Stormwater Design Manual
City of Bloomington Utilities

Last Revised: June 26, 2024

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CHAPTER 1 - INTRODUCTION

1.1 Purpose

This document, the CBU Stormwater Design Manual, contains the necessary technical standards for administering the requirements of the CBU Stormwater Management Ordinance (SMO). This document shall be considered as a companion document to the Ordinance. Whereas the Ordinance contains the majority of the regulatory authority and general requirements of comprehensive stormwater management, this document contains the necessary means and methods for achieving compliance with the Ordinance. In case there are conflicts between the requirements contained in this document and the ordinance, the requirements of the Ordinance shall prevail.

Measures taken to control stormwater impacts shall assure that new development minimizes impacts to downstream sewers, ditches and structures. The following principles apply to all new developments and modifications to existing land uses:

- Design for the minimum amount of downstream, upstream and peripheral impact.
- Design a stormwater collection and conveyance system that requires minimal maintenance.
- Design a stormwater collection and conveyance system that causes a minimal amount of erosion and sedimentation.

Because topography and the availability of adequate outlets for storm runoff vary with the site, the stormwater drainage systems are site specific. It is recommended that each proposed development project be discussed with CBU during the initial planning stage of the project to obtain early input and feedback regarding stormwater issues.

1.2 Description and Use

1.2.1 Compliance with other Standards

Compliance with this standard does not eliminate the need to comply with other applicable City, County, State and Federal ordinances and regulations. This includes, but is not limited to, the submission and approval of preliminary and final subdivision plats, permits for construction in a regulated floodplain/floodway, building and zoning permits, construction inspections, and coordination with other administering authorities. Subsection I-1 includes minimum coordination requirements with each administering authority.

1.2.2 Conflicting Standards

The provisions of this document shall be deemed as additional requirements to minimum standards required by other applicable ordinances and standards. In the case of conflicting requirements, the most restrictive shall apply.

1.3 Additional Standards and References

1.3.1 Additional Design Standards

For design elements not included in this manual, such as Erosion and Sediment Control, or for conflicts in design requirements the following standards shall be used in the order noted:

1. City of Bloomington (CBU) Construction Specifications for Wastewater, Water, and Storm Projects. (most current version). https://bloomington.in.gov/engineering/resourceshttps://bloomington.in.gov/engineering/resources
2. Indiana Department of Environmental Management (IDEM) (most current version). Indiana Storm Water Quality Manual. https://www.in.gov/idem/stormwater/resources/indiana-storm-water-quality-manual/
3. Indiana Department of Transportation (INDOT) Design Manual (most current version). https://www.in.gov/indot/design-manual/
4. INDOT Construction Standards. (most current version). https://www.in.gov/dot/div/contracts/standards/book/sep21/sep.htm

1.3.2 CBU Reference Data

The City's GIS staff maintains spatial data and provides mapping and spatial analysis services to support operations of City Departments, Boards and Commissions. Publicly available GIS information for the City of Bloomington can be accessed from https://bloomington.in.gov/gis.
Note: All GIS and electronic database materials, and any services which may be provided related thereto, are provided "as-is" without any warranty of any kind, and all warranties on merchantability and fitness for a particular purpose are hereby disclaimed.

1.3.3 Additional References

1. City of Bloomington Stormwater Management Ordinance. https://bloomington.in.gov/utilities/stormwater
2. United States Department of Agriculture, Natural Resources Conservation Service. (NRCS) (most current). Web Soil Survey. https://websoilsurvey.nrcs.usda.gov/
3. NRCS TR-55: Urban Hydrology for Small Watersheds. (June 1986). https://www.nrc.gov/docs/ML1421/ML14219A437.pdf
4. IDEM Construction Stormwater General Permit (CSGP) Construction/Stormwater Pollution Prevention Plan Development Guidance (most current) https://www.in.gov/idem/stormwater/construction-land-disturbance-permitting/guidance-for-construction-plan-storm-water-pollution-plan-development/

CHAPTER 2 - GENERAL REQUIREMENTS

2.1 Purpose

The purpose of this chapter is to outline requirements for proposed drainage improvements that fall within the jurisdiction of City of Bloomington Utilities (CBU).

2.1.1 Low Impact Development Statement

A Low Impact Development (LID) approach utilizing green infrastructure (GI) such as bioretention, sand filters, vegetated swales, filter strips, or green roofs is preferred by CBU.

