STORMWATER DESIGN MANUAL

June 2015
Revised November 12, 2015

City of Grove City

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STORMWATER DESIGN MANUAL

1.0 INTRODUCTION

This Manual establishes design criteria for stormwater facilities within the City of Grove City in conjunction with City Code, Section's 971 and 973, Part 11, Title 1, Section 1101 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:

a. Minimize the damage and inconvenience of flooding.
b. Provide drainage systems which continue to provide benefit over the long term.
c. Minimize the expense of maintaining the drainage facilities within the City.
d. Reduce non-point-source pollution.
e. Minimize new impacts on engineered and natural drainage system.
f. 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 principle 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.

Stormwater management facilities shall be designed to meet the requirements of this Manual and submitted to the City Engineer for review. Stormw0ater management facilities shall be included with the construction plans and shall be signed and sealed by an Ohio Professional Civil Engineer. The City shall not approve plans for any site improvement over which it has jurisdiction without documentation from the Director and the City Engineer, that such plan of improvement has been designed to be in compliance with the design requirements herein.

1.2 Drainage Policy

This drainage policy, control guidelines and criteria do not provide solutions to all drainage problems, nor is the Engineer restricted to these design criteria 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 requisite site improvements. Exceptions may be granted to the policies and criteria in such cases when engineering study(s) justify modification.

The general policy of the City shall be as follows:

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 Municipal Separate Storm Sewer System (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 up to the 100-year storm frequency. The system for the upstream tributary area shall be extended through the development.

d. All proposed developments 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. Site improvement plans with supporting documentation shall be submitted to the City for review and approval prior to the commencement of work at any proposed development site.

    1. Supporting documentation 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.

f. This Stormwater Design Manual applies to all land developments. The following exceptions from the Peak Flow Rate Controls are as follows:

    1. Single-family residential lot not part of a larger common development or sale.
    2. Two, three, or four unit multi-family structure not part of a larger common development or sale.
    3. Managed open space associated with parks, golf courses, cemeteries, and other similar land uses including associated paved trails and roadways needed for the function of the land use.
    4. Existing public right-of-way improvements including minor road widening increase in impervious area, and bridge crossings.
    5. Linear utility line installations.
    6. Land preparation for agricultural crops, orchards, woodlots, sod farms, and nursery operations.
    7. Land grading or leveling for erosion control under direction of the local soil conservation district.
    8. Land subdivisions for residential purposes with a minimum lot size of five acres.
    9. Developments with less than 1 acre of disturbance as long as the requirements of 1.2(a) through (f) have been complied with.
    10. Properly permitted environmental restoration projects including wetlands, stream restoration, and other related activities.
    11. Developments within previously approved Stormwater Master Plan.

2.0 STORMWATER SYSTEM DESIGN CRITERIA

2.1 Design Storm Criteria

The following table provides guidance on the design frequency for storm sewers, culverts, and pavement spread.

Table 2-1: Design Storm Criteria

	Collector/Secondary/ Arterial Streets	Residential/ Local/ Private Streets	Commercial, Industrial, Institutional and other Developments	Private Parking Lots
Storm Sewer - Open Channel Flow (full pipe capacity)	5-year	2-year	2-year	2-year
Storm Sewer - Hydraulic Grade Line (in-system)	10-year	5-year	5-year	5-year
Pavement Spread	2-year	2-year	n/a	n/a
Roadway Ditch Design	10-year	5-year	5-year	5-year
Roadway Culverts (non-FEMA streams)	25-year	10-year	10-year	10-year
Roadway Culverts (FEMA streams)	100-year	100-year	100-year	100-year

2.2 Peak Discharge Calculation Methodology

The rational method (Q = CIA) may be used to determine peak discharge rates for storm sewers, culverts, pavement spread, and roadway ditch designs with individual tributary areas generally less than 10 acres using the following formula to determine rainfall intensity.

Intensity = $X / (Y + T)^Z$ (see Table 2-2 for coefficients)
Where T is equal to the time of concentration in minutes

Alternative methods for determining peak flow rates include the National Resources Conservation Service (NRCS) TR-55 methodology and the Green-Ampt Method.

For larger watershed and floodplain studies, the United States Geological Survey (USGS) rural regression equation may be used, specifically Water Resources Investigation Report 89-4126[1] according to the following formulas:

$Q_2 = (56.1)(CONTDA)^{0.782}(SLOPE)^{0.172}(STORAGE)^{-0.297}$

$Q_5 = (84.5)(CONTDA)^{0.769}(SLOPE)^{0.221}(STORAGE)^{-0.322}$

$Q_{10} = (104)(CONTDA)^{0.764}(SLOPE)^{0.244}(STORAGE)^{-0.335}$

$Q_{25} = (129)(CONTDA)^{0.760}(SLOPE)^{0.264}(STORAGE)^{-0.347}$

$Q_{50} = (148)(CONTDA)^{0.757}(SLOPE)^{0.276}(STORAGE)^{-0.355}$

$Q_{100} = (167)(CONTDA)^{0.756}(SLOPE)^{0.285}(STORAGE)^{-0.363}$

Where CONTDA is the contributing drainage area in square miles, SLOPE in the main channel slope in feet/mile; and STORAGE is the storage area in percent. Main channel slope (SLOPE), in feet per mile; computed as the difference in elevation at points 10 and 85 percent of the distance along the main channel from a specified location on the channel to the topographic divide, divided by the channel distance between the two points.

Table 2-2: Rational Method Intensity Formula Coefficients

Storm Frequency (years)	X	Y	Z
2	54.64	10.04	0.88
5	45.04	7.91	0.78
10	48.25	7.38	0.78
25	27.24	3.24	0.59
100	24.83	1.74	0.51

[1] US Geological Survey. (1990). *Techniques for Estimating Flood-Peak Discharges of Rural, Unregulated Streams in Ohio: Water-Resources Investigations Report 89-4126* by G.F. Koltun and J.W. Roberts. Ohio Department of Transportation.

2.3 Pavement Spread

Table 2-3 Pavement Spread Standards for the Design Storm

Street Classification	Maximum Encroachment from Face of Curb	Maximum Inlet Spacing
Residential/Local Streets	14 feet	300 Feet
Collector, Secondary, or Arterial Street	10 feet	200 Feet

a. Detailed calculations for spread are not required if the area to the inlet does not exceed 0.50 acres of area for local and 0.20 acres of area for collector per inlet.

2.4 Roadway Culverts

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

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

c. Culvert/Storm Sewer Pipe Material: The installation of all sewer pipes on this project shall be in accordance with Section 901 of the CMSC, unless specifically indicated otherwise, with materials conforming to the appropriate referenced section of CMSC or ODOT CMS. The following pipe materials will be permitted for use for public sewers.

Outside of Pavement Limits

Flexible Pipe according to the following specifications:

- Polyvinyl Chloride (PVC) pipe <= 15" diameter with minimum of 4 feet coverage and a maximum of 15 feet coverage shall conform to CMSC 720.08 and/or ODOT CMS 707.45.
- High Density Polyethylene (HDPE) pipe between 12" and 36" diameter conforming to CMSC 720.12 and/or ODOT CMS 707.33 with a maximum 20 feet coverage and a minimum 2 feet coverage.
- Polypropylene (PP) pipe between 12" and 36" diameter conforming to ODOT CMS 707.65 or 707.69 and/or CMSC 720.13 or 720.14 with a maximum 20 feet coverage and a minimum 2 feet coverage.

Mandrel testing shall be performed on all flexible pipe per CMSC 901.21.

Rigid Pipe will be required for all sewers greater than 36" diameter (Reinforced Concrete Pipe CMSC 706.02, Concrete Box CMSC 706.05) and is also permitted on all sewers between 12" and 36" diameter.

Within Pavement Limits

Flexible Pipe according to the following specifications:

- Flexible pipe installation which conforms to ODOT CMS 605 may be used for 4" and 6" underdrain tiles.
- High Density Polyethylene (HDPE) pipe <=36" diameter conforming to CMSC 720.12 and/or ODOT CMS 707.33 with a maximum 20 feet coverage and a minimum 2 feet coverage.
- Polypropylene (PP) pipe between <=36" diameter conforming to ODOT CMS 707.65 and/or CMSC 720.13 with a maximum 20 feet coverage and a minimum 2 feet coverage.

Mandrel testing shall be performed on all flexible pipe (except underdrains) per CMSC 901.21.

Rigid Pipe will be required for all sewers greater than 36" (Reinforced Concrete Pipe 706.02. Concrete Box 706.05) and is also permitted for use on 12" to 36" sewers.

d. 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.

e. Allowable Headwater shall not exceed any of the following controls for the design storm:

1. 24 inches below the near, low edge of pavement for drainage areas of 1000 acres or more.
2. 12 inches below the near, low edge of pavement for drainage areas of 1000 acres or less.
3. 4 feet above inlet crown in deep ravine.
4. 1 foot below near edge of pavement for bicycle pathways.
5. Property Damage – 100-year frequency headwater plus 1 foot, shall not exceed any existing or proposed building first floor elevation.

f. Maximum Allowable Outlet Velocity shall be:

1. Turf Channel 5 feet per second.
2. Rock Protection 18 feet per second.

   Notes:

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

g. Structural Design Criteria for culverts shall be the same as that required by the Ohio Department of Transportation (ODOT).

h. 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 shall be included in the design.

i. 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 shall be approved before use.

2.5 Storm Sewers

The criteria for designing storm sewer systems are listed below:

a. All Storm Sewer Systems shall be designed using Manning's Equation or an EPA SWMM based modeling platform where the design storm flow doesn't exceed the flowing full capacity or hydraulic grade line does not exceed the crown of the pipe. For the Manning's Equation use the following formula:

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

and

$$Q = VA$$

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)

b. Hydraulic Gradient Requirement shall be:

1. For design storm, shall not exceed window or grate elevation for an inlet or catch basin.
2. Grade line is based on tailwater or 0.8 D at outlet (whichever is greater) or other critical points within the system.

c. Design Flow Determination:

1. Areas under 10 acres use Rational Method Q = CiA.
2. Areas over 10 acres use Technical Release 55.

d. Minimum time of Concentration: 5 minutes.

e. Runoff Coefficient based on Table 2-4.

f. Manning's "n" Value based on pipe material.

g. Off-site Area: The sewer shall be deep enough and sized accordingly to receive the flow from all its sources within the watershed.

h. Solids: The gradient of the sewer shall be sufficient to avoid deposition of solids by having a minimum full flow open channel velocity of 3.0 feet/second.

i. Material: See Section 2.4(C).

j. Manholes: 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 Director of Public Service. 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.

k. Flow Line: Unless otherwise approved by the Director of Public Service, 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.

l. Specifications: The current City of Columbus and Ohio Department of Transportation (ODOT) "Construction and Material Specifications" (CMSC and ODOT CMS respectively) together with the requirements of the City of Grove City, Ohio, including all supplements thereto shall govern all materials and workmanship involved in the improvements. Please refer to the City of Grove City website Public Service Department Forms section for storm water improvement general notes.

m. Submerged pipe inlets to basins:

The permanent submergence of a storm sewer at the inlet to a basin 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 Director of Public Service, 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".

n. End protection should be 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 Director of Public Service
2. 42-inch through 84-inch culverts – full height headwall with flared wings.
3. Other special type headwalls shall be approved before use.

o. Minimum Cover to subgrade and Maximum Cover over pipe:

See Section 2.4(C).

p. Encasement: See Section 2.4(C).

q. Maximum Length between access structures:

1. Pipes under 60 inch – 350 feet.
2. Pipes 60 inch and over 500 feet.

Table 2-4: Rational Method Runoff Coefficients[2]

