maximum rate of flow of water at a given point and time resulting from a specified storm event.
- (s) **Retention Basin.** A basin designed to retain stormwater runoff with its primary release of water being through the infiltration of said water into the ground.
That part of precipitation which flows over the land.
- (t) **SCS.** Soil Conservation Service, U.S. Department of Agriculture.
- (u) **Sediment.** Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site or origin by water.
- (v) **Storm Sewer.** A system of pipes or other conduits which carries intercepted surface

runoff water, or drainage, but excludes domestic sewage and industrial wastes.

- (w) **Swale.** A wide, shallow ditch which carries surface water runoff.
- (x) **Township.** The Township of Bethel, Berks County, Pennsylvania.
- (y) **Planning Commission.** The Bethel Township Planning Commission.

(z) **Waiver.** A dispensation, granted by the Township Supervisors, from the terms and conditions of this Ordinance where literal enforcement would cause greater economic, planning or site management difficulties than the strict enforcement of this Ordinance would accomplish and when granting of the dispensation would not be contrary to the public interest.

Section 9. Submissions. When subdivision or land development plans as defined by the Municipalities Planning Code are submitted, whether preliminary or final or for approval in sections, or any other plans are submitted as required by this or any other Ordinance, a stormwater management plan in accordance with this Ordinance for the entirely developed project shall be submitted. A note stating that a residue parcel is for "Future Development" or will remain as "agriculture" must be supported with data regarding these uses. If temporary facilities are required for construction of a section, such facilities shall be included in the plans submitted.

Section 10. Applicable Regulations. Where applicable, stormwater management facilities shall comply with the requirements of Chapter 105 of Title 25, or any successor title or chapter of rules and regulations of the Pennsylvania Department of Environmental Protection, as set forth in the Pennsylvania Code and any and all other State and Federal regulations which may apply. Approval of a stormwater management plan by the Township shall not be construed as an indication that the plan complies with the standards of any agency of the Commonwealth of Pennsylvania.

Stormwater management plans which involve a State highway shall be subject to the approval of the Pennsylvania Department of Transportation.

Section 11. Stormwater Calculations and Plan and Report Requirements.

11.(a) A plan indicating the pre-developed drainage areas and time of concentration flow paths used shall be submitted. This plan shall indicate the pre-developed contours of the site in such detail as to be field verified, and shall show all existing stormwater facilities within 200 feet of the property being developed.

11.(b) A plan indicating the post-developed drainage areas, time of concentration flow paths, and all drainage facilities shall be submitted. This plan shall indicate the post-developed drainage areas, time of concentration flow paths, and all drainage facilities, including plan and profile views of the facilities. This plan shall indicate the post-developed contours of the site. All facilities shall be labeled in an easily understandable manner consistent with the stormwater management report.

11.(c) A stormwater management report including all assumptions, methods, references, and calculations for all stormwater drainage facilities shall be submitted.

11.(d) The methodology for calculating stormwater runoff shall be either the Soil Cover Complex Method or

the Rational method.

11.(e) Runoff coefficients utilized in all calculations shall be those as shown in this Ordinance.

11.(f) For pre-development computations, all runoff coefficients shall be based on actual land use assuming summer or good land cover conditions.

11.(g) For post-development computations, all runoff coefficients for cultivated land and fallowed fields shall be based on a winter or poor land cover condition.

11.(h) Pre-developed runoff shall be calculated for the 2, 10, 25, and 100 year storm events.

11.(i) Post-developed runoff rates shall be restricted as follows for each pre-developed drainage area:

1. -The post-developed 10 year storm event peak discharge shall not exceed the pre-developed 2 year storm event peak discharge.

2. -The post-developed peak discharge for the 25, and 100 year storm events shall not exceed the peak discharge for the corresponding pre-developed storm events. In order to achieve this, it is recommended that methods be considered that will direct runoff from impervious areas to pervious areas or infiltration trenches, that will retain/detain the runoff, or, by some other means suitable to the Township Engineer, reduce the post-developed runoff rate to the pre-developed runoff rate as required.

3. -The post developed 25 year storm event peak discharge shall not exceed the capacity of the receiving stormwater facilities. Calculations shall be provided indicating pre and post developed 25 year peak discharge for all receiving stormwater facilities.