LID design approaches are fundamentally different from conventional design approaches and challenge traditional thinking regarding development standards, watershed protection, and public participation. LID combines fundamental hydrologic concepts with many of today's common stormwater strategies, practices and techniques to reshape development patterns in a way that maintains natural watershed hydrologic functions. The five principles of LID are:

1. *Conservation of existing natural and topographic features;*
2. *Minimization of land clearing and impervious surfaces;*
3. *Maintenance or lengthening of the pre-developed time of concentration;*
4. *Installation of integrated structural best management practices; and*
5. *Use of pollution prevention measures and practices.*

2.2 Pre-Submittal

2.2.1 Early Coordination

For the convenience of the applicant, early coordination with CBU staff may be requested by the petitioner, required by other City Departments, and/or necessary for large, unique, or complex projects. The purpose of early coordination is to clarify requirements prior to submittal, minimize review time, and reduce submittal revisions.

2.2.2 Waivers and Special Conditions

CBU has the authority to modify, grant exemptions, and/or waive certain requirements of this Stormwater Design Manual. Modifications, waivers, special conditions, and exceptions may be considered where standards of engineering practice cannot be substantially met due to site restraints or that a waiver or special condition is in the best interest of public good.

2.2.3 Stormwater Permits

Table 2-1 Required Submittals for Stormwater Management Permit

Project Type	Cumulative Disturbed Area	Required Submittals for Permit
All	< 2,500 sq. ft.	No Stormwater Management Permit Needed
Single-family residential (SFR)	2,500 sq. ft to 1 acre	No Stormwater Management Permit Needed
Linear underground utilities		
Non-SFR	2,500 sq. ft to 1 acre	Application Form Construction Plans Stormwater Drainage Report Soil Erosion and Sediment Control Plan O&M Manual
Linear above-ground utilities		
City-owned projects		
All	>1 acre	Application Form Construction Plans Stormwater Drainage Report Stormwater Pollution Prevention Plan O&M Manual

Note: Required submittal items are described further this chapter.

CBU reserves the right to require additional information as necessary to evaluate the adequacy of the proposed stormwater facility.

2.3 Key Performance Standard Requirements

The purpose of this section is to summarize key performance standards for stormwater management on sites requiring a Stormwater Management Permit. These performance standards are intended to limit non-point runoff pollution and reduce the potential for flooding to impact new developments or their neighbors.

Additionally, the subsequent chapters in this design manual include further design standards, requirements, and methodologies and shall be reviewed in their entirety before designs are prepared.

2.3.1 Water Quantity Requirements

The post-construction peak discharge rate of the area disturbed by the construction project shall be less than or equal to the following:

Table 2-3 Peak Discharge Limits

Design Frequency	*Peak Discharge Limit*	*Critical Watersheds (for development greater than 2.5 acres)*
10-year	0.5 cfs/acre	0.25 cfs/acre
100-year	0.9 cfs/acre	0.45 cfs/acre

2.3.2 Detention In-Lieu Fee/Peak Discharge In-Lieu/Water Quantity/Flooding mitigation/flooding waiver

In highly urbanized areas of Bloomington, such as the downtown area, detention may not be feasible and In-Lieu fee would be required. In special circumstances, the director may approve additional stormwater infrastructure in lieu of stormwater detention.

2.3.3 Water Quality Requirements

Total suspended solids (TSS) are a pollutant commonly found in urban runoff, referring to solid particles larger than 2-microns in diameter suspended in stormwater. The upper size limit of TSS depends on the velocity patterns in stormwater flows but is generally considered 100-125 microns in the context of stormwater pollution regulations.

To meet the City's goal of TSS reduction in stormwater, a combination of best management practices (BMP's) shall be designed including LID/GI designs to capture the runoff from a storm of 1-inch depth over the drainage area. The runoff from a 1-inch rainfall is referred to as the water quality volume (WQv),

$$WQ_v = \frac{(P)(R_v)(A)}{12}$$

where;

WQ_v = Water Quality volume (acre-feet)
P = Precipitation Depth, 1-inch
R_v = Volumetric Runoff Coefficient, 0.005 + 0.009(I) where I is the percent impervious cover
A = Drainage Area (acre)

2.3.3.1 Green Infrastructure Requirement

A minimum of 50% of WQ_v shall be treated by green infrastructure. If a development cannot treat a minimum of 50% of WQ_v utilizing GI, then the Owner shall pay an In-Lieu Fee described further in section 2.3.3.2.

