STORMWATER DESIGN MANUAL

March 21, 2008

City of Whitehall

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1.0 INTRODUCTION

This Manual establishes design criteria required for stormwater facilities within the City of Whitehall in conjunction with City Ordinance, Title Three, Chapter 901 and the Ohio Environmental Protection Agency's (OEPA) NPDES Phase II Stormwater Program. While adherence to this Manual will not stop flooding or prevent all damage caused by flooding, it does establish a basis for design which will:

- Minimize the damage and inconvenience of flooding;
- Provide drainage systems which continue to provide benefit over the long term;
- Minimize the expense of maintaining the drainage facilities within the City;
- Reduce non-point-source pollution;
- Minimize new impacts on engineered and natural drainage systems;
- Prevent or reduce impacts to stream and river ecosystems.

1.1 Administration

The Director of Public Service is authorized to administer, implement and enforce the provisions of this Manual. The Director shall serve as the principal executive officer for stormwater management for the purposes of fulfilling the requirements of the OEPA's NPDES Phase II Stormwater Program. Compliance with this Manual will be determined by the Director and his/her office. The Planning Commission shall not recommend for approval the final plat of any development or subdivision over which it has jurisdiction without documentation from the Director and the Engineer, that such the development or subdivision has been designed to be in compliance with the design requirements herein.

1.2 Drainage Policy

1.2.1 This drainage policy, control guidelines and criteria do not provide solutions to all drainage problems, nor is the Engineer restricted to these designs or procedures exclusively. Although the policies as stated will hold true for most development work, the City realizes that there may be individual projects involving special or unusual drainage design problems that should be reviewed prior to completing the drainage plans. Exceptions may be granted to the policies and criteria in such cases when engineering study(s) justify modification.

1.2.2 Experience has shown that most of the more serious flooding situations are "created". Development can lead to ever increasing flooding problems unless well-conceived, cooperative stormwater drainage and flood control programs are undertaken throughout the entire watershed. For this reason, the general policy of the City shall be:

a. Land uses and developments which increase runoff rate or volume shall control the discharge rate of runoff prior to its release to off-site land or the MS4.

b. It is the responsibility of the property owner to not change or alter any drainage course, ditch, flood routing path or drainage system on his/her property that will cause increased runoff, or will damage or cause flooding to adjacent, upstream or downstream property owners.

c. All stormwater drainage systems, including conveyances, within a development shall be designed to have capacity and depth, including sufficient invert elevations to permit future connections, to serve that total tributary area at the design storm frequency, and based on the rate of single family, residential runoff except as noted in subsection 1.3.2.a.4 below. The system for the upstream tributary area must be extended through the development.

d. All proposed development with a runoff rate greater than that which the downstream system has capacity for, or will be designed for, will be required to control the rate of stormwater discharge.

e. All developments will be required to control the peak flow rate of stormwater discharge to that peak rate which existed prior to development.

f. All information necessary shall be submitted to the City to determine how stormwater runoff should be controlled within the development prior to its release to downstream properties. The tributary area and the upstream watersheds should be determined using natural land divides unless man-made alterations are approved by the City's Engineer as the basis for watershed delineations.

1.4 Drainage Easements

In order to provide access for City personnel for inspection and maintenance, the Developer is required to procure and convey to the City an easement for any tile, pipe, detention basin, drainage way, flood routing path, ditch, watercourse, natural stream, man-made stream, storm sewer, or other stormwater component or facility not already within the City right-of-way. The easement must be of sufficient width to allow cleaning, widening, deepening, replacing or other general maintenance of such drainage course or piped system.

When it is necessary to convey stormwater outside the property lines of a proposed improved area in order to discharge into an adequate outlet, the Developer:

a. is required to obtain easements and/or maintenance agreements, in a form and substance satisfactory to the Director, from abutting property owners,

b. is responsible for maintenance agreements of such drainage course unless the easements and/or maintenance agreements require the abutting property owners to repair and maintain the drainage course satisfactorily.

All drainage easements, preservation areas, reserves and other similar areas must be shown on the "final engineering and construction plan(s)". Drainage easements for all on-site drainage system improvements shall be recorded for public use by final plat and deed. For off-site drainage systems improvements, easements should be recorded for public use by either final plat or separate instrument. The maintenance of such drainage easements shall be undertaken in the manner specified in Section 1.5, below.

1.5 Operation and Maintenance of Stormwater Facilities

The City shall provide for inspection and routine maintenance of storm drainage facilities that have been accepted for maintenance by the City. City maintenance may include stormwater conveyance-related structure cleaning and repair. For other storm drainage facilities not accepted for maintenance by the City, the City may provide for remedial maintenance of such facilities based upon the severity of stormwater problems and potential hazard to public health and safety, through the abatement procedures described in below in Section 1.5.1. For the purposes of this Chapter, maintenance associated with privately owned retention/detention basins including, but not limited to, mowing, rivulet repair, basin bottom fill, seeding, fertilizing and/or algae removal, are neither considered "potentially hazardous" to the public nor are they considered "severe" stormwater problems, and maintenance will not be provided by the City except in case of public emergency as determined by the City.

1.5.1 Operation and Maintenance Abatement Procedures

a. Notice To Correct Improper Drainage.
   1. Whenever the City finds that (i) a tract of land is inadequately drained, or (ii) there is excessive erosion or sedimentation upon such land or (iii) that there is an obstruction to or from a culvert, or water course upon such land that interferes with water naturally flowing therein or (iv) that such culvert, storm sewer or watercourse is of insufficient capacity to reasonably accommodate the flow of water, as required by this chapter, the City shall notify the owner or person having possession, charge, or management of such land to remove the obstruction, provide adequate drainage, fill or drain such land, enlarge the culverts, drains or watercourses, mitgate excessive erosion or sedimentation and/or accomplish any other act determined by the City's Engineer necessary to further the purposes of this chapter. Such notice shall be served to such persons by personal delivery, by registered mail at the last known place of residence, or by posting on the premises.

   2. The owner must comply with the City's orders within the time specified and not to exceed 30 days. Failure to comply with such order shall constitute an unlawful act. Each additional day thereafter during which the owner fails to carry out the order of the City shall constitute a separate offense.

      A. In any case where a condition described above exists for more than 30 days after service of notice, the Director may direct the owner to fill or drain such land, remove any obstruction and, if necessary, enlarge the culverts, drains, or watercourses to meet the requirements of this chapter.

      B. In the event an owner fails or refuses to comply with the Director's directive, the City may provide for the performance of the required work and charge the owner the abatement costs.

      C. Each and every owner of real property in the City consents to the entry upon any real property in the City for all reasonable times during normal business hours for the purpose of inspection, repair or maintenance required by this chapter.

3. Non-action by the City to observe or recognize hazardous or unsightly conditions or to recommend denial of a permit or zoning change shall not relieve the owner or person having possession, charge or management of such land from the responsibility for the condition or damage resulting therefrom, and shall not result in the City, its officers or agents being responsible for any condition or damage resulting therefrom.

4. Nothing in this chapter shall be construed as authorizing any person to maintain a private or public nuisance on his property, and compliance with the provisions of this chapter shall not be a defense in any action to abate such nuisance.

5. Nothing in this chapter shall be construed to prevent immediate action by the City in emergency situations. In case of an emergency, the City may direct that action be taken immediately to correct the condition or abate the activity to protect the public health, safety, and welfare. The City may perform the required work and charge the owner the abatement costs.