11.(j) Stormwater runoff shall discharge to an existing watercourse with defined bed and barriers or an existing storm drainage system. A point discharge from a stormwater pipe shall not be permitted within 50 feet of any surface waters or any waters defined as Waters of the Commonwealth. All point discharges from stormwater pipes within 100 feet of surface waters or Waters of the Commonwealth shall utilize Best Management Practices established by DEP or other applicable authorities. Stormwater shall not be concentrated onto adjacent properties such that the velocity of the flow for a 25 year storm event peak discharge would be increased beyond that existing prior to subdivision, land development or the commencement of land disturbance activities unless written approval is given by the adjacent property owners to the proposed discharge of surface runoff and the written agreements are approved by the Township. Calculations shall be provided indicating pre and post developed 25 year peak discharge velocities for all receiving stormwater facilities.

11.(k) When storm drainage will be directed into an adjacent municipality, all provisions for accommodating such storm drainage shall be submitted to the governing body of that municipality for review.

Section 12. Ground Water Recharge (Infiltration/Recharge/Bioretenion)

Maximizing the ground water recharge capacity of the area being developed is required. Design of the infiltration stormwater management facilities shall give consideration to providing ground water recharge to compensate for the reduction in the percolation that occurs when the ground surface is disturbed or impervious surface is created. It is recommended that roof runoff be directed to infiltration BMPs which can be over-designed to compensate for the infiltration losses due to parking areas. It is recommended

that roof runoff be directed to infiltration BMPs which may be designed to compensate for the runoff from parking areas.

Infiltration may not be feasible on every site due to site-specific limitations such as soil type. If it cannot be physically accomplished, due to seasonal high water table, soil permeability rate, soil depth or setback distances from special geologic features, then the design professional shall be responsible to show that this cannot be **physically** accomplished. If it can be physically accomplished, then the volume of runoff to be infiltrated shall be determined from Section 12.A.3 depending on demonstrated site conditions.

A. Infiltration BMPs shall meet the following minimum requirements:

1. Infiltration Requirements:
 - a. Regulated activities will be required to infiltrate, where site conditions permit, a portion of the runoff created by the development as part of an overall stormwater management plan designed for the site. The volume of runoff to be infiltrated shall be determined from Section 12.A.3.
2. Infiltration BMPs intended to receive runoff from developed areas shall be selected based on suitability of soils and site conditions and shall be constructed on soils that have the following characteristics:
 - a. A minimum depth of 36 inches between the bottom of the BMP and the limiting zone.
 - b. An infiltration and/or percolation rate sufficient to accept the additional stormwater load and drain completely as determined by field tests conducted by the Applicant's design professional.
 - c. The infiltration facility shall be capable of completely infiltrating the required retention (infiltration) volume within 4 days (96 hours).
 - d. Pretreatment shall be provided prior to infiltration.
3. The size of the infiltration facility shall be based upon the following volume criteria:
 - a. NRCS Curve Number equation.

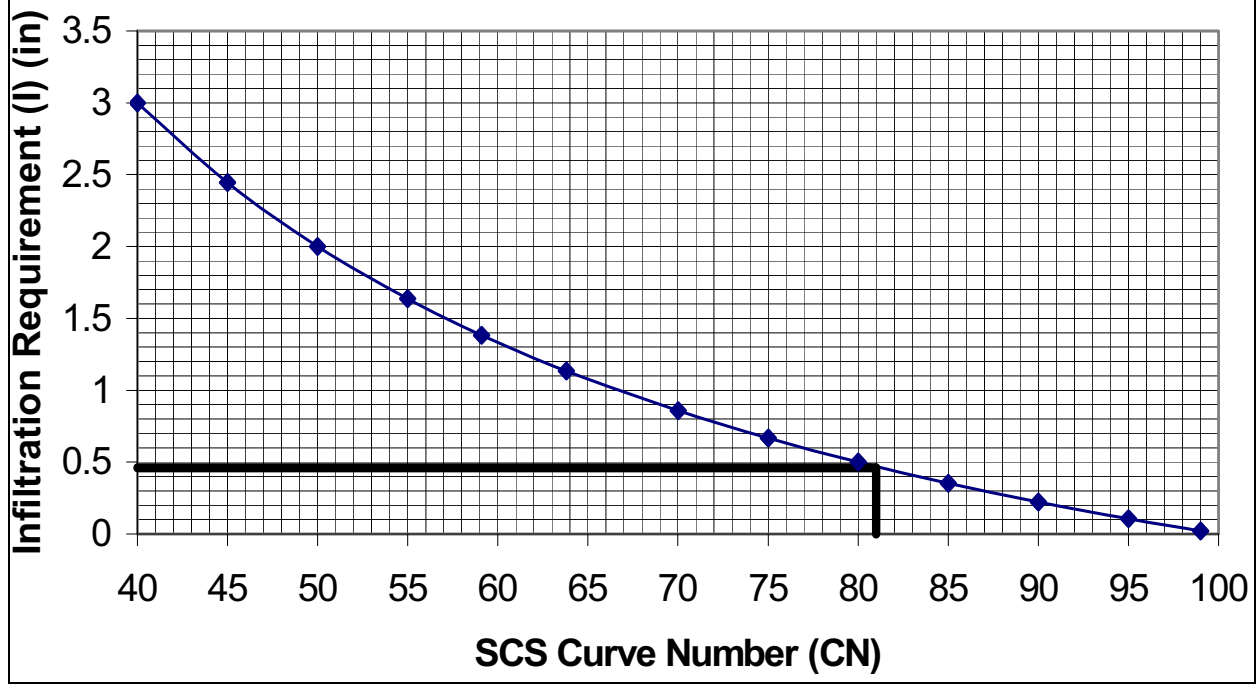
The NRCS runoff equation shall be utilized to calculate infiltration requirements (I) in inches.