2.3.3.2 Green Infrastructure In-Lieu Fee

The applicant is required to provide a justification for not implementing LID/GI BMPs. Should the developer consider GI to be unfeasible for capturing WQv, they are advised to consult with CBU prior to finalizing the concept. In cases where CBU grants approval for an in-lieu fee, the developer will be obligated to pay the GI in-lieu fee corresponding to the WQv that has not been captured as required by Section 2.3.2. The rates for the in-lieu fees are detailed in Table 2-4:

Table 2-4 Green Infrastructure In -Lieu Fee

Year	*Price per Cubic Foot*
April 2024	$22.00
After April 2024	Adjusted based on Consumer Price Index (CPI) Adjusted price per cubic foot = (current CCI / April 2024 CCI) * $22

The U.S. Bureau of Labor Statistics Consumer Price Index (https://www.bls.gov/cpi/) shall be used to adjust the price to the current date.

2.3.3.3 Treatment Train Required

More than one BMP must be implemented as part of a treatment train, unless determined infeasible by the Assistant Director of the Engineering Division of CBU or their designee.

Further treatment of pollutants may be required by the City's MS4 NPDES permit.

2.3.4 Storm Conveyance Design Requirements

The following criteria in Table 2-5 shall be adhered to when designing a facility within stormwater utility jurisdiction. Roadway classifications may be found in the City of Bloomington Transportation Plan.

Table 2-5 Minimum Design Storm Frequency Requirements

Infrastructure	*Minimum Design Frequency*
Storm sewers and inlets on grade	10-year
Storm sewers and inlets in sump	10-year
Culverts - Driveway	10-year
Road Culverts - Arterial	100-year
Road Culverts - Collector	50-year
Road Culverts - Local	25-year
Open Channels/Swales	10-year
Emergency Spillways	100-year

2.4 Stormwater Permit Components

2.4.1 Submittal Content and Format

The submittal materials outlined in this section shall be provided and sealed by an Indiana Licensed Professional Engineer or Professional Land Surveyor engaged in storm drainage design under whose supervision the plans were prepared and shall be submitted directly to CBU.

Required submittal content depends on the type of project and the total cumulative area of land disturbed during construction. The project's disturbed area includes any cumulative surface area that will be disturbed by construction including on site disturbance, off-site soil disposal areas, roads, utilities, or infrastructure that will be part of the project. Further guidance on disturbed area can be found in the City's Title 13: Stormwater Management Ordinance (SMO). Table 2-1 summarizes the project requirements based on project type and amount of disturbance.

CBU reserves the right to reject application submittals not meeting the requirements set forth in this document.

2.4.2 Format of Submittal

All documents shall be submitted in PDF format of a standard size. The preferred maximum size for plans and drawings shall be 36-inch by 24-inch.

PDF drawing submittals shall not contain SHX comments or untitled viewports. AutoCAD drawings exported to PDF may use TrueType fonts or set the PDFSHX system variable to zero if using SHX fonts. Untitled viewports shall be deleted from drawing files or from PDF's prior to submittal. All PDFs shall be labeled, contain a scale, and contain page labels that are descriptive of each sheet when applicable.

2.4.3 Application Form

An Application Form for Stormwater Management Permit must be completed and signed by the applicant. Application forms are available for download online at https://bloomington.in.gov/utilities/stormwater.

2.4.4 Stormwater Drainage Report

The Stormwater Drainage Report shall include the following information:

a) A written narrative describing:
b) Methodology used in the report including a brief description of software used, if applicable.
c) Existing site conditions.
d) Known drainage concerns, specific problem areas identified during site inspections, and downstream conditions.
e) Description of proposed stormwater management techniques
f) A summary of calculations or modeling indicating conformance with water quality and peak discharge performance standards.
g) Drainage area map which indicates all existing and proposed on-site and off-site drainage areas and flow paths to stormwater facilities, and the limits of the 100-year floodplain for all areas with contributing drainage watersheds of five acres or greater. The map shall include a scale, north arrow, and labeled contours at a minimum. Include finish floor elevations of adjacent or impacted properties.
h) Hydrologic calculations, including
    a. Measurement of drainage areas.
    b. Curve number and time of concentration calculations for peak discharge calculations.
    c. Runoff coefficient calculations for peak flow conveyance capacity requirements
    d. Hydraulic calculations, including
    e. Inlet grate and gutter flow calculations showing conformance with design requirements.
    f. Closed conduit and open channel calculations showing conformance with design requirements.

g. Hydraulic grade line calculations showing conformance with design requirements.
h. Summary of design and hydraulic performance of BMP's.
i. Input and output data from hydraulic model, if applicable.