Hydrologic Soil Group	A			B			C			D		
Storm Recurrence Interval (year)	**2-5**	**10**	**100**	**2-5**	**10**	**100**	**2-5**	**10**	**100**	**2-5**	**10**	**100**
Land Use Or Surface Characteristics												
Business												
A. Commercial Area	.75	.80	.95	.80	.85	.95	.80	.85	.95	.85	.90	.95
B. Neighborhood Area	.50	.55	.65	.55	.60	.70	.60	.65	.75	.65	.70	.80
Residential												
A. Single Family	.25	.25	.30	.30	.35	.40	.40	.45	.50	.45	.50	.55
B. Multi-Unit (Detached)	.35	.40	.45	.40	.45	.50	.45	.50	.55	.50	.55	.65
C. Multi-Unit (Attached)	.45	.50	.55	.50	.55	.65	.55	.60	.70	.60	.65	.75
D. ½ Acre Lot Or Larger	.20	.20	.25	.25	.25	.30	.35	.40	.45	.40	.45	.50
E. Apartments	.50	.55	.60	.55	.60	.70	.60	.65	.75	.65	.70	.80
Industrial												
A. Light Areas	.55	.60	.70	.60	.65	.75	.65	.70	.80	.70	.75	.90
B. Heavy Areas	.75	.80	.95	.80	.85	.90	.80	.85	.95	.80	.85	.95
Parks, Cemeteries Playgrounds	.10	.10	.15	.20	.20	.25	.30	.35	.40	.35	.40	.45
Schools	.30	.35	.40	.40	.45	.50	.45	.50	.55	.50	.55	.65
Railroad Yard Areas	.20	.20	.25	.30	.35	.40	.40	.45	.45	.45	.50	.55
Streets												
A. Paved	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
B. Gravel	.25	.25	.30	.35	.40	.45	.40	.45	.50	.40	.45	.50
Drives, Walks, & Roofs	.85	.90	.95	.85	.90	.95	.85	.90	.95	.85	.90	.95
Lawns												
A. 50% - 75% Grass (Fair Condition)	.10	.10	.15	.20	.20	.25	.30	.35	.40	.30	.35	.40
B. 75% Or More Grass (Good Condition)	.05	.05	.10	.15	.15	.20	.25	.25	.30	.30	.35	.40
Undeveloped Surface (By Slope)												
A. Flat (0-1%)	0.04-0.09			0.07-0.12			0.11-0.16			0.15-0.20		
B. Average (2-6%)	0.09-0.14			0.12-0.17			0.16-0.21			0.20-0.28		
C. Steep	0.13-0.18			0.18-0.24			0.23-0.31			0.28-0.38		

[2] *Iowa Stormwater Management Manual*, Iowa State University, 2009. Available from http://www.intrans.iastate.edu/pubs/stormwater/index.cfm

3.0 PEAK FLOW RATE CONTROL FACILITIES CALCULATION REQUIREMENTS

This section provides guidance on the implementation of the peak flow control requirements consistent with the critical storm method. The NRCS runoff curve number (RCN) method is the preferred method to determine runoff volumes and peak flow rates to stormwater control facilities, although the Green-Ampt method coupled with an EPA SWMM modeling engine may be used with permission by the Director Public Service for special situations. Level pool routing calculations shall be performed using TR-20, EPA SWMM, or HEC-1 based modeling platforms.

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 the 1, 2, 5, 10, 25, 50, and 100-year return frequency storms. For sites that increase the volume of runoff, determine the percent increase in runoff for the 1-year, 24-hour storm using a rainfall depth of 2.20 inches and determine the critical storm from the following table. The critical storm shall be detained to the 1-year predeveloped rate.

Table 3:1 Critical Storm Determination

Percent Increase in Runoff Volume	Critical Storm
0-10	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

3.1 Runoff Curve Number

a. For the purpose of determining site pre-development conditions for previously undeveloped land a maximum runoff curve number of 77 shall be used. Areas with land use and soil types that correlate to a runoff curve number less than 77 shall use the lower runoff curve number for all predeveloped calculations. For redevelopment sites with no previously approved peak flow rate controls, a predeveloped runoff curve number equivalent to the existing conditions of the site may be used. The existing conditions may be determined using historical aerial photos dated 2003 or later.

b. Hydrologic Soil Group (HSG) classifications are based on undisturbed, naturally occurring soils. During construction, soils are dramatically changed by the removal of topsoil, compaction of the underlying soil profile, and removal of vegetation. The runoff potential of these soils increase; therefore, for post-developed conditions the hydrologic soil group may require adjustment. The Ohio Department of Natural Resources has created a chart, Appendix 9 of the Rainwater Manual, for adjusting the hydrologic soil group following construction. For the disturbance area of a project, the hydrologic soil group shall follow the guidelines set forth by the Rainwater Manual.

Table 3-2: NRCS Runoff Curve Numbers[3]

Description of Land Use	Hydrologic Soil Group			
	A	B	C	D
Paved parking lots, roofs, driveways	98	98	98	98
Streets and Roads:				
Paved with curbs and storm sewers	98	98	98	98
Gravel	76	85	89	91
Dirt	72	82	87	89
Cultivated (Agricultural Crop) Land:				
With or without conservation treatment (terraces, contours)	62	71	78	81
Pasture or Range Land:				
Poor (<50% ground cover or heavily grazed)	68	79	86	89
Good (50-75% ground cover; not heavily grazed)	39	61	74	80
Meadow (grass, no grazing, mowed for hay)	30	58	71	78
Brush (good, >75% ground cover)	30	48	65	73
Woods and Forests:				
Poor (small trees/brush destroyed by over-grazing or burning)	45	66	77	83
Fair (grazing but not burned; some brush)	36	60	73	79
Good (no grazing; brush covers ground)	30	55	70	77
Open Spaces (lawns, parks, golf courses, cemeteries, etc.):				
Fair (grass covers 50-75% of area)	49	69	79	84
Good (grass covers >75% of area)	39	61	74	80
Commercial and Business Districts (85% impervious)	89	92	94	95
Industrial Districts (72% impervious)	81	88	91	93
Residential Areas:				
1/8 Acre lots, about 65% impervious	77	85	90	92
1/4 Acre lots, about 38% impervious	61	75	83	87
½ Acre lots, about 25% impervious	54	70	80	85
1 Acre lots, about 20% impervious	51	68	79	84

3.2 Directly Connected Impervious Area

The runoff volume and peak flow rates for all directly connected impervious areas should be calculated independently of other land uses and disconnected impervious area. Sites with disconnected impervious areas may be permitted to use a composite runoff curve number to determine runoff volumes and peak flow rates. Directly connected impervious areas are those impervious areas that are hydraulically connected to the conveyance system (i.e. streets with curbs, catch basins, storm drains, etc.) and thence to the basin outlet point (i.e. a retention/detention pond, existing storm sewer/ditch system, natural water body, etc.) without flowing over pervious areas. For example, roof drains that are piped to the back of curb, which then flows to a curb and gutter inlet, which conveys the runoff to a storm sewer system that conveys the runoff to a wet detention basin is considered a directly connected impervious area.

[3] Chow, Ven Te (1988). *Open Channel Hydraulics*, McGraw Hill, Inc.

3.3 Rainfall Depths and Rainfall Distributions

For peak flow rate analysis, the 12-hour rainfall depths, shown on Table 3-3 from National Oceanic and Atmospheric Administration Atlas 14, Sullivant Avenue Station 33-1781, shall be used.

Table 3-3: 12-hour Rainfall Depths

Storm Event (yr)	Rainfall Depth (in)
1	1.88
2	2.25
5	2.79
10	3.24
25	3.88
50	4.42
100	5.00

The Midwest Climate Center Bulletin 71, Rainfall Frequency Atlas of the Midwest, shall be used as the reference document for selection of a rainfall distribution. For quantitative controls the Bulletin 71, 2nd Quartile, 0-10 square mile, 50% curve, and 12-hour duration storm shall be used. If required for water quality peak flow rate calculations, the 1st Quartile, 0-10 square mile, 50% curve, and 2-hour duration storm shall be used and the runoff curve number shall be calibrated to match or exceed the Ohio EPA water quality volume.

3.4 Low Impact Design

The City supports the use of Low Impact Development (LID) principles consistent with the "Technical Guidance on Implementing the Stormwater Runoff Requirements for Federal Projects under Section 438 of the Energy Independence and Security Act", December 2009. Two specific options are available in lieu of the peak flow requirements of this section:

a. Prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 95th percentile rainfall event which is 1.17 inches for the City of Grove City. This is accomplished by the use of practices that infiltrate, evapotranspire, and/or harvest and reuse rainwater.

b. By using continuous simulation modeling techniques, identify the pre-development condition of the site and quantify the post-development runoff volume and peak flow discharges that are equivalent to pre-development conditions. The post-construction rate, volume, and duration of runoff shall not exceed pre-development conditions. The use of flow duration curves is acceptable.

3.5 Time of Concentration Calculation

Use the following formulas to determine predeveloped and post-developed time of concentration with no more than 100 feet permissible for the overland sheet flow calculation

for both existing and proposed conditions unless it is a paved surface. Time of concentration calculations should be calculated independently for directly connected impervious areas where applicable with a minimum time of concentration of 5 minutes. The time of concentration may include up to three components, overland sheet flow, shallow concentrated flow, and channel flow.

3.5.1 Overland Sheet Flow ($T_{c\ sheet}$)

Overland sheet flow is the shallow mass of runoff over plane surfaces (e.g. parking lots, lawns). Overland sheet flow usually occurs over a short distance at the hind end of a drainage area. NRCS recommends limiting overland sheet flow to 100 feet for unpaved areas. For paved surfaces, the maximum is 300 feet. Use the following equation to estimate $T_{c\ sheet}$:

$$T_{c\,sheet} = 0.014\left(\frac{nL}{\sqrt{s}}\right)^{0.75}$$ [4]

Where:

n = Manning's roughness coefficient for overland flow (see Table 3-4), based on very shallow flow depth of up to 0.10 feet

L = Overland flow path length, ft

s = Slope of overland flow path, ft/ft

Table 3-4: Manning's Roughness Coefficient (n) for Overland or Sheet Flow

Surface description	N
Asphalt and concrete:	
New	0.016
Existing (smooth)	0.013
Existing (rough)	0.016
Cement rubble surface	0.024
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Range (natural)	0.13
Grass:	
Short grass prairie (fields)	0.15
Dense grasses (lawns)	0.24
Woods:	
Light underbrush	0.40
Dense underbrush	0.80

[4] Zomorodi, Kaveh, *Revising the NRCS Sheet Flow Travel Time Equation for Flatlands*, AWRA 2005 Annual Water Resources conference, Seattle Washington.

