TOWNSHIP OF LOWER MAKEFIELD
BUCKS COUNTY, PENNSYLVANIA

ORDINANCE NO. _____

AN ORDINANCE OF THE TOWNSHIP OF LOWER MAKEFIELD, BUCKS COUNTY, PENNSYLVANIA, AMENDING CHAPTER 173, STORMWATER MANAGEMENT – DELAWARE RIVER SOUTH WATERSHED, OF THE TOWNSHIP'S CODE OF ORDINANCES TO PROVIDE FOR UPDATED STANDARDS FOR THE CONTROL AND CALCULATION OF STORMWATER RUNOFF, TO REPEAL INCONSISTENT PROVISIONS, AND TO ESTABLISH SEVERABILITY AND EFFECTIVE DATE

WHEREAS, the Township of Lower Makefield, Bucks County, is a township of the second class, organized and existing in accordance with the laws of the Commonwealth of Pennsylvania; and

WHEREAS, the Township, in the exercise of its corporate powers, has the authority to enact, amend, repeal and establish ordinances and regulations governing the management of stormwater within the Township's territorial boundaries; and

WHEREAS, the Township, after due consideration and review, wishes to modify and update certain standards related to the management of stormwater along the Delaware River South Watershed as set forth in Chapter 173 of the Township's Code of Ordinances.

NOW, THEREFORE, be it ORDAINED and ENACTED as follows:

Chapters 173-14, 173-15 and 173-16 of the Stormwater Management – Delaware River Watershed shall be deleted in its entirety and replaced with the following:

§173-14 Volume Control

Volume controls will mitigate increased runoff impacts, protect stream channel morphology, maintain groundwater recharge, and contribute to water quality improvements. Stormwater runoff volume control methods are based on the net change in runoff volume for the two-year twenty-four-hour storm event. Volume controls shall be implemented using the Design Storm Method in Subsection A.

A. Design Storm Method (any regulated activity): This method requires detailed modeling based on site conditions. For modeling assumptions refer to §173-16A.

(1) Postdevelopment total runoff shall not be increased from predevelopment total runoff for all storms equal to or less than the NOAA partial duration 90% Upper Confidence Interval two-year twenty-four-hour rainfall depth with appropriate NRCS distribution, or Table B-1, whichever is greater.

(2) The following applies in order to estimate the increased volume of runoff for the two-year twenty-four-hour duration precipitation event:

a. To calculate the runoff volume (cubic feet) for existing site conditions (predevelopment) and for the proposed developed site conditions (post-development), applicants shall use the Soil Cover Complex Method as shown following this subsection. Table B-3 in Ordinance Appendix B is available to guide a qualified professional and/or an applicant to calculate the stormwater runoff volume. The calculated volume shall be either reused, evapotranspired, or infiltrated through structural or nonstructural means.

Soil Cover Complex Method:

Step 1: Runoff (in) = $Q = (P-0.2S)^2/(P + 0.8S)$ where

P = 2-year Rainfall (in)

S = (1,000/CN) – 10, the potential maximum retention (including initial abstraction, Ia)

Step 2: Runoff Volume (Cubic Feet) = Q x Area x 1/12

Q = Runoff (in)

Area = SWM Area (sq ft)

(3) For all regulated activities, an additional 20% shall be added to the required volume control.

B. Stormwater control measures. The applicant must demonstrate how the required volume is controlled through stormwater best management practices (BMPs) which shall provide the means necessary to capture, reuse, evaporate, transpire or infiltrate the total runoff volume.

(1) If natural resources exist on the site, the applicant is required to submit a SWM site plan which shall determine the total acreage of protected area where no disturbance is proposed.

(a) The acreage of the protected area should be subtracted from the total site area and not included in the stormwater management site area acreage used in determining the volume controls.

Stormwater Management Site Area =

{Total Site Area (for both pre and post development conditions) – Protected Area}

(b) Natural resource areas should be calculated based upon the municipality's own Natural Resource Protection Ordinance. If no ordinance exists, see Table B-2 in Ordinance Appendix B for guidance to assess the total protected area. For additional reference, see Chapter 5, Section 5.4.1, of the PA BMP manual.

(2) Calculate the volume controls provided through nonstructural BMPs. Table B-5 in Ordinance Appendix B is recommended as guidance.