$$I \text{ (Infiltration requirement, in inches)} = (200 / \text{CN}) - 2$$

Where:

CN = SCS (NRCS) curve number of existing conditions contributing to the infiltration facility.

Required Infiltration (I) in inches by NRCS CN



Infiltration requirement based upon NRCS Curve Number.

The retention (infiltration) volume (Re_v) required to meet the infiltration requirement would therefore be computed as:

$$Re_v = I * \text{impervious area (square feet)} / (12 \text{ in/ft}) = \text{Cubic Feet}$$

Where:

I = infiltration requirements (in inches.)

SECTION 13. SWALES, PIPES, CULVERTS AND OTHER CONVEYANCE FACILITIES

13.(a) All stormwater conveyance facilities that service drainage areas within the project site shall be designed based on the 25 year storm event peak discharge to the facility.

13.(b) All stormwater conveyance facilities that convey offsite stormwater through the project site shall be designed based on the 50 year storm event peak discharge to the facility.

13.(c) All stormwater conveyance facilities shall, however, be designed such that the runoff from the 100 year storm event will be able to be conveyed within defined facilities without causing any damage to the public and private property.

13.(d) All stormwater pipes to be maintained by the Township shall be reinforced cement concrete pipe.

- 13.(e)** All pipes shall have a minimum diameter of 15 inches, and a minimum slope of 0.35%. The crown of the pipe shall be at least 12" below the subgrade elevation.
- 13.(f)** Changes in horizontal or vertical direction of pipes shall be accomplished by installing an inlet, manhole or junction box.
- 13.(g)** All stormwater facilities and appurtanances shall be in accordance with PennDOT Form 408, as amended, and in accordance with the requirements of PennDOT's Standards for Roadway Construction, as amended.
- 13.(h)** All storm sewer crossings of streets shall be perpendicular to the street centerline.
- 13.(i)** Trench excavations within street right-of-way areas shall be backfilled with suitable stone aggregate materials from the bottom of the trench to the subgrade elevation; all other areas shall be backfilled with suitable stone aggregate materials from the bottom of the trench to the pipe spring line elevation.
- 13.(j)** Inlets shall be utilized at all inlet ends of pipes within street rights-of-way. Inlets shall also be placed on both sides of the street at low points, at a maximum of 600 feet apart, and at points where the flow in gutters exceeds 3 inches. Inlet capacity information shall be provided for all inlets. All inlets shall have bicycle-proof inlet grates.
- 13.(k)** Where headwalls are utilized, protective grating shall be provided in a manner similar to the detail provided herein.
- 13.(l)** Endwalls and endsections shall be used where stormwater runoff discharges from a stormwater pipe or culvert.
- 13.(m)** The capacities of swales and open channels shall be computed from the Manning Equation. Verification that the velocity in the swale does not exceed the permissible velocity for the design swale lining shall be provided. The Pennsylvania DEP Soil Erosion and Sedimentation Control Manual shall be utilized for this purpose. Swales within Township rights- of-way shall be designed such that they can be maintained with existing Township equipment and resources. All such swale linings and configurations shall be subject to review and approval by the Board of Supervisors. Rip-rap lined swales within Township rights-of-way shall be avoided, but may be allowed if specifically approved by the Board of Supervisors.
- 13.(n)** Stormwater velocities at pipe outlets shall be calculated. Outlet protection consisting of a riprap apron or other suitable control measure shall be provided in accordance with the Pennsylvania DEP Soil Erosion and Sedimentation Control Manual.
- 13.(o)** When drainage swales are traversed by driveways or other crossings, design and construction details of the crossings shall be provided, and calculations indicating that the swales will continue to function in accordance with the swale design shall be provided.