3.5.2 Shallow Concentrated Flow ($T_{c\ shallow}$)

After a short distance (depending on ground cover, but always less than 100 feet), overland sheet flow starts to concentrate in rills, and then in gullies. This flow is referred to as shallow concentrated flow. The velocity of this flow is estimated using a relationship between velocity and slope. To calculate the shallow concentrated flow time of concentration or $T_{c\ shallow}$, first estimate the velocity of flow using the following equation:

$$V = K_u k \sqrt{S}$$

Where:

V = Velocity of flow, ft/s

S = Slope, ft/ft

k = intercept coefficient (see Table 3-5)

K_u = Units conversion factor, 33

Table 3-5: Intercept Coefficient for Shallow Concentrated Flow[5]

Land cover/flow regime	k
Forest with heavy ground litter; hay meadow	0.076
Trash fallow or minimum tillage cultivation; contour or strip cropped, woodland	0.152
Short Grass Pasture	0.213
Cultivated straight row	0.274
Nearly bare and untilled	0.305
Grassed waterway	0.457
Unpaved	0.491
Paved Area; small upland gullies	0.619

Once velocity has been determined, use the equation below to calculate $T_{c\ shallow}$.

$$T_{c\ shallow} = \frac{L}{60V}$$

Where:

$T_{c\ shallow}$ = Shallow concentrated flow travel time, minutes

L = Flow length, ft

V = Velocity of flow, ft/s

[5] Iowa Department of Transportation Office of Design, Design Manual, Chapter 4, November 2010. Available from http://www.iowadot.gov/design/dmanual/04a-05.pdf

3.5.3 Open Channel Flow ($T_{c\ channel}$)

Open channel flow may consist of gutter flow, pipe flow, or flow through a drainage swale. Various forms of the Manning's equation may be used to estimate the velocity in the channel. Use Table 3-6 for Manning's 'n' value for open channel flow through vegetation and use the following equation to determine a travel time:

$$T_{c\ channel} = \frac{L}{60V}$$

Where:

$T_{c\ shallow}$ = Shallow concentrated flow travel time, minutes

L = Flow length, ft

V = Velocity of flow, ft/s

Table 3-6: Values of Manning's Coefficient (n) for Open Channel Flow[6]

Channel material	Manning's 'n'
Concrete	
Trowel finish	0.013
Float finish	0.015
Concrete bottom with rubble or riprap sides	0.030
Vegetation	
Depth of flow up to 0.7 feet	
Lawns cut 4 to 8 inches	0.070
Good stand cut to 12 inches	0.140
Good stand cut to 24 inches	0.250
Fair stand cut to 12 inches	0.120
Fair stand cut to 24 inches	0.200
Depth of flow from 0.7 to 1.5 feet	
Lawns cut 4 to 8 inches	0.050
Good stand cut to 12 inches	0.100
Good stand cut to 24 inches	0.150
Fair stand cut to 12 inches	0.080
Fair stand cut to 24 inches	0.140
Bare Soil	
Recently completed	0.035
Clean after weathering	0.040

[6] Iowa Department of Transportation Office of Design, Design Manual, Chapter 4, November 2010. Available from http://www.iowadot.gov/design/dmanual/04a-05.pdf

4.0 WATER QUALITY CONTROL CRITERIA

Stormwater qualitative control shall be implemented into sites in accordance with general and specific requirements outlined in the current OEPA's general permit for stormwater discharges associated with construction activity. Water quality BMPs shall be designed according to the latest design standards as set forth by the Ohio Department of Natural Resources Rainwater and Land Development Manual. The Ohio EPA refers to the Ohio Department of Natural Resources (ODNR) Rainwater and Land Development Manual for technical design standards for individual Best Management Practices (BMPs) to meet General Construction Permit requirements. Supplemental information for specific BMPs are contained in this Manual. In addition to the minimum standards set forth by the Ohio EPA, the following additional requirements of the City shall be required.

Dry basins as defined by the ODNR Rainwater Manual and Ohio EPA are not permitted as a water quality BMP within the City unless otherwise approved by the Director of Public Service.

4.1 Ohio EPA Water Quality Permit Supplemental Information

The following sections provide guidance pertinent to the design of water quality BMPs within the City of Grove City.

4.1.1 Water Quality Volume (WQv):

The selected BMP(s) shall be sized to treat the water quality volume and ensure compliance with Ohio EPA General Construction Permit. The WQv shall be equivalent to the volume of runoff from a 0.75-inch rainfall using the following formula.

a. Standard 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 4-1)

P = 0.75 inch precipitation depth

A = area draining into the BMP in acres

b. Alternate runoff coefficient (C) calculation

$C = 0.858i^3 - 0.778i^2 + 0.774i + 0.04$

i = percent imperviousness of tributary area

Table 4-1: Water Quality Volume Runoff Coefficients Based on 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 stormwater 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.

Drawdown times are intended to provide both stream channel erosion protection and 80% annual total suspended solids (TSS) removal. BMPs that are a direct tributary to the Scioto River, a 4th Order stream, are not required to provide stream channel erosion protection measures, therefore alternative BMPs that are able to demonstrate 80% TSS removal are acceptable.

Table 4-2: Target Drawdown (Drain) Times for Water Quality BMPs

Best Management Practice	Drain Time of WQv
Infiltration Basin^	24 – 48 Hours
Enhanced Water Quality Swale	24 Hours
Wet Extended Detention Basin*	24 Hours
Constructed Wetlands (above Permanent Pool)+	24 Hours
Sand & Other Media Filtration	40 Hours
Bioretention Cell^	24 Hours
Pocket Wetland#	24 Hours
Vegetated Swale and Filter Strip	24 Hours
Pervious Pavement (extended detention)	24 Hours
Pervious Pavement (infiltration)	48 Hours

*Provide both a permanent pool and an EDv above the permanent pool, each sized at 75% of the WQv.

+Extended detention shall be provided for the full WQv above the permanent water pool.

^The WQv shall completely infiltrate within 24 hours so there is no standing or residual water in the BMP.

#Pocket wetlands shall have a wet pool equal to the WQv, with 25% of the WQv in a pool and 75% in marshes. The EDv above the permanent pool shall be equal to the WQv.

4.1.2 Approval for use of Proprietary BMPs

Approval of alternative BMPs by the Ohio EPA is required prior to approval from the Director of Public Service except for the following:

a. For sites less than 5 acres and not part of a larger common development, or a site of any size directly tributary to the Scioto River, alternative BMPs can be approved by the Director of Public Service with sufficient evidence from the manufacturer that the BMP is able to achieve 80% TSS removal on an average annual basis or current state standard.

b. For sites or larger common developments over 5 acres and not directly tributary to the Scioto River, a 24-hour drawdown time for the water quality volume will be required.

5.0 WATER QUALITY AND DETENTION SYSTEM DESIGN CRITERIA

Although every water quality and peak flow rate control BMP is unique and designed based on specific site conditions, the standards set forth within this section are intended to establish the guidelines for the layout and design of public or residential BMPs within the City of Grove City.

The design of all stormwater BMPs shall conform to the standards set forth within this section and those in Section 4 of this manual. The site and/or construction plans, engineering documents and specifications shall include all pertinent details for any permanent BMP feature.

Table 5-1 provides guidance on the recommended BMPs to use to meet water quality requirements and peak flow rate control requirements. Conditional uses shall seek approval of that particular water quality BMP or peak flow rate control BMP during the Development Plan approval process.

Table 5-1: Water Quality and Peak Flow Rate Control Best Management Practices Applicability

P = Permitted C = Conditional X = Not Permitted	Wet basin	Dry Basin	Wetland Basin	Bioretention	Permeable Pavement Privately Maintained	Permeable Pavement Publicly Maintained	Parking Lot Storage	Infiltration Trench	Sand Filter	Underground Storage	Proprietary Device
Water Quality											
Area of Disturbance < 1 Acre		Not Applicable									
Area of Disturbance 1 to 5 Acres	C	C	P	P	P	C	X	C	C	X	C
Area of Disturbance > 5 Acres	P	C	P	P	P	C	X	C	C	X	C[1]
Peak Flow Rate Control											
Multi-Family Residential Privately Maintained	P	C	P	P	P		P	C	C	P	
Single Family Residential Publicly Maintained	P	X	C	P		C		X	X	X	
Commercial & Industrial	P	C	P	P	P	C	P	C	C	P	

[1]Permitted if Directly Tributary to Scioto River

5.1 Parking Lot Storage

Parking lot storage is surface storage where shallow wet 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 wet ponding areas with controlled release by pipe-size and slope, and increased curb heights.

The major disadvantage is the inconvenience to users during the wet 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.

Wet ponding areas in parking or traffic areas shall be designed for a maximum potential depth of twelve (12) inches. Flood routing or overflow shall occur after the maximum depth is reached.

The minimum allowable unprotected orifice size is 4" in diameter unless adequate protection to protect it from clogging is provided or the use of vortex flow control valves.

5.2 Water Quality Basins (Wet or Wetland)

Please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual for design specifications.

5.3 Bioretention Basins

For sizing and construction of bioretention basins, please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual.

For the materials to be used in a bioretention basin, supplemental information has been provided for the mulch and bioretention soil. The bioretention soil specification is the most important aspect of the design. An improperly designed soil that lacks sufficient infiltration capacity can have long periods of standing water rendering the basin ineffective and adding stress to the vegetation. Improper organics can also have detrimental consequences on the health of selected vegetation.

5.3.1 Mulch

ORGANIC MULCH: Mechanically chipped, shredded, hammered or ground raw wood material from either hard or soft timber. Mulch shall be free of mold, dirt, sawdust, and foreign and deleterious material and shall not be in an advanced state of decomposition. Mulch shall not contain chipped or shredded manufactured boards or chemically treated wood, including but not limited to wafer board, particleboard, chromated copper arsenate (CCA) or penta treated wood.

a. Color: Natural, undyed.
b. Size Range: 3 inches (76 mm) maximum, ½ inch (13 mm) minimum.
c. pH: 6.0 to 7.5.
d. Salinity: less than 3.0 millimhos per cm (mS /cm).
e. Carbon: Nitrogen Ratio: less than 36:1.

5.3.2 Bioretention Soil

SAND: Clean, natural sand meeting the requirements of ASTM C33 for fine aggregate. Other Graduation Characteristics shall fall within the limits specified below:

a. Fineness Modulus (FM) – 2.5 to 3.1.
b. Coefficient of Uniformity – 2.5 to 3.5 preferred (<4.1 acceptable).

ORGANIC AMENDMENT: Mature/stable aerobically composted yard debris (green waste) compost, animal manure compost, biosolids compost or compost derived from a combination three of these feedstocks:

a. pH: 6.0 to 7.5.
b. Salinity: less than 6.0 millimhos per cm (mS / cm).
c. Organic Matter: not less than 35% by weight.
d. Carbon: Nitrogen Ratio: less than 36:1.
e. Solvita® Maturity Index: between 6 and 7.

The compost shall meet all applicable state regulations based on the feedstock type or U.S. EPA 503 Regulations for bio solids compost.

TOPSOIL (optional): A loamy, friable soil essentially free from heavy or stiff clay lumps, stones, cinders, concrete, brick, roots, sticks, brush, litter, plastics, metals, refuse or other deleterious materials in accordance with ASTM D5268. The soil shall be free of herbicides, petroleum-based materials or other substances of a hazardous or toxic nature which may inhibit plant growth. The soil shall be free of noxious weeds, seeds or vegetative parts of weedy plants that cannot be selectively controlled in the planting.

a. pH: 6.0 to 8.0.
b. Salinity: less than 1.5 millimhos per cm (mS /cm).
c. Organic Matter: 3 to 8% by weight.

The soil shall be taken from a well-drained site and have a USDA soil texture classification of a Clay Loam or Loam.

a. Existing topsoil at the site may be used provided it meets the requirements of this section for topsoils.
b. Off-site (borrow) topsoils may be used provided they meet the requirements of this section and their source or location is submitted to and approved by the Engineer or Landscape Architect.

ENGINEERED SOIL MIX: Mix Sand, Organic Amendment and Topsoil components by volume, to obtain Engineered Soil Mix meeting the specified requirements:

a. pH: 5.5 – 7.5 (ASTM D4972).
b. Salinity: less than 0.8 millimhos per cm (mS /cm).
c. Organic Matter: 2 - 10% by weight (ASTM F1647).
d. Phosphorus: Not to exceed 69 mg / kg.
e. Cation Exchange Capacity (CEC): Minimum of 10.
f. Infiltration Rate: 4 to 12 inches per hour (with soil compacted sample to 85% standard proctor), as determined by ASTM F1815 or ASTM D5856.

Mix Design Submittal: Contractor shall submit proposed mix to Director of Public Service for approval prior to final mixing and shipment to project site. Report percentage by volume of Sand, Organic Amendment and Topsoil. Furnish laboratory analysis and a written report, less than six months old, by a qualified testing laboratory stating compliance with the above parameters.

5.4 Infiltration Trenches

Please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual for design specifications.

5.5 Stormwater Treatment Wetlands

Please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual for design specifications.

Use Table 5-2 for approved wetland vegetation within the City of Grove City.