2.4.5 Construction Plans

The following information must be included in the construction plans:

1. Location and Vicinity Map
   a) Location and vicinity of the proposed development
   b) Reference a nearby major roadway intersection
   c) Include the ¼ Section, Township, Range, and Civil Township.
2. Site Grading Plan
   a) Show proposed contour lines in bold lineweight with existing contour lines in regular lineweight. Spot elevations are required where necessary to define the existing or proposed drainage routes.
   b) Show curb and gutter, sidewalk, pavement, ground and other elevations required by site design.
   c) Show drainage structures with rim or other elevations required for drainage.
   d) Show stormwater management facilities and BMP's.
   e) Show arrows indicating direction of overland flow routes.
   f) 100-year water surfrace elevation determined in drainage report.
3. Landscaping and/or Restoration Plan
   a) Location, type, species, quantity, and size of plantings. Plantings shall be listed by both botanical name and common name. Some hybrid plants may not be accepted even if the plant that was hybridized may be.
   b) Projects without landscaping plans may submit a restoration plan showing the final stabilization of all disturbed areas.
4. Stormwater Utility Plan
   a) The stormwater utility plan shall be drawn to a sufficient scale to accurately depict all features that affect stormwater design, and an arrow indicating north shall appear on each page. Existing and proposed on-site land contours shall be shown at one-foot contour intervals except where slopes are steeper than twenty percent. A benchmark, which is easily accessible and re-locatable, shall be shown. The benchmark shall be determined by City datum, unless otherwise permitted by CBU.

   b) The stormwater utility plan shall show the locations of all existing and proposed stormwater facilities with appropriate right-of-way and easement limits. Storm drains and manholes and other structures shall be located by dimensions on the plans in relation to surrounding physical features. However, the areas where physical features are not available, coordinates of manholes and bearings of storm drains shall be based on the state plane coordinate system. The stormwater utility plan shall show the direction of flow, elevation of inverts, gradient, materials and size of existing and proposed storm drains.

c) For all storm sewers a plan and profile in conformance with this manual shall be submitted.

d) The profile shall be shown under the plan and shall extend a sufficient distance downstream of the outlet to allow any pertinent information concerning the outfall channel to be shown. All invert elevations and pipe slopes shall be listed. For each pipe the length, size, material and class shall be annotated on the profile sheet near the dimension line. Detail title and/or number references shall be called out on the profile plan.

e) The storm drain and inlet profile shall generally be drawn on a scale of one inch equals fifty feet horizontal, one inch equals five feet vertical. Where a storm drain is located inside the limits of an existing or proposed pavement or shoulder, the center line grade of the road shall be shown. Where a storm drain is located outside pavement or shoulder, the existing ground over the storm drain with proposed grading shall be shown. If the storm drain is to be constructed on fill, the profile of the undisturbed earth, at the storm drain location, shall be shown. All utility locations at intersections with the storm drain shall be shown.

2.4.6 Soil Erosion and Sediment Control Plan

A Soil Erosion and Sediment Control plan shall include at a minimum:

1. A drawing indicating type and location of all erosion and sediment control measures required to meet performance standards of the Construction Stormwater General Permit and the Indiana Stormwater Quality Manual during construction and through stabilization.
2. A suggested construction sequence to meet erosion and sediment control requirements.
3. Standard details indicating the minimum requirements and installation practices for each type of erosion, sediment control, and stabilization measure.

2.4.7 Stormwater Pollution Prevention Plan (SWPPP)

A SWPPP is required for any site which involves the cumulative disturbance of 1-acre or more of ground surface. Requirements for a SWPPP are set forth in the current Construction Stormwater General Permit issued by IDEM. Further information on best practices for SWPPP preparation can be found in the Indiana Stormwater Quality Manual.