SECTION 14. BASINS

- 14.(a)** Retention/detention facilities shall be designed such that the post- to pre - development requirements

set forth herein are met.

14.(b) All swales, pipes, culverts and other conveyance facilities associated with a basin shall fall under the jurisdiction of Section 13 of this Ordinance.

14.(c) Basins shall be designed with an emergency spillway, located in virgin ground, capable of handling the entire 100 year post-developed flow assuming all other outlet facilities are completely blocked. The emergency spillway water discharge elevation shall be at an elevation at least one foot below the top of the basin berm, and the emergency spillway elevation shall be at least six inches above the highest principal outlet.

14.(d) The top of the berm shall be at least 12" above the peak water elevation for the 100 year storm event.

14.(e) Compaction requirements and berm material requirements for the impoundment embankment shall be provided to demonstrate that the embankment will be structurally sound under all probable operating conditions.

14.(f) Pond retention times shall not exceed 24 hours after the end of the design storm events (where infiltration is being utilized, the retention times required under that section shall be met).

14.(g) Maximum water depth shall not exceed 6 feet.

14.(h) Minimum top width of embankments shall be 3 feet.

14.(i) Determination of the need for protection around the perimeter of basins shall be the responsibility of the applicant, and shall be subject to review by the Township.

14.(j) Minimum grades for turf areas inside detention basins shall be one (1) percent.

14.(k) Maximum side slopes of detention basins shall be 3 horizontally to 1 vertical.

14.(l) A cutoff trench of impervious material shall be provided.

14.(m) Properly spaced and sized concrete cutoff collars or factory welded anti-seep collars shall be provided.

14.(n) Drainage easements, with complete dimensions, shall be provided, at a minimum, corresponding to the 100 year water elevation.

SECTION 15. MAINTENANCE

15.(a) All plans shall clearly indicate on the plan(s) to be recorded the ownership and maintenance responsibility of all stormwater facilities.

15.(b) When any stormwater management facility is located on an individual lot, and when maintenance thereof is the responsibility of that landowner, a description of the facility or systems and the terms of the required maintenance shall be incorporated on a plan of the property. The plan shall be recorded with the

Berks County Recorder of Deeds. In addition, the Township may require as a condition of approval that any deed conveying any interest in such lot contain language indicating that the conveyance is subject to an express covenant by the grantee that the grantee will maintain the stormwater management facility.

15.(c) Maintenance of natural drainage ways: All natural streams, channels, swales, drainage systems and/or areas of surface water concentration shall be maintained in their existing condition unless an alteration is approved by the municipality. All encroachment activities shall comply with the requirements of Chapter 104 (Water Obstructions and Encroachments) of Title 25, Rules and Regulations of the Pennsylvania Department of Environmental Protection, or any successor provision.

15.(d) There shall be provided a drainage easement that conforms substantially with the line of any pond, lake, watercourse, drainage way, channel, storm drainage system, or stream of such width as will be adequate to preserve the unimpeded flow of drainage and to provide for widening, deepening, relocation, improving or protecting such features or drainage facilities. Minimum easement width shall be ten feet (10') from each side of the watercourse, waterbody, stream, pond, or lake, but the Township may require a greater easement when necessary. Bearings and distances shall be provided for the boundaries of easements.

15.(e) Stormwater facilities to be maintained by non-municipal entities shall be provided with adequate easements accessible from public roads over which the Township shall have right of access to correct or maintain such facilities if necessary in the public interest. In such cases, the lot owner will be responsible for all costs of the Township of Bethel. Responsibility of such privately maintained facilities shall be conspicuously noted on the plan to be recorded. Areas within easements shall be kept as lawn or in natural condition to allow maintenance and entrance, and shall not be altered in any way from the approved design and shall be maintained to retain the design capacity.