2.0 STORMWATER RUNOFF CONTROL CRITERIA

2.1 Quantitative Control

Stormwater runoff control shall address both peak rate and total volume of runoff. The peak rate of runoff from an area after development shall not exceed the peak rate of runoff from the same area before development for all storms from one year up to a 100-year return frequency, 24-hour duration storm. In addition, if it is found a proposed development will increase the volume of runoff from an area, the peak rate of runoff from certain more frequent storms must be controlled further. There are two reasons why increases in volume of runoff require a control standard more restrictive than controlling to the predevelopment condition. First, increases in volume mean runoff will be flowing for a longer period of time. When routed through a watershed, these longer flows may join at some point or points downstream thereby creating new peak flows and problems associated with peak flow (flooding and erosion). This is known as the "Routing Problem". Second, longer flow periods of large runoff quantities place a highly erosive stress on natural channels. This stress can be minimized by reducing the rate of discharge. The permissible peak rate shall be determined as follows:

a. For the purpose of determining site pre-development condition a runoff curve number (RCN) of 77 shall be used.

b. Determine the total volume of runoff from a 1-year frequency 24-hour storm, occurring over the area before and after development.

c. Determine the percentage of increase in volume due to development and using this percentage, pick the critical storm from Table 2.

Table 1. Critical Storm for Stormwater Volume Calculations

If the percentage of increase in VOLUME of runoff is;		The Critical Storm for discharge limitations will be:
Equal to or greater than	and less than	
--	10	1 year
10	20	2 year
20	50	5 year
50	100	10 year
100	250	25 year
250	500	50 year
500	--	100 year

d. The peak rate of runoff from the critical storm occurring over the development shall not exceed the peak rate of runoff from a 1-year frequency storm occurring over the same area under predevelopment conditions. Storms of less frequent occurrence (longer return period) than the critical storm, shall have a peak rate of runoff not greater than for the same storm under predevelopment conditions. As an example, if the total volume is to be increased by 35%, the critical storm is a 5-year storm. The peak rate of runoff for all storms up to this intensity shall be controlled so as not to exceed the peak rate of runoff from a 1-year frequency storm under predevelopment conditions in the area. The runoff from a more intense storm up to a 100-year storm need only be controlled so as not to exceed the predevelopment peak rate from the same frequency of storm.

2.2 Qualitative Control

Stormwater qualitative control must be implemented into sites in accordance with general and specific requirements outlined in OEPA's permit for stormwater discharges associated with construction activity (OEPA Permit OCH000002) or its subsequent OEPA-issued revision.

2.2.1 Large Construction Sites

For all construction activities (involving the disturbance of five or more acres of land or will disturb less than five acres, but is a part of a larger common plan of development or sale which will disturb five or more acres of land), the post construction BMP(s) chosen must be able to detain stormwater runoff for protection of the stream channels, stream erosion control, and improved water quality. Structural (designed) post-construction stormwater treatment practices shall be incorporated into the permanent drainage system for the site.

Water Quality Volume (WQv): The selected BMP(s) must be sized to treat the water quality volume and ensure compliance with Ohio's Water Quality Standards in OAC Chapter 3745-1. The WQv shall be equivalent to the volume of runoff from a 0.75-inch rainfall and must be determined according to one of the two following methods.

a. Through a site hydrologic study approved by the local City permitting authority that uses continuous hydrologic simulation and local long-term hourly precipitation records or;
b. Using the following equation:

$$WQv = C * P * A / 12$$

where:

WQv = water quality volume in acre-feet

C = runoff coefficient appropriate for storms less than 1 inch (see Table 3)

P = 0.75 inch precipitation depth

A = area draining into the BMP in acres

Table 2. Runoff Coefficients Based on the Type of Land Use

Land Use	Runoff Coefficient
Industrial & Commercial	0.8
High Density Residential (>8 Dwellings/Acre)	0.5
Medium Density Residential (4 To 8 Dwellings/Acre)	0.4
Low Density Residential (<4 Dwellings/Acre)	0.3
Open Space And Recreational Areas	0.2

Where the land use will be mixed, the runoff coefficient should be calculated using a weighted average. For example, if 60% of the contributing drainage area to the storm water treatment structure is low density residential, 30% is high density residential, and 10% is open space, the runoff coefficient is calculated as follows (0.6)(0.3) + (0.3)(0.5) + (0.1)(0.2) = 0.35.

An additional volume equal to 20 percent of the WQv shall be incorporated into the BMP for sediment storage and/or reduced infiltration capacity. Ohio EPA recommends that BMPs be designed according to the methodology included in the Rainwater and Land Development manual or in another design manual acceptable for use by Ohio EPA.

BMPs shall be designed such that the drain time is long enough to provide treatment, but short enough to provide storage available for successive rainfall events as described in Table 4, below.

Table 3. Target Draw Down (Drain) Times for Structural Post-Construction Treatment Control Practices

	Drain Time of WQv
Infiltration	24 – 48 Hours
Vegetated Swale and Filter Strip	24 Hours
Retention Basins (Wet Basins)	24 Hours
Constructed Wetlands (above Permanent Pool)	24 Hours
Media Filtration, Bioretention	40 Hours

The permittee may request approval from the City Engineer or Director and Ohio EPA to use alternative structural post-construction BMPs. The permittee must demonstrate that the alternative BMPs are equivalent in effectiveness to those listed in Table 4, above. New construction activities shall be exempt from this condition if it can be demonstrated that the WQv is provided within an existing structural post-construction BMP, located downstream, that is part of a larger common plan of development, before being released into an open watercourse.

For redevelopment projects (i.e., developments on previously developed property), post-construction practices shall either ensure a twenty (20) percent net reduction of the site impervious area, provide for treatment of at least (20) percent of the WQv or a combination of the two.

2.2.2 Small Construction Sites

For all small land disturbance activities (which disturb one or more, but less than five acres of land and which are not a part of a larger common plan of development which will disturb five or more acres of land), a description of the measures that will be installed during the construction process to control pollutants in stormwater discharges that will occur after the construction operations have been completed must be included in the SWP3. Practices may include but are not limited to stormwater detention storage (including wet basins), stormwater retention, and flow attenuation by use of open vegetated swales and natural depressions, infiltration of runoff onsite, and sequential systems which combine several practices. The SWP3 shall include an explanation of the technical basis used to select the practices to control pollution where flows exceed pre-development levels.

Velocity dissipation devices shall be placed at discharge locations and along the length of any outfall channel to provide non-erosive flow velocity from the structure to a water course so that the natural physical and biological characteristics and functions are maintained and protected.

3.0 STORMWATER SYSTEM GENERAL DESIGN CRITERIA

3.1 Design Storms

a. The initial/minor drainage system is that part of the storm drainage system which is used regularly for collecting, transporting, and disposing of storm runoff from frequent and low magnitude storm events, snowmelt, and miscellaneous minor flows. The capacity of the initial drainage system should be equal to the maximum rate of runoff expected from a design storm of established frequency (i.e., Initial Storm). For purposes of design, the initial drainage system portion of the overall storm drainage system shall be designed to contain the runoff from a storm with a return period of not less than five-years.

b. The major drainage system is that part of the storm drainage system which carries the runoff which exceeds the capacity of the initial drainage system. The major drainage system shall have the capacity to carry runoff from a storm with a return period of not less than 100-years (i.e., Major Storm) without posing significant threat to property or public safety.