2.4.8 Geospatial Data Submittal

Projects requiring a Stormwater Management Permit shall submit geospatial data to CBU prior to kickoff of construction, and shall be updated after substantial completion of the project. Geospatial data shall be submitted in a shapefile or ArcGIS geodatabase digital format. All data submitted will become a part of the public record.
A template for the geospatial data submittal is provided on the City's website at https://bloomington.in.gov/utilities/stormwater. All pertinent layers and data fields shall be completed for the development. Additional information is provided at the link provided.

Geospatial data submittals shall include the following features at a minimum:

1. **Buildings**: Polygons of new and modified building footprints.
2. **Easements and ROW**: Lines delineating right-of-way and any easements within project boundaries.
3. **Edge of Pavement**: Lines delineating the outside edges of paved or unpaved streets, parking, sidewalks, trails, bike paths, or any other pavement.
4. **Storm Mains**: Features of the storm sewer system represented by a polyline such as pipes, culverts, ditches, hybrid ditches, etc.
5. **Storm Structures**: Features of the storm sewer system represented by a point such as manholes, inlets, wet/dry wells, etc.
6. **Stormwater Quantity/Quality Features**: Polygons, polylines, or point features of the storm sewer system which treat stormwater runoff for water quality and/or quantity such as detention ponds, mechanical BMPs, forebays, rain gardens, underground detention, etc.

Surveyed information provided shall be spatially verified with a minimum of mapping grade GPS, sub-meter or better. Geospatial data shall be provided in Indiana State Plane West coordinate system using North American Vertical Datum of 1988 (NAVD88).

2.4.9 Operations and Maintenance (O&M) Manual

Following completion of construction, the Owner is responsible for long-term operation and maintenance of stormwater management facilities. Owners will be responsible for all maintenance including but not limited to pond banks, erosion control measures, riprap, vegetation, outfall protection and all periodic cleanout and dredging. It is the designer's responsibility to determine which operation and maintenance measures are necessary to prolong the optimal function of the facility.

Stormwater management facilities including pipes, structures, ponds, detention/retention facilities, swales, open channels, subsurface drains, water quality BMPs, and low impact development practices shall have an O&M manual.

Draft O&M Manual submittals must be received by CBU prior to permit approval.

1. The approved O&M manual shall be signed by the owner and notarized before a Certificate of Completion is issued.

    a) If the project is not a City-owned project located in the right-of-way, the document(s), in a form acceptable to CBU and City Legal, shall then be recorded at the Monroe County Recorder's Office. A copy of the recorded O&M document(s) shall be provided to CBU.

    b) If the O&M document(s) relate to a City-owned project located in the right-of-way, then the document(s), in a form acceptable to CBU and City Legal, shall be kept on file with the City Department that owns and/or maintains the stormwater facilities associated with the project. A copy of the O&M document(s) shall be provided to CBU.

2. All O&M manuals shall include the following information, at a minimum:

   a) Owner Information. The first section of the manual shall contain information about all people involved with the operations and maintenance of the facility. This section shall list the names and contact information of all responsible parties, including property owner(s), maintenance staff, and person(s) responsible for performing inspections. The responsibilities of each individual shall be clearly defined. Contact information shall include business or mobile phone number, address for giving notice, and email address (if available).

   b) Site Map. The O&M manual shall include a site map and exhibits drawn to a legible scale on 8.5"x11" or 11x17" sized page that clearly indicates the following:
      - A north arrow and a legend
      - The location of the stormwater management facility or BMP.
      - Plan and cross-section details, showing applicable features.
      - The flow of stormwater through the site, including an overview of the stormwater's path through the onsite stormwater facilities and BMPs.
      - Dimensions, easements, outlets/discharge points and outfall locations, drainage patterns, stormwater runoff flow directions, the extent and depth (elevation) of high water levels, flood, as that term is defined by the State of Indiana Department of Natural Resources, routing path, signage, connecting structures, weirs, invert elevations, structural controls used to control stormwater flows, and other relevant features.