Table 5-2: Approved Wetland Vegetation List

Type	Botanical Name	Common Name
Herbaceous Plants	*Sagittaria latifolia*	Common Arrowhead
	Saururus cernuus	Lizard's Tail
	Scirpus acutus	Hard-stemmed Bulrush
	Scirpus americanus	Chairmaker's Rush
	Scirpus atrovirens	Dark Green Rush
	Scirpus cyperinus	Wool Grass
	Scirpus pungens	Chairmakers' Rush
	Scirpus tabernaemontani	Soft-stem Bulrush
	Scirpus validus	Great Bulrush
	Solidago ohioensis	Ohio Goldenrod
	Solidago riddellii	Riddell's Goldenrod
	Sparganium amercanum	American Bur Reed
	Sparganium eurycarpum	Common Bur Reed
	Verbena hastate	Blue Vervain
	Verbesina alterifolia	Wingstem
Shrubs	*Amphora furicosa*	Indigo Bush
	Rosa palustris	Swamp Rose
	Cephalanthus occidentalis	Buttonbush
	Cornus amomum	Silky Dogwood
	Cornus sericea	Red Oiser Dogwood
	Ilex verticillata	Winterberry
	Salix amygdaloides	Peachleaf Willow
	Salix discolor	Pussy Willow
	Salix sercea	Silky Willow
	Spiraea tomentosa	Steeple Bush

5.6 Sand Filters

Please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual for design specifications.

5.7 Permeable Pavement

For general requirements of pervious pavement systems, please refer to the latest version of the Ohio Department of Natural Resources Rainwater and Land Development Manual. For structural design refer to the Interlocking Concrete Pavement Institute (ICPI), Permeable Interlocking Concrete Pavements Design Manual, Chapter 3[7].

To meet Ohio Department of Natural Resources Rainwater Manual guidance, maximum ratio of impervious area draining onto the surface area of the pervious paver system shall be no greater than 2:1 especially in areas with high potential for organic contaminants such as leaves and tree nuts for example. Higher ratios up to 5:1 may be permissible on a case by case basis for areas with minimal contamination potential.

For all pervious pavement systems, do not use sand or cinders for deicing. Moreover, when this green infrastructure practice is used in areas with potential for organic matter to accumulate such as nuts and leaves, monthly maintenance using a vacuum/regenerative air sweeper may be required during growing season.

For frost depth considerations, the pavement thickness from surface to subgrade is recommended to be ½ of the frost depth; however research has shown that as long as there is sufficient void space for water to expand (9%), it can freeze without movement (Smith, p. 23).[7] For Central Ohio, the frost depth is approximately 34"; therefore a minimum section thickness of 17" should be used.

It is recommended that impervious areas sheet flow onto pervious asphalt surfaces and not be point loaded onto a small area. The maximum surface slope for pervious asphalt surface is 5% (Smith, p. 14).[8]

The following information is in addition to the ODNR guidelines providing additional detail on the use of various types of pavement systems.

5.7.1 Pervious Pavement Stone Aggregate

a. Aggregates should be crushed with minimum 90% fractured faces and a minimum Los Angeles (LA) abrasion <40 per ASTM C131 and C535 (Smith, p. 28).[9]

b. All shall be clean, washed and free of fines with <2% passing the No. 200 sieve per ASTM C 136 (Smith, p. 28). [10]

c. A porosity of at least 30% for the No. 8, 89, or 9 jointing material using ASTM C 29 (Smith, p. 28).[11]

d. A porosity of at least 32% for the No. 57 bedding and No. 2, 3, or 4 subbase and base layers approximately using ASTM C 29 (Smith, p. 28).[12]

e. No. 8 Setting Bed Material: Narrowly graded mixture of washed, crushed stone, or crushed gravel; in accordance with CMSC Section 703.01; coarse-aggregate grading Size 8; with 100 percent passing a ½-inch (12.5-mm) sieve and 0 to 5 percent passing a No. 16 (1.18-mm) sieve. Setting bed material shall be installed with a

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[7] Smith, David R., *Permeable Interlocking Concrete Pavements*, Interlocking Concrete Pavement Institute, Herndon, VA, Fourth Edition, 2011.

[8] Ibid

[9] Ibid

[10] Ibid

[11] Ibid

[12] Ibid

screed to the maximum extent possible to achieve a level surface for placement of pervious paver clay or concrete bricks.

f. No. 8, 89, or 9 jointing material: Narrowly graded mixture of washed, crushed stone, or crushed gravel; in accordance with CMSC Section 703.01; coarse-aggregate grading Size 8; with 100 percent passing a ½-inch (12.5-mm) sieve and 0 to 5 percent passing a No. 16 (1.18-mm) sieve; grading Size 89; with 100 percent passing a ½-inch (12.5-mm) sieve and 0 to 10 percent passing a No. 16 (1.18-mm) sieve; grading Size 9; with 100 percent passing a 3/8-inch (9.5-mm) sieve and 0 to 10 percent passing a No. 16 (1.18-mm) sieve.

g. No. 57 Bedding Layer: Narrowly graded mixture of washed, crushed stone, or crushed gravel; in accordance with CMSC Section 703.01; coarse-aggregate grading Size 57; with 100 percent passing a 1½-inch (37.5-mm) sieve and 0 to 5 percent passing a No. 8 (2.36 mm) sieve.

h. No. 2, 3 or 4 Subbase and Base Layer: Narrowly graded mixture of washed, crushed stone, or crushed gravel; in accordance with CMSC Section 703.01; coarse-aggregate grading Size 2 with 100 percent passing a 3-inch (100-mm) sieve, 0 to 5 percent passing a ¾-inch (19-mm) sieve, and less than 2 percent passing the No. 200 sieve. Grading size 3 with 100 percent passing the 2 ½-inch (63 mm) sieve, 0 to 5 percent passing a ½ inch (12.5 mm) sieve, and less than 2 percent passing the No. 200 (75 um) sieve. Grading size 4 with 100 percent pass the 2-inch (50 mm) sieve, 0 to 15 percent passing the ¾-inch (19 mm) sieve, and less than 2 percent passing the No. 200 (75 um) sieve.

i. Compaction of the bedding, subbase, and base layers of material shall be done with a 10-12 ton vibratory roller with aggregate lifts of no more than 6 inches. Compaction of the setting bed material is not required except after placement of pavers and jointing material using walk behind compaction equipment.

j. The compaction of aggregates will be determined by testing with a Light Weight Deflectometer (LWD) apparatus, in accordance with Indiana Department of Transportation Test Method (ITM 508 12T. More specifically, the preferred testing device is a Zorn ZFG 3.0 Light Weight Deflectometer.

The maximum allowable deflection will be in accordance with Table 5-3.

Table 5-3: Aggregate Compaction Allowable Deflection

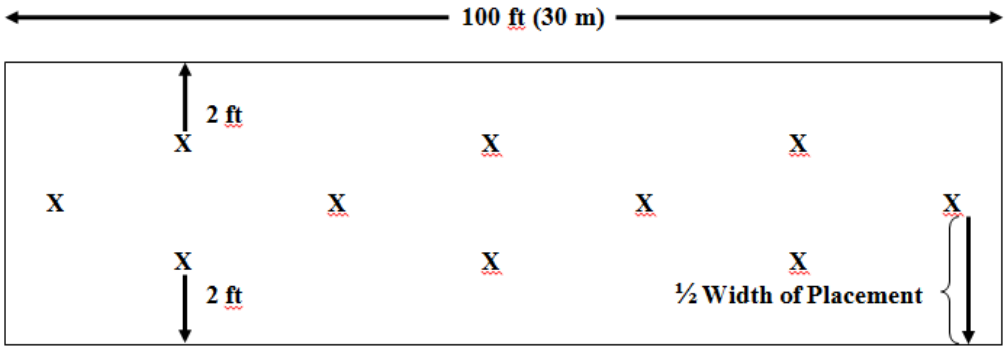
Material Type	Maximum Allowable Deflection (mm)
Lime Modified Soil	0.30
Cement Modified Soil	0.27
Aggregates over Lime Modified Soil	0.30
Aggregates over Cement Modified Soil	0.27

For materials not included in Table 5-3, a test section shall be constructed to determine the maximum allowable deflection with the maximum deflection of open graded aggregates typically being in the 0.40 to 0.50 mm range with a resulting stiffness of over 45 MPa.

Test sections shall be constructed in the presence of the Engineer with the available equipment of the Contractor to determine the roller type, pattern, and number of passes for the maximum allowable deflection.

The Engineer will select an area approximately 100 ft. (30 m) by the width of the material placed for the test section. Areas not meeting these minimum testing area criteria will be considered. The subgrade shall be proof rolled in accordance with CMSC Item 204 prior to construction of the test section for aggregates and the geotextile, geogrid, and/or geomembrane used for the installation installed on the subgrade. Chemically modified soils shall be cured at least 24 hours prior to testing of the test section.

One moisture test will be performed in accordance with AASHTO T 255 for aggregates prior to compaction of the test section. The moisture content value shall be within -3 percentage points of optimum moisture content and the optimum moisture content prior to placement. Ten LWD tests will be performed on the test section at the following approximate locations:



Aggregate Test Section with LWD only - A test section shall be constructed and LWD testing will be performed to determine the maximum allowable deflection if only the LWD is used. The roller shall be operated in the vibratory mode and initially 4 passes shall be placed on the aggregate in the test section. The average deflection of the 10 random tests will be determined after completion of the 4 passes. One additional pass of the roller in the vibratory mode shall be made and 10 LWD tests will be taken at the same locations. If the difference between the average LWD test values obtained from 4 and 5 passes is equal to or less than 0.02 mm, the compaction will be considered to have peaked and the average of the 10 LWD values at 5 passes will be used as the maximum allowable deflection. If the difference between the average LWD test values is greater than 0.02 mm, an additional roller pass in the vibratory mode shall be placed and 10 LWD tests will be taken at the same locations. This procedure will continue until the difference of the average of the 10 LWD tests between consecutive roller passes is equal to or less than 0.02 mm. The maximum allowable deflection will be the lowest average of the 10 LWD test values.

Acceptance of the compaction of aggregates or chemically modified soils will be determined by averaging three LWD tests obtained at a random station determined by the Engineer. The location of the three tests will be at 2 ft. from each edge of the construction area and at 1/2 of the width of the construction area. The average deflection shall be equal to or less than the maximum allowable deflection allowed in Table 5-3 or determined by the test section. The frequency of testing will be one test for each 800 ton for compacted aggregate.

If the average deflection is not equal to or less than the maximum allowable deflection, a moisture test will be performed. Additional LWD tests will be taken at the same locations after 24 hours and the material will be accepted if the LWD tests are equal to or less than the maximum allowable deflection. Otherwise additional compaction may be required.

5.7.2 Pervious Interlocking Concrete Pavers

Pervious pavers can be used on any surface ranging from pedestrian plazas, low speed roadways to heavy industrial and shipping yards. Pervious pavers are not recommended for high speed roadways with posted speed limits above 25 MPH or high volume roadways.

a. Pervious concrete pavers are referred to as Permeable Interlocking Concrete Pavements (PICP) in the paver industry. PICP shall conform to ASTM C936 which limits length-to-thickness ratio to no more than 4:1 to provide interlocking effect. It also limits face area to no more than 101 sq. in.

b. A minimum average compressive strength of 10,000, psi is preferred with no individual unit testing less than 9,200 psi. At a minimum be resistant to freeze/thaw durability when tested according CSA A231.2 which is the Canadian version of ASTM C1645.

c. For vehicular applications, the majority of the pavers shall have a minimum joint width of 10 mm or larger as joint widths less than 10 mm are harder to maintain, require a smaller stone chip that is more susceptible to washing out or migrating into the underlying No. 57 aggregate. Smaller joints associated with soldier courses or other embedded pavers are acceptable.

d. "L" shape pavers shall be used in all public roadway driving lanes.. Other geometries may be used for soldier courses, replacement for striping, parking lanes, parking lots, alleys, sidewalks, and other non-vehicular use applications.

e. All paver areas shall have concrete edge restraints.

f. PICP structural design for vehicular applications requires a minimum soil CBR (96-hour soaked per ASTM D 1883 or AASHTO T 193) of 4%, or a minimum R-value = 9 per ASTM D 2844 or AASHTO T-190, or a minimum Mr of 6,500 psi per AASHTO T-307 to qualify for use under vehicular traffic. Compaction or treatment of the subgrade with cement, lime, or lime/flyash may be required to achieve at least 4% soaked CBR. Expansive soils will need to be treated and will significantly reduce the infiltration capabilities of the native soil. (Ref: Smith Chapter 3)

g. The pavement system from surface to subgrade should be designed using the 1993 AASHTO Method for flexible pavements. The paver and setting bed have a structure layer coefficient of 0.30. The No. 57 aggregate has a structural layer coefficient of 0.09. The No. 2, 3 or 4 aggregates have a structural layer coefficient of 0.06. Care should be taken to obtain a subgrade CBR value and an estimation of traffic load. When a CBR value is not available use a value of 3 (Smith, Chapter 3).[13]

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[13] Smith, David R., *Permeable Interlocking Concrete Pavements*, Interlocking Concrete Pavement Institute, Herndon, VA, Fourth Edition, 2011

h. The soldier course paver shall be a full-length rectangular pervious paver brick of the same thickness as the main system capable of accepting a No 8, 89, or 9 chip material.

i. Color and finish are important decisions that need to be considered during the design process. Specialized face mixes can provide enhanced color durability to prevent fading and alternative textures for specialized applications.