15.(f) If the Township determines at any time that any permanent stormwater management control facility has been eliminated, altered or improperly maintained, the owner or private entity which owns the property shall be advised of corrective measures required and given a reasonable period of time to take necessary action. If such action is not taken by the property owner, the Township may cause the work to be done and charge all costs against the property in accordance with applicable law.

SECTION 16. PRESUBMISSION The Township Engineer shall be afforded the opportunity to review the proposed methodology prior to official submission of the stormwater management report, especially where non-conventional methods are proposed. (i.e., infiltration trenches, retention ponds, etc.).

SECTION 17. SCHEDULE OF INSPECTIONS The Municipal Engineer shall inspect all phases of development of the site, and shall be notified of the commencement of such work at least 5 business days prior to beginning. It is the responsibility of the owner, subdivider, developer or his agent to notify the Municipal Engineer 24 hours in advance of the completion of each identified phase of development.

Any portion of the work which does not comply with the approved plan must be corrected by the developer. No work may proceed on any subdivision or land development or building construction until the required corrections have been made.

If at any state of the work, the Township or its Engineer determines that the soil or other conditions are not as stated or shown on the plan, it may refuse to approve further work and the Township or its designee may revoke existing approvals until a revised plan is submitted and approved.

SECTION 18. TABLES

**Runoff Curve Numbers
(From NRCS (SCS) TR-55)**

LAND USE DESCRIPTION	HYDROLOGIC SOIL GROUP			
	A	B	C	D
Open Space	44	65	77	82
Meadow / Orchard	30	58	71	78
Agricultural	59	71	79	83
Forest	36	60	73	79
Commercial (85% Impervious)	89	92	94	95
Industrial (72% Impervious)	81	88	91	93
Institutional (50% Impervious)	71	82	88	90
Residential				
Average Lot Size				
% impervious				
1/8 acre or less*	65	77	85	90
1/8 - 1/3 acre	34	59	74	82
1/3 - 1 acre	23	53	69	80
1 - 4 acres	12	46	66	78
Farmstead	59	74	82	86
Smooth Surfaces (Concrete, Asphalt, Gravel or Bare Compacted Soil)	98	98	98	98
Water	98	98	98	98
Mining/Newly Graded Areas (Pervious Areas Only)	77	86	91	94

* Includes Multi-Family Housing unless justified lower density can be provided.