3. O&M Practices. Each stormwater management facility and BMP shall require specific inspection and maintenance procedures.

   a) Narrative shall be written in simple, layperson's terms, including:
      - Guidance on owner-required periodic inspections and inspections to be performed by CBU.
      - Guidance on routine maintenance to be performed by the owner including but not limited to mowing and removal of debris.
      - Guidance on remedial maintenance such as inlet replacement, outlet work, etc. to be performed by the owner.
      - Guidance on sediment removal, both narrative and graphical, describing when sediment removal shall occur to ensure that the stormwater management facility or BMP remains effective as a stormwater management device. Guidance shall include instructions as to how the depth of sediment shall be measured and at what measurement removal will be required.
      - Instructions on inspection and clean-out of BMPs, sumps, trash screens, settling pits, and oil/grease collection chambers.
      - Instructions on proper disposal of removed sediments, trash, debris, and other substances.
      - Guidance and methods for preventing water stagnation and all recommended maintenance.

b) The minimum requirements below shall also be incorporated into the inspection and maintenance regimen and clearly documented in the O&M manual.
   - Operation and maintenance procedures and practices shall be reviewed and assessed annually.
   - Access routes, including roadways and sidewalks, shall be inspected annually and maintained as needed.
   - Drainage structures and flow restrictors shall be inspected and cleaned semi-annually or per the manufacturer's recommendations, whichever is more stringent.
   - Volume control facilities and BMPs shall be inspected semi-annually and after significant rainfall events exceeding one and one-half (1.5) inches (as measured by the National Oceanic and Atmospheric Administration) within a 24-hour period, or per the manufacturer's recommendations, whichever is more stringent.
   - The owner shall keep an updated log book or inspection worksheets documenting the performance of the required operation and maintenance activities for perpetuity. Note inspection dates, facility components inspected, facility condition, and any maintenance performed or repairs made. Documentation must be produced upon the request of the CBU Personnel, within forty-eight (48) hours of the request.
   - Vegetation shall be maintained on a regular basis per design specifications.
   - Pest control measures shall be implemented to address insects, rodents, and other pests. Natural pest control is preferred over chemical treatments.
   - Mechanical measures shall be maintained on a regular basis per the manufacturer's recommendations.
   - Signage and fencing shall be installed and maintained where necessary to protect property and the public. Native vegetation plantings shall have "No Mow" or other appropriate signage.
   - Underground vaults and structures shall include design measures to facilitate regular cleaning and maintenance. Confined space entry procedures shall be followed.

4. Right-of-Entry Statement. The O&M manual shall include a statement that CBU has the right to enter the property to inspect the stormwater management facility or BMP. The statement shall be signed and notarized.

5. Implementation Schedule. An inspection and maintenance schedule shall be prepared in a tabular format and included in the O&M manual. This schedule shall provide for routine examination of all stormwater management facilities and BMPs on the property and incorporate the varying maintenance needs of each.

6. Drainage Easement(s) Documentation. The O&M manual shall include a figure showing the location of access and drainage easement(s) around the stormwater management facilities and BMPs.

2.5 Post-Permit Issuance

2.5.1 Notice of Intent

The applicant may not submit the NOI to IDEM (if applicable) or commence land-disturbing activities until the Stormwater Management Permit is issued.

2.5.2 Submittal to Monroe County Soil and Water Conservancy District

If a SWPPP is to be submitted to the Monroe County Soil and Water Conservancy District (SWCD) or directly to IDEM, if directed by the SWCD, then the SWPPP shall be submitted to CBU's MS4 staff for review and a determination made as to whether the plan meets the minimum requirements of the CSGP prior to submission to SWCD or IDEM.

2.6 Project Closeout

2.6.1 Certificate of Completion

A Certificate of Completion shall be required for any project for which a Stormwater Management Permit was issued by CBU. Requirements to obtain a Certificate of Completion are detailed in the SMO. The list of requirements include:

1. An application for a Certificate of Completion submitted to CBU when a project is believed by the responsible parties to be complete.
2. As-built plans meeting requirements set forth in this Chapter and shall be provided to CBU prior to the final walkthrough of the site.
3. Final site walkthrough and inspection by CBU staff.
4. O&M requirements meeting held between CBU, the contractor, and the property owner.
5. Revisions to the O&M documents reviewed by CBU, if applicable, signed by the owner, and recorded with property deed(s) or plat(s).
6. Recording of drainage, utility, and/or access easements with the Monroe County Recorder's Office. A copy of all recorded easements shall be provided to CBU.
7. Delivery of maintenance bond, in an acceptable form, to CBU staff.
8. Final submission of geospatial data, including revisions accepted by CBU, and meeting requirements set forth in this Chapter.

CHAPTER 3 - HYDROLOGY

3.1 Purpose

This chapter sets the hydrologic design procedure requirements that shall be followed when determining the quantity of on-site and off-site stormwater runoff for a project site and the impact on upstream and downstream stormwater facilities.