5.7.3 Pervious Clay Brick Pavers

Pervious clay brick pavers are 2¾ inch thick solid interlocking paving units made of fired clay that allows water to flow through joints between the individual paving units. The joints are filled with open graded, small aggregate to allow for the units to interlock and still provide void space for the water to flow through.

Pervious clay brick pavers may be used in all areas where traditional pavement would be considered for pedestrian use. In addition, pervious clay brick pavers may be used in low volume and low speed (less than 25 MPH) vehicular use areas such as public roads, parking lots and roadside parallel parking.

a. Clay brick pavers are categorized as ASTM C902 for Pedestrian and Light Traffic Paving Brick or ASTM C1272 for Heavy Vehicular Paving Brick. Provide joint widths of at least 6 mm to allow for adequate infiltration capacity. If clay pavers are to be used in roadway applications, the setting bed shall be No. 8 stone and the joints filled to the maximum extent practical with the larger of No. 8, No. 89, or No. 9 stone.

b. At a minimum be resistant to 50 freeze and thaw cycles when tested according to ASTM C67.

c. All paver areas shall have concrete edge restraint.

d. Structural design for vehicular applications assumes a minimum soil CBR (96-hour soaked per ASTM D1883 or AASHTO T 193) of 4%, or a minimum R-value = 9 per ASTM D 2844 or AASHTO T-190, or a minimum Mr of 6,500 psi per AASHTO T-307 to qualify for use under vehicular traffic. Compaction or treatment of the subgrade with cement, lime, or lime/flyash may be required to achieve at least 4% soaked CBR. Expansive soils will need to be treated and will significantly reduce the infiltration capabilities of the native soil (Smith, Chapter 3).[14]

e. The pavement system from surface to subgrade should be designed using the 1993 AASHTO Method for flexible pavements. The paver and setting bed have a structure layer coefficient of 0.30. The No. 57 aggregate has a structural layer coefficient of 0.09. No. 2, 3, or 4 aggregates have a structural layer coefficient of 0.06. Care should be taken to obtain a subgrade CBR value and an estimation of traffic load. When a CBR value is not available use a value of 3 (Smith, Chapter 3).[15]

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[14] Smith, David R., *Permeable Interlocking Concrete Pavements*, Interlocking Concrete Pavement Institute, Herndon, VA, Fourth Edition, 2011

[15] Ibid

f. Pavers shall be laid in a herringbone pattern to increase interlocking stability.

g. The soldier course paver shall be a full-length rectangular pervious paver brick of the same thickness as the main system capable of accepting a No 8, 89, or 9 chip material.

h. Color and finish are important decisions that need to be considered during the design process.

5.7.4 Pervious Concrete

Pervious concrete is a type of pervious pavement that when cast has between 15-25% void space within the concrete. These void spaces are interconnected so that water and air are able to pass through from the top surface of the concrete down into aggregate storage layers below. Pervious concrete does not contain fine aggregates and is sometimes referred to as 'no-fines' concrete. Coarse aggregate, Portland cement, water and admixtures are the component materials of pervious concrete.

Pervious concrete may be used in all areas where traditional concrete would be considered for pedestrian use. In addition, pervious concrete may be used in vehicular use areas such as parking lots and roadside parallel parking. It is not recommended for travel lanes on public roadways, but has been successful in low volume residential streets and alleys. Pervious concrete shall comply with current editions of ACI 522.1 and ASTM C94.

a. A model specification and structural design guidance is available from the Ohio Ready Mixed Concrete Association with the following exceptions:

   1. Wet cure with UltraCure by McTech Group or equivalent;
   2. Placement of concrete should be done with a hydraulically actuated pipe roller and;
   3. Joints shall be saw-cut; rolled joints are not to be permitted.[16]

b. Slump tests and traditional strength tests cannot be used with pervious concrete. Testing shall be for density (unit weight), void content and thickness. These tests include ASTM C 172, ASTM C 29, ASTM C 42 and ASTM C 1688.

c. All pervious concrete areas shall have concrete edge restraints.

d. Structural design for vehicular applications assumes a minimum soil CBR (96-hour soaked per ASTM D 1883 or AASHTO T 193) of 4%, or a minimum R-value = 9 per ASTM D 2844 or AASHTO T-190, or a minimum Mr of 6,500 psi per AASHTO T-307 to qualify for use under vehicular traffic. Compaction or treatment of the subgrade with cement, lime, or lime/flyash may be required to achieve at least 4% soaked CBR. Expansive soils will need to be treated and will significantly reduce the infiltration capabilities of the native soil (Smith, Chapter 3).[17]

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[16] Maloney, M. (2013). Pervious pavement as public infrastructure [Powerpoint slides].

[17] Smith, David R., *Permeable Interlocking Concrete Pavements*, Interlocking Concrete Pavement Institute, Herndon, VA, Fourth Edition, 2011

e. Pervious concrete can be colored with pigment during the mixing process and should be considered during the design process.

5.7.5 Pervious Asphalt

Pervious asphalt is a type of asphalt with approximately 16-20% air void space within the asphalt after installation. These void spaces are interconnected so that water and air are able to pass through from the top surface of the asphalt down into aggregate storage layers below. Pervious asphalt does not contain fine aggregates smaller than a No. 8 aggregate. A polymer modified asphalt binder (6%) is the main component that differentiates standard asphalt from pervious asphalt. Pervious asphalt has been around since the early 1970s and was previously referred to as open graded friction course and used on highways to reduce road spray.

Pervious asphalt may be used in all areas where traditional asphalt would be considered for pedestrian use. In addition, pervious asphalt may be used in low volume and low speed (less than 25 MPH) vehicular use areas such as parking lots and roadside parallel parking. It also has been successful in low volume residential streets and alleys.

a. The ODNR considers The University of New Hampshire Stormwater Center (UNHSC) Design Specification for Porous Asphalt Pavement a reliable specification for pervious asphalt mix design.[18]

b. Pervious asphalt structural design for vehicular applications assumes a minimum soil CBR (96-hour soaked per ASTM D 1883 or AASHTO T 193) of 4%, or a minimum R-value = 9 per ASTM D 2844 or AASHTO T-190, or a minimum Mr of 6,500 psi per AASHTO T-307 to qualify for use under vehicular traffic. Compaction or treatment of the subgrade with cement, lime, or lime/flyash may be required to achieve at least 4% soaked CBR. Expansive soils will need to be treated and will significantly reduce the infiltration capabilities of the native soil. (Smith, Chapter 3).[19]

c. The pavement system from surface to subgrade should be designed using the 1993 AASHTO Method for flexible pavements. The No. 57 aggregate has a structural layer coefficient of 0.09. No. 2, 3, or 4 aggregates have a structural layer coefficient of 0.06. Care should be taken to obtain a subgrade CBR value and an estimation of traffic load. When a CBR value is not available use a value of 3 (Smith, Chapter 3).[20]

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[18] University of New Hampshire Stormwater Center (2009). *Design specifications for Porous Asphalt Pavement and infiltration Beds.*

[19] Smith, David R., *Permeable Interlocking Concrete Pavements*, Interlocking Concrete Pavement Institute, Herndon, VA, Fourth Edition, 2011

[20] Ibid

5.8 Underground Storage

Underground storage may be used to provide storage volume to meet the peak control rate requirements, but shall not be used to provide water quality on its own unless coupled with an approved water quality BMP.

a. Adequate flood routing shall be provided if the system becomes clogged or surcharges onto the surface.
b. The minimum allowable unprotected orifice size is 4" in diameter unless adequate protection is provided to protect it from clogging or the use of vortex flow control valves.
c. The maximum ponding depth at any point in the parking lot is 12" for the 100-year storm.
d. The use of perforated pipe to maximize storage volume in the surrounding stone backfill is not permitted without an approved pretreatment device.

6.0 WET BASIN DESIGN STANDARDS

Although every wet basin is unique and designed based on specific site conditions, the standards set forth within this section are intended to establish the guidelines for the layout and design of wet basins within the City.

6.1 Existing Wet Basin Investigation Requirements

When existing wet basins are proposed to become part of a stormwater management system to meet peak flow rate and water quality requirements and to be incorporated into a development the following information is required:

a. Photos of the existing basin.
b. Bathymetry Survey.
c. Discussion of the current conditions, including the presence of trees, inlet/outlet structures, etc.
d. A proposed usage description outlining any changes, including increased embankment height, inlet/outlet structures, etc.
e. Stone facing shall be installed on all existing and proposed basin inlet and outlet structures per the City of Grove City Standard Drawing C-GC-23 and C-GC-24 (modified as necessary).

6.2 Dam Safety Classifications

All dams shall adhere to the State of Ohio's Dam Safety Regulations (Title XV, Chap. 1521 of the Ohio Revised Code, Rule 1501:21-13-01).

The following dam types do not require construction permits per Ohio Dam Safety Laws, Section 1521.06:

a. A dam that is or will be less than 10 feet in height and greater than 6 feet and that has or will have a storage capacity of not more than 50 acre-feet at the elevation of the top of the dam, as determined by the ODNR Chief. For the purposes of this section, the height of a dam shall be measured from the natural stream bed or lowest ground elevation at the downstream or outside limit of the dam to the elevation of the top of the dam.
b. A dam, regardless of height, that has or will have a storage capacity of not more than 15 acre-feet at the elevation of the top of the dam.
c. A dam, regardless of storage capacity, that is or will be 6 feet or less in height.
d. A dam, dike or levee that belongs to a class exempted by the ODNR Chief.

6.3 Outlet/Inlet Treatment

a. <u>Submerged Outlet/Inlet Structures</u>

The City encourages the use of submerged storm pipes in lieu of exposed outlet/inlet structures. Submerged Outlets may consist of a siphon pipe. Inlet pipes that are equal to

or larger in diameter than 36 inches should 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). The City requires the remaining exposed portion of pipe headwall include stone-facing (refer to the City of Grove City Standard Drawing C-GC-23 and C-GC-24). When an inlet pipe is at least partially submerged at the wet basin, the conditions listed below shall also be met.