3.2 Initial Storm – Physical Design Criteria for On-Site Improvements

a. Depth of flow in natural channels shall not exceed bank full stage with backwater effects considered.

b. Depth of flow of the design storm in man-made ditches or swales shall not exceed 80% of the channel depth. Velocity of flow shall be determined in accordance with the design criteria for open channels in Section 4.4 c (3), and shall not exceed 5 feet per second, or a rate determined by the City's Engineer to be detrimental to the watercourse. Where flows exceed this rate, special channel lining and erosion protection shall be provided.

c. Depth of flow in road-side ditch swales shall not exceed one foot or be of such depth that flow would extend out of the right-of-way if the side ditch is less than one foot in depth. Velocity at this depth shall not exceed six feet per second for grass swales or ten feet per second for paved ditches.

d. Depth of flow in streets with curb and gutter shall not exceed the curb height. Velocity of flow in the gutter at design depth shall not exceed ten feet per second. In addition to the above, the following are maximum encroachments of the minimum five-year initial design storm onto the pavement. See Section 4.3 for specific design criteria for curb inlet design.

e. For minor streets carrying traffic from the individual residence to collector and secondary streets, the flow may spread to the crown of the street.

f. For collector and secondary streets, one lane shall be free from water.

g. For primary streets, one lane in each direction shall be free from water.

h. For freeways, no encroachment is allowed on traffic lanes.

i. In design of a storm sewer pipe conduit, the conduit may be designed on the basis of flowing full with surcharge to gutter line. Backwater effects must be considered.

3.3 Major Storm – Physical Design Criteria for On-Site Improvements

a. The major storm floodway and floodway fringe for natural streams shall be as defined by the Federal Emergency Management Agency (FEMA), U.S. Army Corps of Engineers, the Ohio Department of Natural Resources, or where such determinations have not been made by these agencies, the major storm floodway and floodway fringe for natural streams may be estimated through a technical analysis by a registered Professional Engineer in the State of Ohio, in a manner found acceptable by the City.

b. Many of the drainage ways associated with the major storm system are in areas beyond those designated as floodway or floodway fringe. For these areas, the major storm flood limits shall be determined by the U.S. Army Corps of Engineers' HEC-RAS model or other accepted methods of determining water profiles using the major design storm runoff. One half foot of elevation must be added to the flood profile as freeboard to provide protection in the event of future encroachments into the floodway fringe or in the drainage way.

c. In order to protect the integrity of the non-street drainage rights-of-way, the design engineer is encouraged to design routing paths for multi-purpose functions. Pedestrian and bicycle paths lend themselves naturally to this application. Linear parks aligned along the major drainage corridor are also very effective, but usually require greater width than would normally be necessary for drainage purposes.

d. Where the street is designed as the major drainage system, the depth of flow shall not exceed 12-inches at gutter line for minor, collector and secondary streets, and shall not exceed 6-inches depth at crown for primary streets and freeways. The same maximum depth criteria will apply where a major drainage way crosses the street. Where a major drainage way is located outside the street, right-of-way easements will be provided.

e. In determining the required capacity of surface channels and other drainage ways provided for the major storm runoff, the street storm inlets and conduit provided for the initial design storm may be assumed to carry a portion of the total runoff volume, if appropriate. The following equation shall be used to determine the required capacity of surface channels and drainage ways in their design, when a portion of the runoff is conveyed within the initial piped system:

$$Q_{100} = C\ I_{10} A + 0.96\ (I_{100} - I_{10})\ A$$

and

$$Q_{\text{flood routing path}} = Q_{100} - Q_{\text{pipe}}$$

Where:

$Q_{\text{flood routing path}}$ = Design flow, major storm runoff (cfs)

Q_{pipe} = Peak flow within piped system (i.e., 5-year event) (cfs)

Q_{100} = Peak flow for 100-year event (cfs)

C = Rational runoff coefficient, site developed condition

I_{10} = rainfall intensity for 10-year storm event (inches/hour)

I_{100} = rainfall intensity for 100-year storm event (inches/hour)

A = Drainage area contributory to design point (acres)

f. Retention and Storage: Areas designed for storage of stormwater by retention should be incorporated into the natural features of the general area, when possible. Cooperative planning and joint owner construction of detention or retention facilities and use of natural land contours is encouraged. No such facilities will be permitted which may be or become aesthetically unpleasing, or which may result in construction, or maintenance problems. The City encourages that detention or retention facilities be designed as multipurpose spaces such as open space, recreation and/or scenic areas. The City encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval.

3.4 Methods of Calculation

The following methods of calculation shall be used unless otherwise approved by the City's Engineer:

a. Rainfall volumes shall be in accordance with data for Central Ohio provided in "*Bulletin 71: Rainfall Frequency Atlas of the Midwest*", 1992 and any subsequent updates thereto.

b. Rainfall distribution for stormwater management systems is to be in accordance with SCS Type II Rainfall Distribution.

c. The appropriate Runoff Curve Number (i.e., "RCN" factor) may be determined by using Technical Release No. 55 (S.C.S.) or its Ohio Supplement.

3.5 Drainage Area Determination

The drainage area shall be determined from any of the following sources, which are listed in order of priority preference:

a. Actual field investigation;

b. County Auditor, topographic maps;

c. U.S. Geological Survey quadrangle (7.5 minute series) contour maps;

d. Soil Survey of Franklin County, Ohio, U.S.D.A.

4.0 STORMWATER SYSTEM SPECIFIC DESIGN SPECIFICATIONS

4.1 Roadway Culverts

a. General specifications. The size and shape of the culvert should be such that it will carry a predetermined design peak discharge need to specify without the depth of water at the entrance or the velocity at the outlet exceeding allowable limits.

b. Design procedure. The culvert design procedure recommended for use is Hydraulic Design Series No. 5, U.S. Department of Transportation.

c. Preferred construction. Single span culverts, including concrete box and slab top are preferred. Multiple cell pipe culverts, when they are the only structures that will meet the physical requirements introduced by rigid headwater controls, will be acceptable.

d. Material. The culvert material shall be concrete, at a minimum diameter of 12 inches. Corrugated steel or metal pipe material will not be allowed.

e. Drainage area. The drainage area in acres, and the estimated runoff or design discharge in cubic feet per second, and the storm frequency in years shall be shown on the plan for each culvert.

f. Inlet elevation. The flowline elevation at the culvert inlet should be set deep enough to provide an adequate outlet for future storm sewer improvements upstream.

g. Design storm frequency (roadway culverts), shall be:

   1. 10-year frequency 24-hour storm event for private drives, local and collector streets.

   2. 25-year frequency 24-hour storm event for arterial streets.

h. Design flow. For method of calculation, refer to Table 4.

   1. storm shall not exceed or cause any of the following:
   2. 18-inches below the top of curb
   3. 12-inches below the edge of pavement
   4. 1.2 times the diameter of culvert
   5. Diameter or rise plus two feet, in deep ravines
   6. Property Damage – 100-year frequency headwater plus 1-foot, shall not exceed any existing or proposed building first floor elevation

Table 4. Acceptable Methods of Calculation for Design Flow in Roadway Culverts

DRAINAGE AREA (ACRES)	STORMWATER QUANTITY				
	PEAK DISCHARGE ONLY	PEAK DISCHARGE AND TOTAL RUNOFF VOLUME		STORAGE VOLUME	
		HOMOGEN. LAND USE	NON-HOMOGEN.	HOMOGEN.	NON-HOMOGEN.
LESS THAN 200	RATIONAL OR PEAK DISCHARGE	PEAK DISCHARGE	(*) TABULAR HYDRO-GRAPH	GRAPHICAL	(*) STORAGE-INDICATION
200 TO 300	PEAK DISCHARGE				
GREATER THAN 300	(*) TABULAR HYDROGRAPH			(*) STORAGE INDICATION	

*Note: The "Tabular Hydrograph" and "Storage-indication" methods are preferred and are normally used to check drainage calculations submitted to the City Engineer

Method References:

Rational: (Q = CIA); MORPC, Stormwater Design Manual, 1977

Graphical: Ibid., Pg. 143

Peak Discharge: U.S. Department of Agriculture, Soil Conservation Service, Urban Hydrology for Small Watersheds, Technical Release No. 55, 1986

Storage– Indication: MORPC, Stormwater Design Manual, 1977, Pg. 143.