3.2 Determination of Runoff Rates and Volumes

Runoff rates shall be computed for the area of the parcel under development plus the drainage area tributary to the parcel under development. Hydrologic methodology shall be determined as shown in Table 3-1.

Table 3-1 Criteria for Determining Hydrologic Method.

Development Area	*Drainage Area*	*Depressional Storage*	*Required Methodology*
Less than 5 acres	Less than 25 acres	None	Rational Method or TR-55 (curve number)
Less than 5 acres	More than 25 acres	None	TR-55 (curve number) Method
More than 5 acres	More than 25 acres	Significant	
Any	More than 1 sq. mi.	Any	Contact IDNR*

*Note: For the design of any major drainage system (tributary area greater than 1 square mile) the discharge must be obtained from or be accepted by the Indiana DNR. Other portions of the site must use the discharge methodology in the applicable section of this Chapter.

3.2.1 Rational Method

The Rational Method may be used to determine runoff rates for smaller developments or those without detention as listed in Table 3-1. Note that for the purpose of determining the post-developed runoff coefficients, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group from the NRCS web soil survey for disturbed areas shall be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

In the Rational Method, the peak rate of runoff, Q, in cubic feet per second (cfs) is computed as:

$$Q=CIA$$

where;

Q = Flow
C = Runoff coefficient representing the characteristics of the drainage area
I = Average intensity of rainfall in inches per hour for a duration equal to the time of concentration (t_c) for a selected rainfall frequency.
A = Tributary drainage area in acres.

Values for the runoff coefficient "C" are provided in Table 3-2 and Table 3-3, which show values for different types of surfaces and local soil characteristics. The composite "C" value used for a given drainage area with various surface types shall be the weighted average value for the total area calculated from a breakdown of individual areas having different surface types. Rainfall intensity shall be determined from the rainfall frequency data shown in Table 3-6.

Table 3-3 Rural Runoff Coefficients

Vegetation and Topography	*Open Sand Loam*	*Clay and Silt Loam*	*Tight Clay*
Woodland			
Flat, 0 ≤ slope < 5%	*0.10*	*0.30*	*0.40*
Rolling, 5 ≤ slope < 10%	*0.25*	*0.35*	*0.50*
Hilly, 10 ≤ slope ≤ 30%	*0.30*	*0.50*	*0.60*
Pasture			
Flat, 0 ≤ slope < 5%	*0.10*	*0.30*	*0.40*
Rolling, 5 ≤ slope < 10%	*0.16*	*0.36*	*0.55*
Hilly, 10 ≤ slope ≤ 30%	*0.22*	*0.42*	*0.60*
Cultivated			
Flat, 0 ≤ slope < 5%	*0.30*	*0.50*	*0.60*
Rolling, 5 ≤ slope < 10%	*0.40*	*0.60*	*0.70*
Hilly, 10 ≤ slope ≤ 30%	*0.52*	*0.72*	*0.82*

Note:Values of C for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.
Source: INDOT Design Manual.

Table 3-3 Urban Area Runoff Coefficients

Character of Surface	*Runoff Coefficient, C*
Business	
Downtown	0.70 to 0.95
Neighborhood	0.50 to 0.70
Residential	
Single-Family	0.30 to 0.50
Multi-Units, Detached	0.40 to 0.60
Multi-Units, Attached	0.60 to 0.75
Residential Suburban	0.25 to 0.40
Apartment	0.50 to 0.70
Industrial	
Light	0.50 to 0.80
Heavy	0.60 to 0.90
Park, Lawn, Cemetery, Grassy Area	0.10 to 0.25
Railroad Yard	0.20 to 0.35
Unimproved	0.10 to 0.30
Pavement	
Asphalt or Concrete	0.80 to 0.95
Brick	0.70 to 0.85
Other Impervious	0.75 to 0.95
Water Impoundment	1.00

Note:Values of C for earth surfaces are further varied by degree of saturation, compaction, surface irregularity and slope, by character of subsoil, and by presence of frost or glazed snow or ice.
Source: INDOT Design Manual.

3.2.2 TR-55 (Curve Number Method)

In general, TR-55 methodology shall be used as outlined in the U.S. Department of Agriculture (USDA) - NRCS TR-55 Manual. A computer model such as TR-20 (NRCS) or HEC-HMS (USACE) that can generate hydrographs based on the NRCS TR-55 time of concentration and curve number calculation methodologies may be used along with a 24-hour duration NRCS Type II storm.