(3) Volume controls provided through nonstructural BMPs should be subtracted from the required volume to determine the necessary structural BMPs.

Required Volume Control (ft^3)	–	Nonstructural Volume Control (ft^3)	=	Structural Volume Requirement (ft^3)

(4) Calculate the volume controls provided through structural BMPs. Table B-6 in Ordinance Appendix B is recommended as guidance. See PA BMP manual, Chapter 6, for description of the BMPs.

(5) Infiltration BMPs intended to receive runoff from developed areas shall be selected based on the suitability of soils and site conditions. (See Table B-6 in Ordinance Appendix B for a list of infiltration BMPs.) Infiltration BMPs shall be constructed on soils that have the following characteristics:

(a) A minimum soil depth of 24 inches between the bottom of the infiltration BMPs and the top of bedrock or seasonally high water table, or other soil limiting zone.

(b) An infiltration rate sufficient to accept the additional stormwater load and dewater completely as determined by field tests. A minimum of 0.2 inch/hour should be utilized and for acceptable rates a safety factor of 50% should be applied for design purposes (e.g., for soil which measured 0.4 inch/hour, the BMP design should use 0.2 inch/hour to insure safe infiltration rates after construction).

(c) All open-air infiltration facilities shall be designed to completely infiltrate runoff volume within three days (72 hours) from the end of the design storm.

(6) Soils. A soils evaluation of the project site shall be required to determine the suitability of infiltration facilities. All regulated activities are required to perform a detailed soils evaluation by a qualified design professional which at minimum addresses soil permeability, depth to bedrock, depth to seasonally high water table, or other soil limiting zone, and subgrade stability. The general process for designing the infiltration BMP shall be:

(a) Analyze hydrologic soil groups as well as natural and man-made features within the site to determine general areas of suitability for infiltration practices. In areas where development on fill material is under consideration, conduct geotechnical investigations of sub-grade stability; infiltration may not be ruled out without conducting these tests.

(b) Provide field tests such as double ring infiltrometer or hydraulic conductivity tests (at the level of the proposed infiltration surface) to determine the appropriate infiltration rate. Percolation tests are not recommended for stormwater design purposes.

(c) Design the infiltration structure based on field determined capacity at the level of the proposed infiltration surface and based on the safety factor of two.

(d) If on-lot infiltration structures are proposed, it must be demonstrated to the municipality that the soils are conducive to infiltrate on the lots identified.

(e) An impermeable liner will be required in detention basins where the possibility of groundwater contamination or karst topography exists. A detailed hydrogeologic investigation may be required by the municipality.

(f) All runoff to an infiltration or extended detention subsurface basin must either be pretreated or the basin's storage volume increased to account for the loss of volume in the subsurface basin due to sediment accumulation. This loss should be based upon the expected life of the basin. If pretreatment is needed, it must remove 50% of the total suspended solids in the runoff from the basin's tributary area maximum design storm.

(g) Groundwater mounding may occur beneath stormwater management structures designed to infiltrate stormwater runoff. Concentrating recharge in a small area can cause groundwater mounding that affects the basements of nearby homes and other structures. A groundwater mounding analysis must be performed to determine whether or not the underlying aquifer will be able to manage the infiltration loading proposed without raising the groundwater to within two feet of the infiltration surface or affecting nearby structures. A simplified spreadsheet was developed by USGS to solve the Hantush Analytical Equation, which can be used to calculate groundwater mounding. The documentation and spreadsheet can be found in the USGS publication Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basin, also available at http://pubs.usgs.gov/sir/2010/5102/.

C. Alternate criteria for redevelopment sites. For redevelopment sites, one of the following minimum design parameters shall be accomplished, whichever is most appropriate for the given site conditions as determined by the Township of Lower Makefield:

(1) For all onsite impervious areas, meet the full requirements specified by §173-14A through B; or

(2) Reduce the total impervious surface on site by at least 20% based upon a comparison of existing impervious surface to proposed impervious surface.

§173-15 Stormwater peak rate control in management districts

Peak rate controls for large storms, up to the one-hundred-year event, is essential in order to protect against immediate downstream erosion and flooding. The following peak rate controls have been determined through hydrologic modeling of the Delaware River South Watershed.