SCS TR-20 and US Army COE HEC-1

Tabular Hydrography: SCS TR-55, Chap. 5 SCS TR-20, US Army COE's HEC-1

USGS regression equations for Central Ohio may be used where applicable, for estimating peak flows for culvert design and to estimate peak release rates

j. Manning's roughness coefficient (n). Manning's Roughness Coefficient (n) should be as given in Table 5 unless an alternate value is approved by the City Engineer.

k. Maximum allowable headwater. The maximum allowable headwater for the design storm shall not exceed or cause any of the following:

1. 18-inches below the top of curb;
2. 12-inches below the edge of pavement;

3. 1.2 times the diameter of culvert; or
4. Diameter or rise plus two feet, in deep ravines.
5. Property Damage – 100-year frequency headwater plus 1-foot, shall not exceed any existing or proposed building first floor elevation.

l. Entrance loss coefficient (Ke). The Entrance Loss Coefficient (Ke) should be as given in Table 5 based upon the headwall configuration unless an alternative value is approved by the City Engineer.

m. Minimum cover to subgrade. Should be 30 inches from top of pipe to subgrade.

n. Maximum allowable outlet velocity, shall be:

1. Turf Channel 5 f.p.s.
2. Rock Protection 18 f.p.s

Notes:

- When the outlet velocity exceeds 18-feet per second, a stilling basin or other such energy dissipation structure must be used.
- The downstream channel must have the ability to handle the flow satisfactorily.

o. Structural design criteria. The structural design criteria for culverts shall be the same as that required by the Ohio Department of Transportation (ODOT).

p. Emergency flood routing. The emergency flood routing shall be capable of routing the 100-year storm over or around the culvert without creating a hazard or causing potential for erosion or personal property damage. Adequate scour protection must be included in the design.

q. End protection should be as follows:

1. 12-inch through 36-inch culverts – full-height headwall
2. 42-inch through 84-inch culverts – full height headwall with flared wings
3. Other special type headwalls must be approved before use

Table 5. Design Coefficients for Roadway Culverts

TYPE STRUCTURE	MANNING'S ROUGHNESS COEFFICIENT (n)	ENTRANCE LOSS COEFFICIENT (Ke)*
CONCRETE PIPE	0.013	0.2
BOX: 4-sided BOX: 3-sided	0.013 weighted by wetted perimeter minimum 0.018	0.2 TO 0.5 0.2 TO 0.5
SLAB TOP	0.03 TO 0.05	0.2 TO 0.5

* As a function of the headwall configuration.

4.2 Storm Sewers

The criteria for designing storm sewer systems are listed below:

a. No water will be allowed to cross a street intersection unless it is carried in a storm drain. All storm sewer systems shall be designed using Manning's Equation:

$$Q = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

and

$$Q = AV$$

where :
Q = Rate of discharge (cfs)
A = Area of cross-section of flow (sq.ft.)
V = Mean velocity of flow (fps)

n = Manning's roughness coefficient
R = A/wp = Hydraulic radius (ft)
S = Slope of pipe or hydraulic grade line if surcharged (ft/ft)
wp = Wetted perimeter (ft)

c. <u>Hydraulic Gradient Requirement</u> shall be:
   1. Based on a 5-year storm, shall not exceed window or grate elevation for an inlet or catch basin.
   2. Grade line based on tailwater or 0.8 D at outlet (whichever is greater) or other critical points within the system.
   3. The invert of the first storm drain appurtenance shall be above the computed floodplain elevation, unless otherwise permitted by the City Engineer.

d. <u>Design Flow Determination</u>:
   1. Areas under 200 acres use Rational Method Q = CiA
   2. Areas between 200 and 300 acres transition between Rational Method and Technical Release 55
   3. Areas over 300 acres use Technical Release 55
   4. Minimum times of Concentration:
      - Curb inlet - 10 minutes
      - Catch basin - 15 minutes

e. <u>Runoff Coefficient</u>
   1. Based on Table 6, with 0.4 as a minimum.

f. <u>Manning's "n" Value</u>
   1. All storm sewers shall be based on pipe material and approved by the City Engineer.

g. <u>Off-site Area</u>: The sewer must be deep enough to receive the flow from all its sources within the watershed.

h. Size: The size of the storm sewer must be adequate for flowing full, based on the design storm (see Subsection 4.2 (b), listed above) with the 5-year storm hydraulic grade line contained to the system. Pipe for storm drains shall not be less than 12 inches in diameter.

i. Solids: The gradient of the sewer must be sufficient to avoid deposition of solids.

j. Material: All storm drainpipe shall be PVC, HDPE or reinforced concrete. Other materials may be approved at the direction of the City engineer. All pipes shall have sufficient strength to withstand an HS-20 live load.

k. Manholes: Manholes shall be provided at all changes in alignment and grade of storm drains and at such other locations as necessary to maintain a maximum interval of 400 feet between manholes or storm drains. The main conduit, if over 24-inches in diameter, will be required to be separated from all curb and gutter inlets unless a special design is approved by the City's Engineer. Furthermore, the main conduit will be required to be separated from all deep curb and gutter inlets, which have a depth greater than 6.5 feet from invert to the top-of-casting elevation.

All catch basins shall be constructed with flow restriction in the first section of pipe diameter for one (1) length of pipe. The use of orifice plates is not allowed unless otherwise approved by the City Engineer.

l. Flow Line: Unless otherwise approved by the City's Engineer, the flow line of pipes should be set such that the crown of pipes, at junctions, are at the same elevation; if the outlet elevation permits, the crown of the outlet pipe may be lower. The flowline elevations of sewers should be set to avoid using concrete encasement.

m. Specifications: Methods of construction and trench backfill shall be as per the requirements of the City and the City of Columbus "Construction and Materials Specifications", latest edition, as approved for use by the City's Engineer.

n. Submerged pipe outlets: The submergence of a permanent pool of water above the flowline invert elevation of a storm sewer at the outlet is discouraged and shall not be permitted to a depth greater than the ½ the pipe diameter or a depth of two-feet at the outlet, whichever is less. When submergence is allowed upon approval by the City's Engineer, special requirements shall include, but may not be limited to:

1. Submergence "zone" shall not extend beneath pavement;
2. Submergence "zone" shall not extend beyond the first manhole;
3. "O-ring" sealed gasketed pipe joints shall be installed along the storm sewer for the full length of the submergence zone;
4. Anti- seepage collars shall be installed in the submergence "zone".

o. End protection: Standard headwalls or endwalls are to be constructed at the inlet and outfall of all storm drains, and shall be pre-cast or poured in place and shown on the plan and profile. as follows:

1. 12-inch through 36-inch culverts – full-height headwall. If the outlet is not located within a channel bank or within the direct flow path of crossing

floodwaters, half-headwalls at the outlet may be used if approved by the City's Engineer. In no instance will half-headwalls be allowed on non-concrete conduit
2. 42-inch through 84-inch culverts – full height headwall with flared wings
3. Other special type headwalls must be approved before use

p. Minimum cover to subgrade:
   1. Desirable, under pavement and within influence of traffic load - 30 inches from top of pipe to subgrade.
   2. Desirable, beyond influence of traffic load – 18 inches from top of pie to ground surface.

q. Maximum cover over pipe:
   1. The supporting strength of the conduit, as installed, divided by a suitable factor of safety must equal or exceed the loads imposed upon it by weight of earth plus any superimposed loads.
   2. The design procedure recommended for use in structural design of storm sewers is outlined within the Design Manual Concrete Pipe, available from American Concrete Pipe Association, wide trench installation.

r. Encasement: Class A concrete encasement shall be required within the limits of existing or proposed paved areas inside right of way, in areas influenced by traffic loading, or under paved driveway entrances adjacent to right of way as directed by the City's Engineer, where the minimum cover during construction or proposed cover over the outside top of the pipe to top of subgrade is 30 inches or less. In addition, all PVC and polyethylene pipe allowed to be installed in the right of way shall be concrete encased per CMS 910. Any concrete encasement of flexible pipe shall extend from structure to structure.

s. Velocity in sewer for design flow:
   1. 3 fps Minimum
   2. 7 fps Maximum
   3. No minimum for outlets from ponding areas

t. Maximum Length between access structures:
   1. Pipes under 60-inch – 350 feet
   2. Pipes 60-inch and over 500 feet

Table 6. Runoff Coefficients "C" for Typical Land Uses in Columbus

Cover Type and Hydrologic Condition	Average percent impervious area (5)	Runoff Coefficient for Hydrologic Soil Group (7)			
		A	B	C	D
Fully developed urban areas (vegetation established) (1)					
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		0.94	0.94	0.94	0.94
Open space (lawns, parks, golf courses, cemeteries, etc)					
Poor condition (grass cover, 50%)		0.29	0.48	0.63	0.70
Fair condition (grass cover 50% to 75%)		0.07	0.30	0.48	0.58
Good condition (grass cover >75%)		NA	0.19	0.39	0.50
Commercial and business (TND – TC) (6)					
Industrial					
Residential Districts by Average Lot Size (6):					
Multi-family (TND – NC)	80	0.63	0.75	0.80	0.83
1/12 to 1/6 acre lots (TND – NG)	75	0.56	0.70	0.77	0.83
1/8 acre (TND – NE)	65	0.44	0.60	0.72	0.77
1/4 acre	38	0.19	0.40	0.56	0.65
1/2 acre	25	0.11	0.32	0.50	0.60
1 acre	20	0.08	0.29	0.48	0.58
Undeveloped or agricultural lands(1)					
Cultivated Land:					
Without conservation treatment		0.35	0.52	0.67	0.75
With conservation treatment		0.21	0.34	0.46	0.52
Pasture, grassland, or range – continuous forage for grazing. (2)	Hydrologic condition:				
	Poor	0.29	0.48	0.63	0.70
	Fair	0.07	0.30	0.47	0.58
	Good	NA	0.19	0.39	0.50
Meadow – continuous grass, protected from grazing and generally mowed for hay.		NA	0.16	0.34	0.46
Brush – brush-weed-grass mixture with brush the major element. (3)	Poor	0.06	0.27	0.44	0.56
	Fair	NA	0.13	0.37	0.48
	Good	NA	0.06	0.25	0.37
Woods. (4)	Poor	0.04	0.26	0.44	0.56
	Fair	NA	0.18	0.37	0.48
	Good	NA	0.12	0.32	0.44
Farmsteads – buildings, lanes, driveways, and surrounding lots.	--	0.17	0.39	0.54	0.63

Notes:
NA – Method to derive value is not applicable for curve number values less than 40.
(1) Average runoff condition, and Ia=0.2s.
(2) Poor: <50% ground cover or heavily grazed with no mulch.
Fair: 50 to 75% ground cover and not heavily grazed.
Good: >75% ground cover and lightly or only occasionally grazed.
(3) Poor: <50% ground cover.
Fair: 50 to 75% ground cover.
Good: >75% ground cover.
(4) Poor: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.
Fair: Woods are grazed but not burned, and some forest litter covers the soil.
Good: Woods are protected from grazing, and litter and brush adequately cover the soil.
(5) The average percent impervious area shown was used to develop the composite CN's which were then used to derive runoff coefficient values. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a runoff coefficient of 0.94 (or CN of 98), and pervious areas are considered equivalent to open space in good hydrologic condition.
(6) Acronyms for zoning of residential districts are as follows:
TND – TC: Traditional Neighborhood Development – Town Center
TND – NC: Traditional Neighborhood Development – Neighborhood Center
TND – NG: Traditional Neighborhood Development – Neighborhood General
TND – NE: Traditional Neighborhood Development – Neighborhood Edge
(7) These runoff coefficients were calculated from CN's drawn from the NRCS (SCS) Peak Discharge Method from TR-55 assuming a 10-year, 24-hour storm. For larger design storms, the runoff coefficients should be increased using the following C value correction factors:
1.0 for the 10-year design storm and less
1.1 for the 25-year design storm
1.2 for the 50-year design storm
1.3 for the 100-year design storm

4.3 Curb Inlets

a. General: The satisfactory removal of surface water from curbed pavement is as important as any other phase of stormwater control. The spread of water on the pavement for the design storm is considered as the best control for pavement drainage. The design procedure recommended for use is Hydraulic Engineering Circular No. 12, available from the Superintendent of Documents, U.S. Government Printing Office. On combined runs of over 600 feet contributing to a sag vertical curve, an additional inlet may be required near the low point, plus or minus two-tenths foot above the inlet at the sag.

b. Design storm (curb inlets). The following shall be used:
   1. Two-year storm frequency
   2. Rational method of calculation
   3. Ten minutes for minimum time of concentration
   4. 0.015 for roughness coefficient for composite roadway paved and gutter section
   5. Maximum width of spread of flow:

Street Width	Width of Spread
≤ 30 ft.	8 ft.
> 30 ft.	9 ft.

c. Underdrains: Four (4) inch curb drains connections shall be placed 30-inches below the top of the curb on the up-grade side of the inlet. It is desirable to have the storm sewers, draining to the inlets, set such that the elevation of the top of the sewer is not higher than the top of the 4-inch curb drain.

d. The maximum distance for overland flow shall be 300 feet before entering a surface yard inlet or 425 feet before entering a curb inlet. Except, that the maximum overland drainage area tributary to any yard inlet or curb inlet shall not exceed 1.5 acres. The maximum spacing for curb inlets shall not exceed 400 feet unless approved by the City.