1. Submergence of inlet pipes is limited to the next upstream manhole or catch basin along the storm sewer system.
2. All lengths of submerged storm pipe shall include "O-ring" sealed gasket pipe joints.
3. All lengths of the submerged storm pipe shall have bedding and backfill material consistent with the compacted embankment material.

b. 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.

c. Structure Requirements

All headwall structures shall be in accordance with City of Grove City Standard Drawing C-GC-24 (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 Grove City Standard Drawing C-GC-4 (modified as necessary).

d. 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.

e. 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 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:

1. 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
2. Selecting the projection of the collar away from the outlet pipe and
3. Determining the minimum number of collars: N = 0.075 x (L/V).

f. Wall/Façade Appearance

All headwalls, endwalls, catch basins or exposed structures (including basin outlet structures) within the basin are required to include natural or manufactured stone facing on the exposed faces of the structure. Stone is to be north shore buff limestone. Alternate selections must be approved by the City Service Director. A sample pallet is to be submitted to the City's Service Director for approval. Refer to the City of Grove City Standard Drawing C-GC-23 and C-GC-24 for a graphical representation of the required stone facing detail and related features.

g. Emergency Spillways

Emergency Spillways should meet all of the following criteria unless they are located in areas where a basin is not located adjacent to a stream or roadway, in which case, an emergency spillway is then not required. However, an adequate flood routing path is required from the basin.

1. They shall not operate (convey flow) for any routed design storm less than the 50-year event.
2. 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".
3. They shall be designed to pass the 50-year peak inflow to the basin on its own without attenuation (the plans shall include a detail demonstrating the necessary dimensions of the control section, both width and breadth).

h. Miscellaneous

The following general criteria must be met:

1. Roof drain (downspout) outlets directly to a wet basin are not permitted.
2. All orifice plates may conform to the requirements of City of Columbus Standard Drawing, No. AA-S145. The minimum allowable installed orifice size is 4 inches in diameter unless protected by a means acceptable to the City.
3. All inlet structures (e.g., pipe headwalls) shall be recessed into the adjoining wet basin grading to diminish the amount the structure is visible.

6.4 Basin Grading

Refer to the City of Grove City Standard Drawing C-GC-98 for a graphical representation of the required basin grading and related features.

6.5 Geotechnical Considerations

Design of wet basin liners and embankments shall be by a qualified geotechnical engineer or geologist. Acceptable soils used in wet basin liners or embankments shall meet the following minimum criteria:

a. Free of large rocks, roots, limbs and other deleterious materials which would adversely affect the design integrity of the liner.
b. Classified under the Unified Soil Classification System as CL, CH or SC.
c. Minimum 15% passing the No. 200 sieve.
d. Have a plasticity index (PI) >= 15.
e. Have a laboratory permeability of 1x10-6 cm/sec or less based on a minimum of two undisturbed core (tube) samples taken from the liner.

1. Wet Basin Liner

   Wet basin liners consisting of acceptable soils as described above shall be a minimum of 2 feet in thickness. Localized granular, organic, or other deposits (which would be sources for wet basin leakage) shall be removed and replaced with suitable soils. Disking of up to 6 inches of surface material for re-compaction is acceptable, if necessary. The material shall be compacted at optimum moisture content to (but not exceeding) 3 percent above optimum moisture content in loose lifts not to exceed 8 inches in thickness. The installation of wet basin liners shall be under the supervision of a geotechnical engineer, geologist or other City of Grove City approved entity who shall certify that the liner was installed in accordance with this policy. Alternative wet basin liners accompanied by a geotechnical report may be used upon review and approval by the City of Grove City. These include, but are not limited to poly-liners (minimum 30 mil) and bentonite (typically 1 to 3 lb/ft^2).

2. Embankment Materials

   All outlet embankment materials shall consist of cohesive soils compacted to a minimum of 98 percent of the maximum density obtainable with the Standard Proctor Test method (ASTM Standard D-698). Certified test results shall be submitted to the City prior to installation or the test is to be performed at the time of installation, in the presence of the City or its assigned representative. The compacted outlet embankment shall be free of vegetative material and other construction debris. The engineering plan shall include notes and other references regarding the conditions and requirements for construction of the outlet embankment, including design information for a key trench, if necessary.

6.6 Shoreline Protection

Shoreline protection shall be installed below and above the normal pool elevation of the basin to prevent erosion along the perimeter. The protection shall be comprised of a 6" depth of 1" to 3" diameter, clean and washed limestone cobbles or tied concrete block matting per ODOT Item 601. Refer to the City of Grove City Standard Drawing C-GC-98 for a graphical representation of the required shoreline protection features.

6.7 Wet Basin Amenities

When developing wet basins, it is the intent of the City to incorporate features within the basin as amenities to the development. The following amenities may be required to be included with the basin design at the discretion of the City.

6.7.1 Observation/Fishing Platform

Any wet basin that includes an incoming stormwater pipe of 30 inches or greater may be required to include at least one platform made of wood or other material. The size of the platform shall be a minimum of 10' x 10'.

6.7.2 Walkway

Installation of an 8-foot minimum bituminous walkway around the circumference of the wet basin edge for wet basins within residential subdivisions. The walk may be at generally the same elevation around the wet basin but shall vary in distance from the normal water surface. The construction of the path will be in conformance with City Standard Specifications.

6.7.3 Landscape

All basins are required to meet the minimum standards for landscape plantings based upon information provided within the City's codified ordinances. All disturbed areas are to be stabilized per the requirements outlined within Section 10.0 of this manual.

6.7.4 Fountains and Aerators

Wet basins are to include one (1) fountain for every ¾ of an acre of surface area. In addition, the basin must include an air diffuser below the fountain to improve water circulation and quality. The infrastructure to be installed that is necessary to provide power to the fountain and aerator shall be installed in a manner to coincide with the overall basin landscaping aesthetics.

6.7.5 Depth of Water Surface Elevation

The water surface elevation is a critical aspect of the general aesthetics of a wet basin. For this reason, the proposed water surface elevation for wet basins within residential subdivisions and publicly viewed private developments shall not be any lower than 5-feet below any adjoining roadway or viewing area, so long as adequate freeboard is available for stormwater detention. The viewing area is defined as the level area above the freeboard of the wet basin. This area may be comprised of the finished floor elevation of the homes nearest to the wet basin or the finished grade between the nearest homes.

6.7.6 Trash Racks

At a minimum, all outlet structures shall have a grate to prevent large debris from passing through. Trash racks may be constructed from galvanized metal (rebar) and shall meet the specifications provided below.

a. Catch basin riser structures shall have imbedded rebar at all window openings with a height of 1-foot or greater, spacing not to exceed 4-inches, and a pre-fabricated grate top.
b. Pipe and headwall structures shall have a fabricated galvanized metal grate of the type similar to that shown on the City of Grove City Standard Drawing C-GC-99. The City, upon review, may approve other types and forms of trash racks.

6.7.7 Wet Basin Vegetation

The City permits the planting of wetland species vegetation within designated areas of a wet basin for purposes of general water quality considerations or as mitigation in conformance with the requirement for State of Ohio 401 Water Quality Certification. The wetland planting area must not exceed 50 percent of the total pond surface area. Refer to Table 5-2 for a listing of acceptable wetland species vegetation. Deviation from the plants listed in Table 5-2 must be submitted to the City's Urban Forester and Engineer for approval.

6.7.8 Fence Installation

A fence is required to be installed along the top of the basin side slope at locations where the basin embankment begins less than 20 feet from the back of the curb or edge of the pavement. The fence shall be installed per the City of Grove City Standard Construction Drawing C-GC-96 "Reinforced Fencing" or as approved by the Director of Public Service.

6.8 Wet Basin Maintenance

6.8.1 Treatment of Algae

The use of herbicides/pesticides to control the growth of aquatic vegetation is regulated by the State of Ohio. Private or public wet or wetland basins that are within the regulatory jurisdiction of the State of Ohio are subject to the criteria of the Ohio Surface Water Regulations (Ohio Administrative Code 3745-1 Water Quality Standards), pertaining to the application of chemicals. Refer to the Ohio State University Extension fact sheet associated with notifying the Ohio EPA prior to applying aquatic herbicides in ponds for additional information.

6.8.2 Goose Control

Stormwater basins are often constructed with mowed turf grass around the perimeter making it an ideal habitat for geese as they can walk into and out of wet basins easily to forage on grass and escape back to the water when threatened. Tall vegetation at the edge of the pond can discourage geese as they are not able to see through the taller grass and are less likely to venture out of pond to forage. Another up and coming solution is to plant turf type grasses that do not taste well to geese, which discourages their use of the pond and they will seek other areas. Such grasses include Titan Limited, Turf-type Tall Fescue or Jacklin Pixie.

7.0 DRAINAGE EASEMENTS

In order to provide access for City personnel for inspection and maintenance, the Owner or Developer is required to procure and convey to the City a minimum 20-foot easement and/or declaration of restrictions for any tile, pipe, detention basin, water quality BMP, drainage way, flood routing path, ditch, watercourse, natural stream, man-made stream, storm sewer, or other stormwater component that is to be maintained by the City or that drains runoff from publicly owned land owned by the City.

The Owner and/or Developer shall comply with the procurement, execution, and maintenance of the Easement, and their responsibilities to the City and to adjacent and downstream property owners. The easement shall be of sufficient width, minimum of 20-foot, to allow cleaning, widening, deepening, replacing or other general maintenance of such drainage course or piped system. Such declaration of restrictions shall include the operation and maintenance requirements as specified in the City approved plans.

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 Owner or Developer:

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

Any required drainage easement, preservation areas, reserves and other similar areas shall be shown on the required plans and reflected on the final plat or a separate recorded document approved by the City.

8.0 STREAM CORRIDOR PROTECTION ZONE REQUIREMENTS

The Stream Corridor Protection Zone (SCPZ) is established through designation of a riparian setback that will be required on all jurisdictional streams. The Director of Public Service may request from a developer or owner confirmation from a regulatory authority that a particular drainage system is or is not a jurisdictional stream. The riparian setback shall be kept in a natural state to the maximum extent practical so that it can perform its inherent function of erosion protection, flood storage, and water quality protection. Encroachments into the SCPZ for the purposes of development can be permitted with mitigation as required per Sec. 8.6 of this Manual.

8.1 SCPZ Delineation

For all jurisdictional streams a riparian setback will be required and shown on all site improvement plans. The full setback width shall be centered on the stream or an the valley of the stream, per 8.1.1. For all jurisdictional streams except the Scioto River the full setback width is defined by Equation 1, which was developed by the Ohio Department of Natural Resources (ODNR) based on regional curve analysis. Exceptions to the full SCPZ are provided in 8.1.a. The Scioto River SCPZ shall be extended 50-feet from the FEMA Floodway limits or the 100-year floodplain limits, whichever is less.

(Equation 1)

$SCPZ = 147 \times DA^{0.38}$

SCPZ = Total riparian setback width measured in feet, centered on the watercourse

DA = Drainage area in square miles

a. Exceptions to Equation 1
    1. The SCPZ shall be expanded to the FEMA floodway if the Equation 1 width is less
    2. Any wetlands partially located within the SCPZ setback limits shall have the SCPZ expanded to include the entire wetland.
    3. The SCPZ shall consist of a minimum width of 25 feet centered on the stream or valley
    4. The SCPZ width may be reduced to 100-feet each side of the ordinary high water mark as long as the width is greater than the floodway or wetland.

8.1.1 Alternative SCPZ Delineation Method

Once the total SCPZ width has been determined, the following method can be used to determine a more accurate site-specific position of the riparian setback boundaries (either side of the SCPZ limits):

The delineation of the zone is based on centering the stream within the zone which creates an equal setback distance on either side of the stream. For streams with well-defined meander patterns this creates an unusual setback geometry often protecting areas of higher elevation outside the floodplain and not protecting areas within the floodplain or even floodway at

lower elevations on the other side. The SCPZ concept was meant to protect the valley of stream within its anticipated potential meander pattern.

To create a modification and thus, a more accurate SCPZ, the Ohio Department of Natural Resources (ODNR) provides guidance in the Rainwater and Land Development Manual, Chapter 2, page 21-26, on how to more accurately delineate the SCPZ boundary. The following steps summarize the technique:

Step 1: On a plot of the stream valley, draw cross-section lines at a width wider than the total SCPZ distance and at a desired spacing through the valley of the stream generally perpendicular to the centerline of the valley and to contours lines near the anticipated SCPZ boundary. The more cross-section lines that are drawn, the more accurate the delineation will be.