RATIONAL RUNOFF COEFFICIENTS
By Hydrologic Soils 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	0.08 ^a	0.13	0.16	0.11	0.15	0.21	0.14	0.19	0.26	0.18	0.23	0.31
	0.14 ^b	0.18	0.22	0.16	0.21	0.28	0.20	0.25	0.34	0.24	0.29	0.41
Pasture	0.12	0.20	0.30	0.18	0.28	0.37	0.24	0.34	0.44	0.30	0.40	0.50
	0.15	0.25	0.37	0.23	0.34	0.45	0.30	0.42	0.52	0.37	0.50	0.62
Meadow	0.10	0.16	0.25	0.14	0.22	0.30	0.20	0.28	0.36	0.24	0.30	0.40
	0.14	0.22	0.30	0.20	0.28	0.37	0.26	0.35	0.44	0.30	0.40	0.50
Forest	0.05	0.08	0.11	0.08	0.11	0.14	0.10	0.13	0.16	0.12	0.16	0.20
	0.08	0.11	0.14	0.10	0.14	0.18	0.12	0.16	0.20	0.15	0.20	0.25
Residential Lot Size 1/8 Ac	0.25	0.28	0.31	0.27	0.30	0.25	0.30	0.33	0.38	0.33	0.36	0.42
	0.33	0.37	0.40	0.35	0.39	0.44	0.38	0.42	0.49	0.41	0.45	0.54
Lot Size 1/4 Ac	0.22	0.26	0.29	0.24	0.29	0.33	0.27	0.31	0.36	0.30	0.34	0.40
	0.30	0.34	0.37	0.33	0.37	0.42	0.36	0.40	0.47	0.38	0.42	0.52
Lot Size 1/3 Ac	0.19	0.23	0.26	0.22	0.26	0.30	0.25	0.29	0.34	0.28	0.32	0.39
	0.28	0.32	0.35	0.30	0.35	0.39	0.33	0.38	0.45	0.36	0.40	0.50
Lot Size 1/2 Ac	0.16	0.20	0.24	0.19	0.23	0.28	0.22	0.27	0.32	0.26	0.30	0.37
	0.25	0.29	0.32	0.28	0.32	0.36	0.31	0.35	0.42	0.34	0.38	0.48
Lot Size 1 Ac	0.14	0.19	0.22	0.17	0.21	0.26	0.20	0.25	0.31	0.24	0.29	0.35
	0.22	0.26	0.29	0.24	0.28	0.34	0.28	0.32	0.40	0.31	0.35	0.46
Industrial	0.67	0.68	0.68	0.68	0.68	0.69	0.68	0.69	0.69	0.69	0.69	0.70
	0.85	0.85	0.86	0.85	0.86	0.86	0.86	0.86	0.87	0.86	0.86	0.88
Commercial	0.71	0.71	0.72	0.71	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72
	0.88	0.88	0.89	0.89	0.89	0.89	0.89	0.89	0.90	0.89	0.89	0.90
Streets	0.70	0.71	0.71	0.71	0.72	0.74	0.72	0.73	0.76	0.73	0.75	0.78
	0.76	0.77	0.79	0.80	0.82	0.84	0.84	0.85	0.89	0.89	0.91	0.95
Open Space	0.05	0.10	0.14	0.08	0.13	0.19	0.12	0.17	0.24	0.16	0.21	0.28
	0.11	0.16	0.20	0.14	0.19	0.26	0.18	0.23	0.32	0.22	0.27	0.39
Parking	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87	0.85	0.86	0.87
	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	0.97	0.95	0.96	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 : Rawls, W.J., S.L. Wong and R.H. McCuen, 1981, "Comparison of Urban Flood Frequency Procedures", Preliminary Draft, U.S. Department of Agriculture, Soil Conservation Service, Baltimore, MD.

**Roughness Coefficients (Manning's "n") For Overland Flow
(U.S. Army Corps Of Engineers, HEC-1 Users Manual)**

Surface Description	n	
	-	
Dense Growth	0.4	0.5
Pasture	0.3	0.4
Lawns	0.2	0.3
Bluegrass Sod	0.2	0.5
Short Grass Prairie	0.1	0.2
Sparse Vegetation	0.05	0.13
Bare Clay-Loam Soil (eroded)	0.01	0.03
Concrete/Asphalt - very shallow depths (less than 1/4 inch)	0.10	0.15
- small depths (1/4 inch to several inches)	0.05	0.10

Roughness Coefficients (Manning's "n") For Channel Flow

Reach Description	n
	-
Natural stream, clean, straight, no rifts or pools	0.03
Natural stream, clean, winding, some pools or shoals	0.04
Natural stream, winding, pools, shoals, stony with some weeds	0.05
Natural stream, sluggish deep pools and weeds	0.07
Natural stream or swale, very weedy or with timber underbrush	0.10
Concrete pipe, culvert or channel	0.012
Corrugated metal pipe	0.012-0.027 ⁽¹⁾
High Density Polyethylene (HDPE) Pipe	
Corrugated	0.021-0.029 ⁽²⁾
Smooth Lined	0.012-0.020 ⁽²⁾

(1) Depending upon type, coating and diameter

(2) Values recommended by the American Concrete Pipe Association, check Manufacturer's recommended value.

Section 19. Ratification and Repeals

All Ordinances or parts of Ordinances that are inconsistent with the Provisions of this Ordinance are hereby repealed in so far as but only in so far as the same are inconsistent with the provisions of this ordinance.

Section 20. Severability

If any sentence, clause, section or part of this Ordinance for any reason is 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 that the intent of the Board of Supervisors that this Ordinance would have been adopted if such unconstitutional, illegal or invalid sentence, clause, section or part thereof had not been included herein.

Section 21. Effective Date

This Ordinance shall be effective five (5) days after enactment.

ORDAINED and ENACTED as an Ordinance by the Board of Supervisors of the Township of Bethel, County of Berks, Pennsylvania, in lawful session duly assembled, this 23rd day of October, 2006.

BETHEL TOWNSHIP
BOARD OF SUPERVISORS