4.4 Detention Facilities

Areas designed for storage of stormwater by retention should be incorporated into the natural features of the general area, when possible. Cooperative planning and joint owner construction of detention or retention facilities and use of natural land contours is encouraged. The City encourages that detention or retention facilities be designed as multipurpose spaces such as open space, recreation and/or scenic areas. The City encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval.

a. Ownership and maintenance. The owner and thus responsible party to provide maintenance and operation of a stormwater management facility (i.e., detention, retention basin, etc.), whether public or private, shall be determined to the satisfaction of the City prior to the acceptance by the City's Council of the relevant subdivision plat and the acceptance of the final engineering and construction plan. No lot sales will be permitted until this is done.

b. Location: All stormwater management facilities will be located in a reserve/open space as shown on the preliminary plat and final plat and will be owned by a homeowners association or an entity otherwise approved by the City's Council.

c. Types of facilities: In development and developing urban and suburban areas, several means for controlling stormwater runoff could be used. This usually involves storing runoff on or below the ground surface. The following types of storage facilities may be considered for detention and are subject to approval by the City's Engineer and OEPA: rooftops, parking lots, underground tanks and surface basins or ponds and man-made stormwater wetland systems. All surface detention shall be wet or permanent-pool basins. No dry detention basins are permitted.

4.5.1 Parking Lot Storage

Parking lot storage is surface storage where shallow ponding is designed to flood specific graded areas of the parking lot. Controlled release features are incorporated into the surface drainage system of the parking lot. Parking lot storage is a convenient multi-use structural control method where impervious parking lots are planned. Design features include small ponding areas with controlled release by pipe-size and slope, and increased curb heights.

The major disadvantage is the inconvenience to users during the ponding function. This inconvenience can be minimized with proper design consideration. Clogging of the flow control device and icy conditions during cold weather are maintenance problems. Parking lot design and construction grades are critical factors. This method is intended to control the runoff directly from the parking area, and is usually not appropriate for storing large runoff volumes.

a. Ponding areas in parking or traffic areas shall be designed for a maximum potential depth of twelve (12) inches.

b. Flood routing or overflow must occur after the maximum depth is reached.

4.5.2 Tank Storage

Tank storage utilizes an underground tank or chamber, either prefabricated or constructed in place, which has a special controlled release feature. This method is most applicable where land area is valuable, such as in industrial and commercial areas. Construction cost and operation costs make this method relatively expensive. Storage trenches, a variation on basic tank storage, are rock-filled underground storage tanks. The storage is provided within the void spaces between the rock material.

4.5.3 Wet Detention Basins

Wet Detention Basins (Ponds) are permanent ponds where functional stormwater management storage is provided above the normal water level with special features for controlled release. Historically, wet detention basins have proven extremely effective in abating increased runoff and channel erosion from urbanized areas. They are a major Soil Conservation land treatment practice. Wet detention basins must be constructed outside of any existing stream channels and outside of the stream corridor protection zone.

All wet detention basins must meet water quality and quantity detention criteria in Section 2 of this manual.

Some problems encountered with wet detention basins are: site reservation (land requirements), permanent easements, complexity of design and construction, safety hazards and maintenance problems. However, the recreational, aesthetic, and water quality benefits of permanent wet detention ponds justify their use in many applications. A five (5) foot chain link fence may be required where a wet retention basin is to be constructed adjacent to an existing single-family development for that part along the existing single-family section, if a sufficient submerged bench cannot be constructed in the basin (see Section 4.5.3 b below).

a. The City encourages use of fountains for aeration and reserves the right to require such an appurtenance as a condition to plan approval.

b. The side slopes for a Wet Detention basin should be:

   - A maximum slope of 2:1 horizontal to vertical below the permanent storage pool;
   - A minimum 5 foot wide, 2-foot maximum depth submerged bench at waters edge around perimeter of the permanent storage pool;
   - A maximum 3:1 horizontal to vertical above the submerged bench.

c. Unless otherwise approved by the City's Engineer, a minimum of 20 % of the pool area should be ten-feet deep for water-quality benefit.

d. <u>Rock Channel Protection</u> Type D, may be required to be placed at the normal water elevation, around the entire perimeter of the basin, five feet wide, centered on the normal water elevation.

e. <u>Wetland Perimeter</u> A wetland shelf may be constructed around the perimeter of the basin. The wetland shelf should have a minimum width of 10 feet, and a maximum depth of 8 inches, and be planted in wetland plants.

f. <u>Debris-control structures</u>: Debris-control structures may be required and should be considered as an essential part of the design. The procedure recommended for use is <u>Hydraulic Engineering Circular No. 9</u>, available from the Superintendent of Documents, U.S. Government Printing Office, Washington D.C. For dams and levies over ten feet in height, refer to Section 1521.062, O.R.C.

g. <u>Submerged Outlet/Inlet Structures</u>:
   1. The City permits the use of submerged storm outlets. Submerged Outlets may consist of a siphon pipe where such pipe is no smaller than 12- inches in diameter. For smaller outlet requirements, a bolted-on orifice plate may be used as the control feature, to be placed at the structure within the embankment. The siphon pipe material must be concrete. When using a submerged outlet, a stormwater detention basin must also include one or more additional stage outlet(s) with sufficient capacity to convey the 100-year storm discharge without overtopping the pond embankment.

2. Inlet pipes that are equal to or larger in diameter than 36-inches must be submerged to at least the "springline" of the pipe (i.e., normal pool at a depth equal to the elevation at one-half the diameter of the pipe). When an inlet pipe is at least partially submerged at the pond, the conditions listed below must also be met.

3. Submergence of inlet pipes is limited to the next upstream manhole or catch basin along the storm sewer system.

4. All lengths of submerged storm pipe shall include "o-ring" sealed gasket pipe joints.

5. All lengths of the submerged storm pipe shall have bedding and backfill material consistent with the compacted embankment material.

6. Riser Outlet Structures: Catch basins/manholes used as the outlet structures may have a maximum elevation that is no more than 1.5 feet above the normal pool elevation and may include windows and grate-top openings. Where a catch basin is used as a second-stage outlet structure, the slope of the pond embankment must be graded to reduce the visibility of the structure.

   Calculations must show that the capacity of the window(s)/grate top does not exceed the capacity of the "barrel" of the riser structure (calculated using the orifice equation).

7. Structure Requirements: All headwall structures shall be in accordance with City of Columbus Standard Drawing AA-S166 (36-inch diameter or less) or City of Columbus Standard Drawings AA-S167 (greater than 36-inch diameter). All riser structures shall be in accordance with City of Columbus Standard Drawing AA-S162. (modified as necessary.)

8. Bedding/Backfill Material: The bedding and backfill material for all storm pipe outlets shall consist of 100 percent cohesive embankment material or controlled-density fill. Where inlet storm pipes are submerged, bedding and backfill material for those pipes shall consist of 100 percent cohesive embankment material to the next structure upstream along the storm sewer system.

9. Anti-Seep Collars:
   - Anti-seep collars shall be used at all outlet storm pipe locations and shall be located (spaced) and sized in accordance with the criteria provided below. All anti-seep collars shall be constructed with material that provides a watertight connection to the pipe and is of a material that is compatible to the pipe. Anti-seep collars shall also be used along the submerged portion of any storm inlet pipes.

   - The anti-seep collars shall be located along the length of the outlet pipe within the saturation zone of the embankment (refer to Exhibit No. 1), at approximately equal spacing and at intervals not exceeding 25 feet. The saturation zone is considered to extend through the embankment from the elevation of the riser (normal pool) to the downstream embankment toe.

- The anti-seep collars shall be designed to increase the length along the line of seepage (along the outlet pipe) by at least 15 percent. The proper design of the anti-seep collars may be achieved by either:

  - Selecting the number of collars and determining the minimum projection of the collar away from the outlet pipe: V = 0.075 x (L/N); or

  - Selecting the projection of the collar away from the outlet pipe and determining the minimum number of collars:

    N = 0.075 x (L/V)

    Where:

    V = collar projection in feet
    N = number of collars
    L = length of outlet pipe within the saturation zone

11. Emergency Spillways: Emergency Spillways, when included in the designed pond outlet feature, must meet all of the following criteria:
    - They shall not operate (convey flow) for any design storm less than the 50-year event.