Step 2: Draw a circle with diameter equal to the total SCPZ width and place center of circle onto center of cross-section line. Move center of circle along cross-section line in either direction until the intersection point of the circle and cross section are at the same elevation on both sides of the stream valley. When equal elevations are obtained, this defines the SCPZ boundary at the cross section, place a mark at each intersection location. Repeat for each cross section.

Step 3: Connect the SCPZ marks on each cross section with straight lines along valleys that are generally straight which should keep the SCPZ line outside of any drawn circles. For curved stream valleys, the SCPZ should generally follow the curvature of the valley keeping the width equal to the calculated SCPZ width and most, if not all, of the lines outside of the drawn circles.

<u>Delineation Exceptions:</u>

a. The SCPZ shall not be any closer to the edge of the stream channel (ordinary high water mark) than 10% of the total SCPZ width or 25 feet whichever is greater. When this occurs, the SCPZ shall be shifted away from the stream so that the side closest to the stream is no closer than 10% or 25 feet whichever is greater, from the ordinary high water mark. The total width of the SCPZ remains consistent with the calculated width.
b. The SCPZ shall be extended to the top of slope if the SCPZ line intersects a slope of greater than 15%. In this case, the SCPZ width increases on the side with the 15% slope, the other side remains as calculated.
c. The SCPZ shall be increased to include FEMA designated floodway limits.

8.2 Non-Conforming Structures or Uses

a. Man-made roadside ditches specifically used for roadside drainage that are classified as jurisdictional by the Ohio EPA or United States Army Corps of Engineers are exempt from the provisions of this section.

b. Non-conforming structures and uses within the SCPZ, existing at the time of passage of this Manual, that are not permitted under this Manual may be continued but shall not be expanded, changed or enlarged except as set forth in this title.

c. Non-conforming structures may be repaired or restored if damaged, destroyed, terminated or abandoned within six months from the date of damage/destruction or the adoption of this Manual, whichever is later, at the property owner's own risk. The owner shall also comply with applicable requirements of Chapter 1329, the City of Grove City Code of Ordinances.

d. Residential and associated accessory structures or use within the SCPZ existing at the time of passage of this Manual may be expanded subject to the following provisions:

   1. The expansion conforms to existing zoning regulations.

   2. The expansion shall not impact the stream channel or the floodway.

   3. The expansion shall not exceed an area of 15% of the footprint of the existing structure (or use) that lies within the SCPZ. Expansions exceeding 15% of the footprint within the SCPZ shall be obtained through the variance process as set forth in Chapter 1133, the City of Grove City Code of Ordinances.

e. Non-residential structure (or use) expansions will be permitted only through the variance process as set forth in Chapter 1133, the City of Grove City Code of Ordinances.

8.3 Permitted Uses

a. Passive Uses: Uses that are passive in character shall be permitted in the SCPZ, including, but not limited to, passive recreational uses such as hiking, fishing, and picnicking, as permitted by federal, state and local laws. Construction of paved trails to further such passive recreational uses is also permitted as well as associated structures including boardwalks, pathways constructed of pervious material, picnic tables, playground equipment, athletic fields, and wildlife viewing areas.

b. Removal of Damaged or Diseased Trees: Damaged or diseased trees as determined by the City of Grove City Urban Forester may be removed by the property owner or easement holder from the SCPZ. To prevent felled logs and branches from damaging downstream properties and/or blocking watercourses or otherwise exacerbating flooding, logs and branches resulting from the removal of damaged or diseased trees greater than 6 inches in diameter at the cut end shall be cut into sections no longer than 6 feet, anchored to the shore in an acceptable manner or removed.

c. Revegetation and/or Reforestation: Revegetation and/or reforestation of the SCPZ shall use species pursuant to Table 8-1 within the Stormwater Drainage Manual, which lists species of plants and shrubs recommended for stabilizing flood prone areas. Proper selection of species is dependent on soil conditions, available water and amount of sun exposure. Species selection should be coordinated with and approved by the City's Urban Forester.

d. Public Utilities: Placement or crossing of the SCPZ with sanitary sewer, storm sewer, and/or water lines and public utility transmission lines may be located within the SCPZ and disturbances of the setback necessary to place and/or maintain such utilities are also authorized. The placement, construction and maintenance of such utilities shall minimize disturbance to riparian areas and shall mitigate any necessary disturbances. The developer and/or landowner shall secure the appropriate state and federal permits required for installations of this type.

e. Public Roadways: Crossings of streams and SCPZs for roadways shall be minimized

and approved at the discretion of the City. The placement, construction and maintenance of the roadway shall minimize disturbance to riparian areas and shall mitigate any necessary disturbances. The developer and/or landowner shall secure the appropriate state and federal permits required for installations of this type. The addition of a designated bike path as part of the roadway crossing may be required by the City.

f. Stream Restoration: Construction activities associated with properly permitted stream or wetland restoration projects shall be permitted within the SCPZ. Copies of the appropriate permits shall be made available to the City two weeks prior to the commencement of earth disturbing activities.

g. Emergency Channel Maintenance Activity: Activity to restore or maintain the flood carrying capacity of the main channel area by the property owner or easement holder may be permitted, subject to authorization by the Director of Public Service and, if applicable, by appropriate state and/or federal agencies. Such activity may include, but not be limited to removal of offending trees or brush or the accumulation of sediment in the main channel that is necessary to restore flow carrying capacity of the main channel.

h. Stormwater outfalls, including headwalls, endwalls, and associated outlet open ditches.

8.4 Prohibited Uses

Any use not permitted under Section 8.3 shall be prohibited in the Stream Corridor Protection Zone unless otherwise approved by the City and mitigated through the requirements of Section 8.7. The following is a list containing some of the uses that are specifically prohibited:

a. Structures of any kind including buildings, swimming pools, signs, billboards, electric lines, telecommunication lines (with the exception of transmission lines), cable TV lines, and other improvements deemed unacceptable by the Director of Public Service.

b. Dredging or filling: There shall be no drilling, filling, dredging, diking, ditching, grading, or dumping of soils, spoils, liquid, or solid materials. No floodplain fill will be graded for areas within the Stream Corridor Protection Zone except those that are required for permitted uses.

c. Parking lots, roads, driveways, or other human- made impervious cover

d. Parallel utility lines, above or below grade.

e. Stormwater detention and/or water quality BMPs.

f. Motorized vehicles, except as needed for permitted uses.

g. Herbicides and pesticides, except as approved by the Director of Public Service.

h. Removal of topsoil, sand, gravel, rock, native ground cover/vegetation, oil or gas, with the exception of permitted uses or as approved by the Director of Public Service.

i. Disturbance of natural vegetation except for the following:

    1. Maintenance of lawns, landscaping, shrubbery, or trees existing at the time of passage of this ordinance.

    2. Cultivation of lawns, landscaping, shrubbery, or trees in accordance with an approved landscaping plan submitted in conformance with this Manual.

    3. Conservation measures designed to remove damaged or diseased trees or to

control noxious weeds or invasive species.

j. Any subsurface or surface sewage disposal or treatment area except for:

1. Undeveloped parcels that have received site evaluation approval and/or permit approval prior to the enactment of this ordinance.

2. Dwellings served by disposal/treatment systems existing at the time of passage of this Manual when such systems are properly sited (approved site evaluation) and permitted or in accordance with the Franklin County Public Health Department and/or the Ohio Environmental Protection Agency. Existing failing systems which are located within the SCPZ can be upgraded with approval of the Franklin County Public Health Department and/or the Ohio Environmental Protection Agency.

8.5 Construction Requirements

The following conditions shall apply to all Stream Corridor Protection Zones:

a. Except as otherwise provided in this Manual, the Stream Corridor Protection Zone shall be preserved in its natural state.

b. Prior to any soil disturbing activity, the Stream Corridor Protection Zone shall be clearly delineated by the applicant or their designated representative on the site. Such delineation shall also be identified on the Erosion and Sediment Control Plan and this delineation shall be maintained throughout soil disturbing activities.

c. No later than the conclusion of construction, the applicant shall permanently delineate the Stream Corridor Protection Zone in an aesthetically harmonious manner, approved by the City, such that the location of the riparian setback boundary defining the Stream Corridor Protection Zone is apparent to the casual observer and permits access to the zone.

d. Language preventing property owners from constructing facilities and performing activities that are prohibited within the Stream Corridor Protection Zone shall be shown on the plat or separate instrument and reflected on all deeds.

e. Land within the SCPZ may be deeded fee simple to the City, pending City approval.

f. The applicant shall obtain all necessary permits from the Army Corps of Engineers, Ohio EPA, and other regulatory agencies. The applicant is responsible for all permitting fees.

8.6 Mitigation of SCPZ Disturbances

For proposed uses within the SCPZ not permitted under this section, mitigation shall be provided for proposed impervious area or managed open space encroachments as follows.

a. Proposed Impervious Area. Proposed impervious areas within the SCPZ not permitted under this section shall be mitigated in one of the following ways upon approval by the Director of Public Service:

1. Mitigation by reducing the impervious area within an existing offsite or onsite SCPZ by two times the proposed impervious area encroachment, re-vegetating according to specifications in this Manual, and placing the area into a

conservation easement.

2. Mitigation by reducing the managed open space or agricultural area within an existing offsite or onsite SCPZ by four times the proposed impervious area encroachment, re-vegetating according to specifications in this Manual, and placing the area into a conservation easement.

3. Install an intensive or extensive Green Roof equal in surface area to managed open space within the SCPZ or two times the proposed area of impervious surface within the SCPZ.

b. Proposed Managed Open Space. Proposed managed open space area within the SCPZ not permitted under this section shall be mitigated as described below upon approval by the Director of Public Service:

1. Mitigation by reducing the managed open space or agricultural area within an existing offsite or onsite SCPZ by two times the proposed managed open space area encroachment, re-vegetating according to specifications in the Stormwater Design Manual, and placing the area into a conservation easement.

All areas that are designated to be used for SCPZ mitigation shall be permanently restricted by a recorded conservation easement held by the City. The easement is required to be recorded prior to the completion of proposed site improvement construction activities. The conservation easement is only required for SCPZ mitigated areas.

a. It is the responsibility of the property owner to properly maintain the SCPZ. The conservation easement shall include the right of the City or its authorized agents, upon reasonable notice to the property owner, to enter upon the property for the purposes of accessing the Stream Corridor to inspect and monitor compliance with the terms of the conservation easement and this article. The conservation easement shall be perpetual, shall be in the form approved by the City, and shall run with the land and be binding upon the property owner and the successors in interest in the property or in any part thereof. Conservation easements shall be established by deed if no subdivision map is being filed, or by plat filed with the Franklin County Recorder's Office. The recorded conservation easement shall, at a minimum, also include:

1. Date of issuance, a written narrative of authorized regulated activities permitted in this section of this Ordinance, all of the prohibitions set forth, and in the case of permitted disturbances, a description of the disturbance(s) to be implemented;

2. Survey plans for the property as a whole and, where applicable, for any additional properties subject to the conservation easements. Such survey plans shall be submitted on the surveyor's letterhead, signed and sealed by the surveyor, and shall include metes and bounds descriptions of the property, the site, and the areas subject to the conservation easement in Ohio State Plane Coordinates, North American Datum 1983, and shall depict the boundaries of the site and all areas subject to the conservation easement as marked with flags, signs or stakes on site. All such survey plans shall be submitted on paper and in digital CAD or GIS file on a media and format defined by the City. The flags, signs or stakes shall be numbered and identified on the survey plan; and

3. A copy or copies of deeds for the property as a whole that indicate the deed book and pages where it has been recorded with Franklin County.

b. The easement shall require the landowner to establish and maintain visible monuments at prominent locations along the boundary of the area subject to the easement.

c. The conservation easement may include language reserving the right to make minor changes to accommodate necessary regulatory approvals upon the written consent of the City, provided such changes are otherwise consistent with this Manual. Any subsequent requests for minor changes to a conservation easement not associated with another land use application shall be subject to approval by the City. Such requests shall be in writing and shall be accompanied by all necessary supporting documentation. Upon the complete submittal of the written request and supporting documentation, the City shall have 90 days to decide whether to grant the request, pending an extension upon mutual agreement of all parties involved.