A. Standards for managing runoff from each subarea in the Delaware River South Watershed for the two-, five-, ten-, twenty-five-, fifty-, and one-hundred-year design storms are shown in Table 173-15.1. Development sites located in each of the management districts must control proposed development conditions runoff rates to existing conditions runoff rates for the design storms in accordance with Table 173-15.1.

Table 173-15.1

Peak Rate Runoff Control Standards by Stormwater Management Districts in the Delaware River South Watershed

District	Design Storm Postdevelopment (Proposed Conditions)	Design Storm Predevelopment (Existing Conditions)
A	2-year	1-year
	5-year	5-year
	10-year	10-year
	25-year	25-year
	50-year	50-year
	100-year	100-year
B	2-year	1-year
	5-year	2-year
	10-year	5-year
	25-year	10-year
	50-year	50-year
	100-year	100-year
C*	2-year	1-year
	5-year	2-year

* In District C, development sites which can discharge directly to the Delaware River South main channel or major tributaries or indirectly to the main channel through an existing stormwater drainage system (i.e., storm sewer or tributary) may do so without control of postdevelopment peak rate of runoff greater than the five-year storm. Sites in District C will still have to comply with the groundwater recharge criteria, the water quality criteria, and stream bank erosion criteria. If the postdevelopment runoff is intended to be conveyed by an existing stormwater drainage system to the main channel, assurance must be provided that such system has adequate capacity to convey the flows greater than the two-year predevelopment peak flow or will be provided with improvements to furnish the required capacity. When adequate capacity in the downstream system does not exist and will not be provided through improvements, the postdevelopment peak rate of runoff must be controlled to the predevelopment peak rate as required in District A provisions (i.e., ten-year postdevelopment flows to ten-year predevelopment flows) for the specified design storms.

B. General. Proposed conditions rates of runoff from any regulated activity shall not exceed eighty percent (80%) of the peak release rates of runoff from existing conditions for the design storms specified on the Stormwater Management District Watershed Map (Ordinance Appendix D) and in this section of the chapter.

C. District boundaries. The boundaries of the stormwater management districts are shown on official maps and are available for inspection at the municipal office and county planning offices. A copy of the map at a reduced scale, and four other maps with zoomed-in extents are included in Ordinance Appendix D. The exact location of the stormwater management district boundaries as they apply to a given development site shall be determined by mapping the boundaries using the two-foot topographic contours (or most accurate data required) provided as part of the SWM site plan.

D. Sites located in more than one district. For a proposed development site located within two or more stormwater management district category subareas, the peak discharge rate from any subarea shall meet the management district criteria for the district in which the discharge is located.

E. Off-site areas. When calculating the allowable peak runoff rates, developers do not have to account for runoff draining into the subject development site from an off-site area. On-site drainage facilities shall be designed to safely convey off-site flows through the development site.

F. Site areas. The stormwater management site area is the only area subject to the management district criteria. Nonimpacted areas or nonregulated activities bypassing the stormwater management facilities would not be subject to the management district criteria.

G. Alternate criteria for redevelopment sites. For redevelopment sites, one of the following minimum design parameters shall be accomplished, whichever is most appropriate for the given site conditions as determined by the Township of Lower Makefield:

   (1) For all onsite impervious areas, meet the full requirements specified by Table 173-15.1 and §173-15A through F; or

   (2) Reduce the total impervious surface on site by at least 20% based upon a comparison of existing impervious surface to proposed impervious surface.

H. "No-harm" option. For any proposed development site not located in a provisional direct discharge district, the applicant has the option of using a less restrictive runoff control (including no detention) if the applicant can prove that no harm would be caused by discharging at a higher runoff rate than that specified by the plan. The no-harm option is used when an applicant can prove that the postdevelopment hydrographs can match predevelopment hydrographs, or if it can be proved that the postdevelopment conditions will not cause increases in peaks at all points downstream. Proof of "no-harm" would have to be shown based upon the following downstream impact evaluation, which shall include a downstream hydraulic capacity analysis consistent with § 173-15H, to determine if adequate hydraulic capacity exists. The land applicant shall submit to the municipality this evaluation of the impacts due to increased downstream stormwater flows in the watershed.