    - They shall be reinforced with concrete or designed erosion control materials (geotextiles) consisting of 100 percent synthetic, non-biodegradable materials [the plans should include a specification for the intended geotextile, referencing the required physical properties or the specific material. Reference the State of Ohio, Department of Transportation Construction and Material Specifications Section 712.11, Type "E."

    - They must include a designed "control section" that, when combined with the capacity of the principal spillway, will pass the major storm flood discharge up to the 100-year event [the plans must include a detail demonstrating the necessary dimensions of the control section, both width and breadth.

12. Miscellaneous: The following general criteria must be met:
    - Roof drain (downspout) outlets directly to the pond are not permitted

    - All orifice plates shall conform to the requirements of City of Columbus Standard Drawing, No. AA-S145.

    - All inlet structures (e.g., pipe headwalls) must be recessed into the adjoining pond grading to diminish the amount the structure is visible.

4.6 Alternative Stormwater Best Management Practices

Several alternative BMP's have been approved for use in stormwater management by the Ohio EPA (OEPA Construction General Permit, OEPA Permit OCH000002 or its subsequent OEPA revisions). Such practices include Stormwater Treatment Wetlands, Bioretention, Infiltration Trenches, and Grass Filter Strips. Design criteria for these BMP's can be found in the *Rainwater and Land Development Manual* from the Ohio Department of Natural Resources.

5.0 REFERENCES

National Menu of Best Management Practices for Storm Water Phase II, United States Environmental Protection Agency, August 2002

Rainwater and Land Development, Ohio Department of Natural Resources, December, 2006.

VegSpec and PLANTS Database, United States Dept. of Agriculture, Natural Resource Conservation Service, http://plants.usda.gov

Glossary

The following definitions shall apply to this Manual:

Attenuation: to reduce the amount, volume or concentration of pollutants or surface water.

100-year Flood: A flood which has the probability of occurring once every one-hundred (100) years or having a one (1) percent chance of occurring each year.

Baseflow: Minimum, long-persistence flow in streams produced mainly by seepage; sometimes called subsurface flow.

Best Management Practice (BMP): Measures including structural and non-structural BMPs that are determined to be the most effective, practical means of preventing or reducing point source or non-point source pollution inputs to storm water runoff and water bodies (see Practices).

Channel: Natural or artificial watercourse of perceptible extent, with a definite bed and banks to confine and conduct continuously or periodically flowing water. Channel flow thus is that water which flows by gravity and is characterized by a free water surface within the banks of a defined channel.

Water Quality Volume (CPWQv): The volume of storm water runoff which shall be captured and treated prior to discharge from the developed site after construction is complete. CPWQv is equivalent to the volume generated by a 0.75 inch rainfall.

City: The City of Whitehall.

City Engineer: The City of Whitehall City Engineer.

Contamination: The presence of or entry into a public water supply system, the MS4, Waters of the State, or Waters of the United States of any substance which may be deleterious to the public health and/or the quality of water.

Conveyance: Any pipe, channel, inlet, drain, or other structure that facilitates the movement or removal of water.

Dam: an artificial barrier usually constructed across a stream channel to impound water. Dams must have spillway systems to safely convey normal stream and flood flows over, around, or through the dam. Spillways are commonly constructed of non-erosive materials such as concrete. Dams should also have a drain or other water-withdrawal facility to control the pool or lake level and to lower or drain the lake for normal maintenance and emergency purposes.

Design Storm: A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years), which is used to calculate the runoff volume and peak flow rate.

Detention: Runoff enters an area of detention faster than it leaves. It occurs in depressions, the natural landscape, or constructed stormwater facilities. While detention can be designed into ponds with or without a permanent pool, dry ponds often are referred to as detention ponds.

Detention Basin: a facility designed for the temporary storage of stormwater runoff for the purpose of delaying and attenuating flow to the downstream receiving system. For the purpose of this design manual, this definition excludes storage in areas of parking lots, rooftops, underground tanks and other water quality-based applications, such as bio-retention basins. Note that per Section 5.2.2 General Requirements all detention basins installed within the City of Grove City shall be wet ponds with a permanent normal pool.

Detention Storage: Storm runoff collected and stored for a short period of time and then released at a rate much less than the inflow rate. (e.g. a dry reservoir)

Development: Any action in preparation for construction activity which results in an alteration of either land or vegetation, including but not limited to clearing, grubbing, grading, filling, excavation or any other development operations and the construction of new facilities, buildings, parking areas, recreational areas, etc.

Dike: an artificial barrier used to divert or restrain flood waters from tidal bodies of water.

Discharge: Any substance introduced to the Waters of the State or to surface runoff which is collected or channeled by the MS4 which do not lead to treatment works and/or the addition of any pollutant to the Waters of the State from a point source.

Disturbed: Earth surface subject to erosion due to the removal of vegetative cover and/or earthmoving activities.

Ditch: An open channel constructed for the purpose of drainage or irrigation with intermittent flow.

Drainage: A general term applied to the removal of surface or subsurface water from a given area, either by gravity or by pumping, commonly applied herein to surface water.

Drainage System or Drainageway: The surface and subsurface system for the removal of water from the land, including both the natural elements of streams, marshes, swales and ponds, whether of an intermittent or continuous nature, and man-made elements which include culverts, ditches, channels, storage facilities and the storm sewer system.

Easement: Property titled to the City for the operation and maintenance of storm water drainage and management systems.

Engineer: A Professional Engineer registered in the State of Ohio as required by Chapter 4733 of the Ohio Revised Code.

Environmental Protection Agency (EPA): The U.S. Environmental Protection Agency or, where appropriate, a designation for the Director or other duly authorized official of such Agency.

Erosion: The general process whereby soil or surface material is moved by flowing surface or subsurface water or is worn away by the action of wind, water, ice or gravity.

Erosion control: Measures that reduce or prevent erosion.

Extended Detention: A stormwater design feature that provides for the gradual release of a volume of stormwater (typically 0.25 - 0.75 inch per impervious acre) over a 24 to 48-hour interval to increase settling of urban pollutants and protect channels from degradation.

Facility: Any operation, including construction sites, required by the Federal Clean Water Act to have a permit to discharge storm water associated with activities subject to NPDES Permits as defined in 40 CFR, Part 122.

Flood: A temporary rise in the level of rivers, streams, watercourses and lakes which results in inundation of areas not ordinarily covered by water.

Flood Plain: The relatively level land to either side of a channel, which is inundated during high flows. It is often used to reference the 100-year flood plain.

Forebay: A distinct area near an inlet of a pond to enhance deposition of incoming sediments.

Geotextile: A woven or nonwoven, water-permeable fabric generally made of synthetics such as polypropylene. It's used to slowly pass runoff or as bedding for rock to keep the rock separate from adjacent soil.

Grading: Changing the ground surface condition, elevation, and/or slope through excavation or fill of material.

Hydrologic Soil Group: One of four classifications of soil based on the minimum infiltration characteristics for bare soil after prolong wetting as used by the United States Department of Agriculture Natural Resources Conservation Service *Technical Release No. 55, Urban Hydrology for Small Watersheds.*

Impervious Surface: Any constructed surface; including but not limited to, rooftops, sidewalks, roads, and parking lots; covered by impenetrable materials such as asphalt, concrete, brick, and stone. These materials seal surfaces, repel water and prevent precipitation and runoff from infiltrating soils. Soils compacted by urban development are also highly impervious.