8.7 Exceptions

SCPZ requirement exceptions may be granted by the Director of Public Service, however, this shall not absolve the developer or property owner from complying with all applicable state and federal regulations.

8.8 Flood Prone Area and SCPZ Stabilization

Proper selection of species for stabilization of flood prone and SCPZ areas is dependent upon several factors, including soil conditions, available water and amount of sun exposure. Proper species selection and installation shall account for these factors.

Table 8-1: Species of Plants and Shrubs Recommended for Stabilizing Flood Prone Areas

Riparian Corridor—Trees

Botanical Name	Common Name
Acer spp.	Maple(s)
Betula nigra	River Birch
Carya spp.	Hickory(s)
Celtis occidentalis	Common Hackberry
Cercis Canadensis	Eastern Redbud
Crataegus phaenopyrum	Washington Hawthorne
Crateaegus crusgalli	Cockspur Hawthorne
Fagus grandiflora	Beech
Fraxinus Americana	White Ash
Gleditsia triacanthos	Honeylocust
Hamamelis virginiana	Common Witchhazel
Liriodendron tulipifera	Tulip Poplar
Liquidambar styraciflua	Sweetgum
Platanus occidentalis	Sycamore
Populus deltoids	Eastern Cottonwood
Prunus serotina	Black Cherry
Quercus alba	White Oak
Quercus palustris	Pin Oak
Quercus rubra	Red Oak
Ulmus rubra	Slippery Elm

Riparian Corridor--Shrubs

Botanical Name	Common Name
Aronia melanocarpa	Black Chokeberry
Cornus racemosa	Gray Dogwood
*Cornus stolonifera**	Red-osier Dogwood
Lindera benzoin	Spicebush
*Salix spp.**	Willow(s)
Sambucus canadensis	Elderberry
Viburnum dentatum	Southern Arrowwood
Viburnum prunifolium	Blackhaw Viburnum
Viburnum lentago	Nannyberry Viburnum
Viburnum trilobum	American Cranberrybush

*In stream plantings for rapid shade cover and bank stabilization

9.0 OPERATION AND MAINTENANCE PLANS

The owner/developer of a site that includes the implementation of structural and nonstructural BMPs to manage stormwater from the site and provide qualitative treatment shall prepare an Operation and Maintenance (O&M) Plan. The O&M plan shall be submitted to the City for review and shall be approved prior to the commencement of construction activities. The O&M Plan shall meet the minimum requirements of the latest version of the Ohio EPA General Construction Permit and include an O&M Agreement signed by the owner/developer and a requirement for annual inspection reports filed on forms provided by the City and conducted by a licensed Ohio Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), or Certified Professional in Storm Water Quality (CPSWQ).

The O&M plan shall be a stand-alone document which contains the following minimum requirements:

a. A designated entity for stormwater inspection and maintenance responsibilities.
b. The routine and non-routine maintenance tasks to be undertaken.
c. A schedule for inspection and maintenance tasks.
d. Any necessary legally binding maintenance easements and agreements.
e. A map showing the location of the BMPs and access and maintenance easements.
f. BMP details.
g. Procedures for properly disposing of collected pollutants within the BMPs in accordance with local, state, and federal regulations.

10.0 EROSION AND SEDIMENT CONTROL

The developer shall prepare a Stormwater Pollution Protection Plan (SWP3) in accordance with the general and specific requirements outlined in the OEPA's permit for stormwater discharges associated with construction activity or its subsequent OEPA-issued revision. The SWP3 shall include erosion and sediment structural and non-structural BMPs to address the management of construction site stormwater runoff throughout land disturbing activities. The SWP3 shall be submitted to the City for review and shall be approved prior to the commencement of land disturbing activities. A copy of the OEPA Notice of Intent (NOI) submission shall be made available to the City.

A copy of the approved SWP3 shall be maintained onsite in a location easily accessible by the City at all times during construction activities. The owner/developer is required to modify the SWP3 as necessary during construction activities to appropriately manage the construction site stormwater runoff during the various phases of construction. The SWP3 required to be kept on-site shall be modified and revised to reflect the installed BMPs at all times.

It shall be the responsibility of the owner/developer to provide notification to the City 48 hours prior to commencement of initial site earth disturbance. No construction activity such as grading, cutting, or filling shall be commenced until erosion and sedimentation control devices have been installed to the satisfaction of the City.

No person shall cause or allow earth disturbing activities on a development area except in compliance with the standards set out in this manual and the applicable items below:

a. An SWP3 shall be approved prior to any earth disturbing activities on development areas, including those development areas being a part of a larger common plan of development or sale. The person proposing such earth disturbing activities shall develop and submit for approval a plan, as part of the final site improvement plans, containing erosion and sediment pollution control practices so that compliance with other provisions of this manual shall be achieved during and after development. Such a plan shall address specific requirements contained within this Manual.

b. The SWP3 shall contain a description of the controls appropriate for each construction operation covered by this Manual and the operator(s) shall implement such controls. The terms shall clearly describe for each major construction activity appropriate control measures and the general timing (or sequence) during the construction process that the measures will be implemented; and which contractor is responsible for implementation (e.g., contractor A will clear land and install perimeter controls and contractor B will maintain perimeter controls until final stabilization). The erosion and sediment control practices used to satisfy the conditions of this Manual shall meet the standards and specifications in the current edition of Ohio's Rainwater and Land Development manual or other standards acceptable to the City.

11.0 GLOSSARY

The following definitions shall apply to this Manual:

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, otherwise known as the base flood.

Attenuation: Is the gradual loss of intensity of flow.

Best Management Practice(s) (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 stormwater runoff and water bodies and reduction in peak flow rates.

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 shall 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. A permit from ODNR is not required for impoundments with a total storage volume of less than 15 ac-ft, or less than 50 ac-ft for impoundments with a height of less than 10 feet, or unlimited storage for heights of less than 6 feet.

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.

Design Storm: A rainfall event of specified size and return frequency which is used to calculate the runoff volume and peak flow rate.

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 does not lead to treatment works and/or the addition of any pollutant to the Waters of the State from a point source.

Disturbance: 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: The surface and subsurface system for the removal of water from the land, including both the natural elements of streams, marshes, swales and wet basins, 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 stormwater 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 Ohio and/or U.S. Environmental Protection 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 (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 stormwater associated with activities subject to NPDES Permits as defined in 40 Code of Federal Regulations (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.

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.

Green Roof: A roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane. It may also include additional layers such as a root barrier and drainage and irrigation systems.

Hydrologic Soil Group: One of four classifications of soil based on the minimum infiltration characteristics for bare soil after prolonged wetting as used by the United States Department of Agriculture Natural Resources Conservation Service *Technical Release No. 55, Urban Hydrology for Small Watersheds*. The Franklin County Soil Survey should be used as the reference source for soils types and hydrologic soil groups within the City of Grove City.

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.

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

Jurisdictional Stream: Any watercourse that is deemed to be classified as Waters of the United States by a regulatory governmental agency such as the Ohio EPA or United States Army Corps of Engineers. Classifications include ephemeral, intermittent, and perennial.

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

Larger Common Plan of Development of Sale: A contiguous area where multiple separate and distinct construction activities may be taking place at different times on different schedules under one plan. A common plan is broadly defined as any announcement or piece of documentation (including a sign, public notice or hearing, sales pitch, advertisement, drawing, permit application, zoning request, computer design, etc.) or physical demarcation (including boundary signs, lot stakes, surveyor, markings, etc.) indicating that construction activities may occur. A larger common plan or sale needs to also consider spoil areas, staging areas and borrow sites. A public body need not consider all their construction projects within their entire jurisdiction to be part of an overall common plan. Discrete construction projects within a larger common plan or development or sale are located at least ¼ mile apart and the area between the two projects is not being disturbed, each individual project can be treated as a separate plan of development or sale provided any interconnecting road, pipeline, or utility project that is part of the same "common plan" is not concurrently being disturbed.

Low Impact Development or "LID": A term used to describe a land planning and engineering design approach to manage stormwater runoff. One of the primary goals of LID is to reduce the volume of runoff

by infiltrating runoff, evaporation of rainwater back into the atmosphere, and finding other beneficial uses for excess runoff rather than exporting it as a waste product to downstream storm sewers.

Levee: An artificial barrier that diverts or restrains flood waters from streams and lakes. Per the Ohio Department of Natural Resources, sufficient freeboard shall be provided to prevent overtopping of the levee due to passage of the design flood or due to severe frost damage, ice damage, stream obstruction or wave action. The design freeboard shall not be reduced without the approval of the ODNR Chief.

- For levees in Class I, the minimum elevations of the top of the levee shall be three feet higher than the maximum adjacent water surface elevation during passage of the design flood.
- For levees in Class II and Class III, the minimum elevations of the top of the levee shall be two feet higher than the maximum adjacent water surface elevations during passage of the design flood.
- Where special condition of severe frost damage, ice damage, stream obstruction, wave action, or impact of other structures may occur, the ODNR Chief may require elevations higher than required item 1 above.

Managed Open Space: Land that is regularly maintained via mowing, fertilizing, landscaping, and other actions that prevent the land from being in a natural state such as single-family residential lawns, golf courses, cemeteries, and other similar types of development.

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):

- 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.
- Designed or used for collecting or conveying stormwater;
- Which is not a combined sewer; and
- 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.

OAC: Ohio Administrative Code.

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

Ordinary High Water Mark (OHWM): A line on the shore established by the fluctuations of water and indicated by physical characteristics, or by other appropriate means that consider the characteristics of the surrounding areas.

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

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

Person: Any individual, owner, operator, association, organization, partnership, firm, corporation, municipal corporation, joint venture, agency, County or State agency, unincorporated associate, party, the federal government, any combination thereof or other entity recognized by law.

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 BMPs and associated specifications prepared by the Ohio Department of Natural Resources Division of Soil and Water Conservation. The compilation of technical standards and design specifications are methods of controlling construction related surface runoff, erosion and sedimentation. A copy of the manual may be obtained by contacting the Director of Public Service or the Ohio Department of Natural Resources, Division of Soil & Water Conservation.

Riparian Setback: 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 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 basin: 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.

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

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.

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

Stormwater Master Plan: A study prepared by a Professional Engineer to determine specific allowable discharge rates for a larger common development or watershed area. These types of studies are typically initiated due to downstream restrictions or other special circumstances that require a higher level of stormwater control within the study area.

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 #OHC000004. The SWP3 shall be certified by an Engineer, and shall indicate the stormwater management strategy, including the specific measures and sequencing to be used to manage stormwater

on a development site before, during and after construction and shows the details of any earth-disturbing activity on the site.

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. To be classified as a stream, the waterway shall meet certain requirements as defined by the Ohio EPA and/or US Army Corps of Engineers and may then be classified as either an ephemeral, intermittent, or perennial stream.

Stream Corridor Protection Zone" or "SCPZ": A transitional area between terrestrial and aquatic ecosystems, and adjacent to perennial, intermittent, and ephemeral streams, lakes, and estuarine-marine shorelines, that is distinguished by gradients in biophysical conditions, ecological processes, and biota, through which surface and subsurface hydrology connect water bodies with their adjacent uplands. The riparian zone includes those portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., a zone of influence).

Structural BMP: A constructed facility or measure to help protect receiving water quality and control stormwater quantity.

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.

Water Quality Volume: A volume captured for the purposes of treating pollutants and protecting stream stability. This volume is prescribed by the Ohio EPA Construction General Permit and is equivalent to the volume generated by a 0.75 inch rainfall.

Watershed: A region draining to a specific river.

Wetland: An area that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated or hydric soil conditions as defined by the Ohio EPA and/or US Army Corps of Engineers.