(1) The downstream impact evaluation shall include hydrologic and hydraulic calculations necessary to determine the impact of hydrograph timing modifications due to the proposed development upon a dam, highway, structure, natural point of restricted stream flow, or any stream channel section, established with the concurrence of the municipality.
(2) The evaluation shall continue downstream until the increase in flow diminishes due to additional flow from tributaries and/or stream attenuation.
(3) The peak flow values to be used for downstream areas for the design return period storms (two-, five-, ten-, twenty-five-, fifty-, and one-hundred-year) shall be the values from the calibrated model for the Delaware River South Watershed. These flow values can be obtained from the watershed plan.
(4) Applicant-proposed runoff controls that would generate increased peak flow rates at storm drainage problem areas would, by definition, be precluded from successful attempts to prove "no-harm," except in conjunction with proposed capacity improvements for the problem areas consistent with § 173-15H.
(5) Financial considerations shall not constitute grounds for granting a no-harm exemption.
(6) Capacity improvements may be provided as necessary to implement the no-harm option which proposes specific capacity improvements to provide that a less stringent discharge control would not create any harm downstream.
(7) Any no-harm justifications shall be submitted by the applicant as part of the drainage plan submission per Article IV.

I. Downstream hydraulic capacity analysis. Any downstream capacity hydraulic analysis conducted in accordance with this chapter shall use the following criteria for determining adequacy for accepting increased peak flow rates:
(1) Natural or man-made channels or swales must be able to convey the increased runoff associated with a two-year return period event within their banks at velocities consistent with protection of the channels from erosion. Acceptable velocities shall be based upon criteria included in the Department of Environmental Protection's Erosion and Sediment Pollution Control Program Manual.
(2) Natural or man-made channels or swales must be able to convey increased twenty-five-year return period runoff without creating any hazard to persons or property.
(3) Culverts, bridges, storm sewers or any other facilities which must pass or convey flows from the tributary area must be designed in accordance with the Department of Environmental Protection's Chapter 105 regulations (if applicable) and, at minimum, pass the increased twenty-five-year return period runoff.

J. Regional detention alternatives. For certain areas within the study area, it may be more cost-effective to provide one control facility for more than one development site than to provide an individual control facility for each development site. The initiative and funding for any regional runoff control alternatives are the responsibility of prospective applicants. The design of any regional control basins must incorporate reasonable development of the entire upstream

watershed. The peak outflow of a regional basin would be determined on a case-by-case basis using the hydrologic model of the watershed consistent with protection of the downstream watershed areas. Hydrologic model refers to the calibrated model as developed for the stormwater management plan. It is a requirement that, even if regional basins are proposed for the water quantity control, that the water quality, streambank erosion and recharge criteria be accomplished on site or as close to the source of the runoff as possible.

§173-16 Calculation methodology

A. The following criteria shall be used for runoff calculations:
   (1) For development sites not considered redevelopment, the ground cover used to determine the existing conditions runoff volume and flow rate shall be as follows:
      (a) Wooded sites shall use a ground cover of "woods in good condition." A site is classified as wooded if a continuous canopy of trees exists over a 1/4 acre.
      (b) The undeveloped portion of the site including agriculture, bare earth, and fallow ground shall be considered as "meadow in good condition," unless the natural ground cover generates a lower curve number (CN) or Rational "c" value (i.e., woods) as listed in Tables B-4 or B-7 in Appendix B[II] of this chapter.
   (2) For development and redevelopment sites, the ground cover used to determine the existing conditions runoff volume and flow rate for the developed portion of the site shall be based upon actual land cover conditions. If the developed site contains impervious surfaces, 40% of the impervious surface area shall be considered meadow in the model for existing conditions.

B. Stormwater runoff peak discharges from all development sites with a drainage area equal to or greater than 200 acres shall be calculated using a generally accepted calculation technique that is based on the NRCS Soil Cover Complex Method. Table 173-16.1 summarizes acceptable computation methods. The method selected by the design professional shall be based on the individual limitations and suitability of each method for a particular site. The municipality may allow the use of the Rational Method (Q = CIA) to estimate peak discharges from drainage areas that contain less than 200 acres.

Q	=	Peak flow rate, cubic feet per second (CFS)
C	=	Runoff coefficient, dependent on land use/cover
I	=	Design rainfall intensity, inches per hour
A	=	Drainage Area, acres.