Infiltration: The gradual downward flow of water from the surface through soil to groundwater.

Landscape: To mow, seed, sod, plant, and to do other activities which are not earth changes.

Larger common plan of development or sale: means a contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under one plan.

Levee: an artificial barrier that diverts or restrains flood waters from streams and lakes.

Material: Soil, sand, gravel, clay, or any other organic or inorganic material.

Municipal Separate Storm Sewer System (MS4): As defined at 40 CFR 122.26(b)(8), "means a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

A. Owned or operated by a State, City, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law)...including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity.

B. Designed or used for collecting or conveying storm water;
C. Which is not a combined sewer; and
D. Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2."

National Pollutant Discharge Elimination System (NPDES): A national program under Section 402 of the Clean Water Act for regulation of discharges of pollutants from point sources to Waters of the United States. Discharges are illegal unless authorized by an NPDES permit.

NPDES Permit: A permit issued by the EPA (or by a State under authority delegated pursuant to 33 USC § 1342(b)) that authorizes the discharge of pollutants to Waters of the United States, whether the permit is applicable on an individual, group, or general area-wide basis.

Ohio EPA: The Ohio Environmental Protection Agency.

Operate: To drive, conduct, work, run, manage, or control a tool, piece of equipment, vehicle, or facility.

Owner: Any person with a legal or equitable interest in a piece of the land or parcel.

Permeability: The capacity for transmitting runoff through a material or into soil. The relevant soil property is the saturated hydraulic conductivity, that is the amount of water that would move vertically through a unit of saturated soil per unit time under hydraulic gradient.

Permittee: The applicant in whose name a valid permit is duly issued.

Pollutant: Anything which causes or contributes to pollution

Pollution: The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any Water of the State or Water of the United States, that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to the public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Practices: Schedules of activities, prohibitions of practices, maintenance procedures and other management practices and techniques (both structural and non-structural) used to lessen the environmental impacts of land use and to prevent or reduce the pollution of Waters of the State. BMPs also include treatment requirements, operating procedures and practices to control facility and/or construction site runoff, spillage or leaks, sludge or waste disposal or drainage from raw material storage. Techniques may involve basins, vegetation, altering construction operations, open space development, riparian buffers or other means of limiting environmental impacts.

Rainwater and Land Development Manual: A manual describing construction and post-construction best management practices and associated specifications prepared by the Ohio Department of Natural Resources Division of Soil and Water Conservation. A copy of the manual may be obtained by contacting the City Engineer or the Ohio Department of Natural Resources, Division of Soil & Water Conservation.

Return period: Also known as the *recurrence interval*, it is the average period between precipitation events or flood events of a certain size based on the records and statistics.

Riparian Corridor: An area of trees, shrubs, and surrounding vegetation located adjacent to streams, rivers, lakes, ponds, and wetlands which serve to stabilize erodible soil, improve both surface and ground water quality, increase stream shading and enhance wildlife habitat.

Riprap: Rock or stone placed over a bedding of geotextile, sand or gravel used to armor slopes against flowing water or wave action.

Runoff: The portion of rainfall, precipitation, melted snow or irrigation water that flows across the ground surface and is eventually returned to streams.

Runoff Coefficient: The fraction of total rainfall that will appear at the conveyance as runoff.

Sediment: Soils or other surface materials (including, but not limited to rock, sand, gravel and organic material or residue associated with or attached to the solid) that can be transported or deposited by the action of wind, water, ice or gravity as a product of erosion or sedimentation.

Sediment Pollution: Degradation of Waters of the State by sediment as a result of failure to apply management or conservation practices to abate wind or water soil erosion, specifically in conjunction with earth-disturbing activities on land used or being developed for commercial, industrial, residential or other non-farm purposes.

Sediment Settling Pond: A sediment trap, sediment basin or permanent basin that has been temporarily modified for sediment control, as described in the latest edition of the Rainwater and Land Development manual.

Sedimentation: The processes that operate at or near the surface of the ground to deposit soils, debris and other materials either on the ground surfaces or in water channels or the action of deposition of sediment that is determined to have been caused by erosion.

Sheet Flow: Diffuse runoff flowing overland in a thin layer not concentrated and not in a defined channel.

Site: The entire area of land surrounding the discharge activity.

Site Map: A plan or set of plans showing the details of any earth-disturbing activity of a site.

Soil Erosion: The movement of soils that occurs as a result of wind, rain, precipitation, or flowing water.

Soil Hydraulic Conductivity: The property describing permeability or the ability of water to move through soils, typically measured in saturated conditions (Ks).

Stabilization: Vegetative or structural soil-cover controlling erosion (including but not limited to permanent and temporary seed, mulch, sod, pavement, etc.) or the use of vegetative and/or structural practices that prevent exposed soil from eroding.

State: The State of Ohio.

Storm Drainage System: All facilities, channels, and areas which serve to convey, filter, collect and/or receive storm water, either on a temporary or permanent basis.

Stormwater: Water runoff resulting from precipitation, snow melt, or irrigation runoff as defined in 40 Code of Federal Regulation 122.26(b)(13).

Stormwater Conveyance System: All storm sewers, channels, streams, ponds, lakes, etc. used for conveying concentrated storm water runoff or storing storm water runoff and filtering pollutants

Stormwater Pollution Prevention Plan (SWP3): A set of plans and specifications, prepared and approved in accordance with the specific requirements of the City Engineer and the Ohio EPA, NPDES Permit #OHC000003. The SWP3 shall be certified by an Engineer, and shall indicate the storm water management strategy, including the specific measures and sequencing to be used to manage storm water on a development site before, during and after construction and shows the details of any earth-disturbing activity on the site.

Stormwater Retention/Detention BMPs: Retention storage and detention storage that control storm water by gathering runoff in wet ponds, or dry basins, and slowly releasing it to receiving waters or drainage systems. These practices can be designed to both control storm water volume and settle out particulates for pollutant removal.

Stormwater Runoff: Surface water runoff which converges and flows primarily through water conveyance features such as swales, gullies, waterways, channels or storm sewers.

Stormwater Treatment: The removal of pollutants from urban runoff and improvement of water quality, accomplished largely by deposition and utilizing the benefits of natural processes.

Stream: A system including permanent or seasonally flowing water, often with a defined channel (bed and bank), flood plain, and riparian ecosystem.

Structure: Anything manufactured, constructed or erected which is normally attached to or positioned on land, including, but not limited to buildings, portable structures, earthen structures, roads, parking lots, and paved storage areas.

Topography: The relative slopes, positions and elevations of the landscape's surface.

Underdrain System: The drainage system utilized in bioretention and occasionally detention practices to maintain positive drainage.

Watercourse: any natural or constructed conveyance of water including, but not limited to lake, pond, stream, river, creek, ditch, channel, canal, conduit, gutter, culvert, drain, gully, swale, or wash in which water flows either continuously or intermittently.

Water Quality Volume: The extended detention volume captured for the purposes of treating pollutants and protecting stream stability downstream. This volume is prescribed by the Ohio EPA Construction General Permit.

Watershed: A region draining to a specific river, river stream or body of water.

Wetland: An area that is inundated or saturated by surface or ground-water at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated or hydric soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.