C. All calculations consistent with this chapter using the Soil Cover Complex Method shall use the appropriate design rainfall depths for the various return period storms according to the region for which they are located as presented in Table B-1 in Ordinance Appendix B. The SCS Type II rainfall curve is found on Figure B-1 in Ordinance Appendix B. If a hydrologic

computer model such as PSRM or HEC-1/HEC-HMS is used for stormwater runoff calculations, then the duration of rainfall shall be 24 hours.

TABLE 173-16.1

Acceptable Computation Methodologies For Stormwater Management Plans

Method	Method Developed By	Applicability
TR-20 (or commercial computer package based on TR-20)	USDA NRCS	Applicable where use of full hydrology computer model is desirable or necessary
TR-55 (or commercial computer package based on TR-55)	USDA NRCS	Applicable for land development plans within limitations described in TR-55
HEC-1/HEC-HMS	United States Army Corps of Engineers	Applicable where use of full hydrologic computer model is desirable or necessary
PSRM	Penn State University	Applicable where use of a hydrologic computer model is desirable or necessary; simpler than TR-20 or HEC-1
Rational Method (or commercial computer package based on Rational Method)	Emil Kuichling (1889)	For sites less than 200 acres, or as approved by the municipality and/or Municipal Engineer
Other methods	Varies	Other computation methodologies approved by the municipality and/or Municipal Engineer

D. All calculations using the Rational Method shall use rainfall intensities consistent with appropriate times-of-concentration for overland flow and return periods from NOAA Atlas 14, Volume 2 Version 3, or latest version. Times-of-concentration for overland flow shall be calculated using the methodology presented in Chapter 3 of Urban Hydrology for Small Watersheds, NRCS, TR-55 (as amended or replaced from time to time by NRCS). Times-of-concentration for channel and pipe flow shall be computed using Manning's Equation.

E. Runoff Curve Numbers (CN) for both existing and proposed conditions to be used in the Soil Cover Complex Method shall be based on Table B-4 in Ordinance Appendix B.

F. Runoff coefficients (C) for both existing and proposed conditions for use in the Rational Method shall be consistent with Table B-7 in Ordinance Appendix B.

G. Runoff from proposed sites graded to the subsoil will not have the same runoff conditions as the site under existing conditions because of soil compaction, even after top-soiling or seeding. The proposed condition "CN" or "C" shall increase by 5% to better reflect proposed soil conditions.

H. The Manning Equation is preferred for one-dimensional, gradually varied, open channel flow. In other cases, appropriate, applicable methods should be applied; however, early coordination with the municipality is necessary.

I. Outlet structures for stormwater management facilities shall be designed to meet the performance standards of this chapter using the generally accepted hydraulic analysis technique or method of the municipality.

J. The design of any stormwater detention facilities intended to meet the performance standards of this chapter shall be verified by routing the design storm hydrograph through these facilities using the Storage-Indication Method. For drainage areas greater than 200 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 that shall use a total runoff volume that is consistent with the volume from a method that produces a full hydrograph.

K. Runoff volumes for the two-year storm shall be computed separately for the pervious and directly connected impervious surfaces of a drainage area and then combined. The use of a weighted CN value for volume calculations is not acceptable.

GENERAL PROVISIONS

A. All other ordinances, portions of ordinances, or any section of the Code inconsistent with this Ordinance, are hereby repealed.

B. The provisions of this Ordinance are severable. If any section, clause, sentence part or provision thereof shall be held illegal, invalid, or unconstitutional by a court of competent jurisdiction, such decision of the court shall not affect or impair any of the remaining sections, clauses, sentences, parts or provisions of this Ordinance. It is hereby declared to be the intent of the Township of Lower Makefield that this Ordinance would have been adopted if such illegal, invalid or unconstitutional section, clause, sentence or part of a provision had not been included herein.

C. This Ordinance shall be effective five (5) days after enactment by the Board of Supervisors of Lower Makefield Township, Bucks County, Pennsylvania.

ENACTED AND ORDAINED BY THE TOWNSHIP OF LOWER MAKEFIELD

THIS _____ DAY OF _____, 2024.

BOARD OF SUPERVISORS
TOWNSHIP OF LOWER MAKEFIELD

BY: _____
JOHN B. LEWIS, Chair

ATTESTED TO:

_____
Township Manager