Table 3-4 provides curve numbers for different land use classifications. Rainfall depths to be used with TR-55 methodology are shown in Table 3-7.

In urban or developed areas, the time of concentration shall be the sum of the inlet time and flow time in the stormwater facility from the most remote part of the drainage area to the point under consideration. The flow time in the storm sewers may be estimated by the distance in feet divided by velocity of flow in feet per second. The velocity shall be determined by the Manning's Equation. Inlet time is the combined time required for the runoff to reach the inlet of the storm sewer. It includes overland flow time and flow time through established surface drainage channels such as swales, ditches, and sheet flow across such areas as lawns, fields, and other graded surfaces.

For sheet flow calculations, maximum sheet flow length shall not exceed 100 feet. Note that for the purpose of determining the post-developed conditions curve numbers, due to significant disturbance to the upper soil layers during the construction activities, the initially determined hydrologic soil group for disturbed areas shall be changed to the next less infiltrating capacity category (i.e., A to B, B to C, and C to D).

The post-developed CN for the protected undisturbed or restored disturbed areas may be determined based on pre-development underlying soil layer.

Table 3-4 Curve Numbers for Hydrologic Soil Groups

	Curve Number for Hydrologic Soil Group				
Description of Area	% Imp	A	B	C	D
Lawns, open spaces, parks, golf courses cemeteries, etc.					
Good condition 75% or more grass coverage		39	61	74	80
Fair condition 50% to 75% grass coverage		49	69	79	84
Poor condition less than 50% grass coverage		68	79	86	89
Parking Lots, Roofs and Driveways		98	98	98	98
Streets and Roads:					
Paved w/curbs & storm sewers excl. ROW		98	98	98	98
Gravel including ROW		76	85	89	91
Dirt including ROW		72	82	87	89
Paved w/open ditches including ROW		83	89	92	93
Commercial and Business Areas	85%	89	92	94	95
Industrial and Manufacturing Districts	72%	81	88	91	93
Residential					
1/8 acre lot or less, Apartments and Townhouses	65%	77	85	90	92
¼ acre lot	38%	61	75	83	87
1/3 acre lot	30%	57	72	81	86
½ acre lot	25%	54	70	80	85
1 acre lot	20%	51	68	79	84
2 acre lot	12%	46	65	77	82
Developing Areas					
Newly graded w/o vegatation or control measures		77	86	91	94
Newly graded w/ established erosion control measures		74	83	88	90
Agricultural Land Uses					
Pasture or Range Land					
Good condition, protected from grazing		39	61	74	80
Fair condition, some grazing, mowed for hay		49	69	79	84
Poor condition, used for grazing		68	79	86	89
Cultivated land with conservation treatments		62	71	78	81
Cultivated land without conservation treatments		72	81	88	91
Wood or forested land					
Mature stand with good cover		25	55	70	77
Mixed specimens with average cover		36	60	73	79
Thin stand, with poor cover		45	66	77	83

3.3 Rainfall

Rainfall intensity to be used with the Rational Method shall be taken from Table 3-6.
Rainfall depths to be used with the TR-55 Method shall be taken from Table 3-7. The NRCS Type II distribution ordinates are found in Table 3-8, and shall be used only when a rainfall generator is not available in the chosen hydrologic modeling software.

Table 3-6 Rainfall Intensities (Inches/Hour) for Storm Durations

Duration	*Return Period (Years)*					
	2	5	10	25	50	100
5 Min	4.61	6.59	7.46	8.60	9.52	10.4
10 Min	3.58	5.12	5.76	6.58	7.21	7.84
15 Min	2.92	4.19	4.72	5.42	5.95	6.49
30 Min	1.93	2.87	3.28	3.83	4.25	4.69
1 Hour	1.18	1.80	2.09	2.48	2.80	3.13
2 Hour	0.690	1.06	1.23	1.48	1.69	1.92
3 Hour	0.491	0.753	0.883	1.07	1.22	1.39
6 Hour	0.297	0.456	0.535	0.650	0.747	0.853
12 Hour	0.175	0.264	0.307	0.368	0.419	0.474
24 Hour	0.106	0.159	0.185	0.221	0.251	0.283

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 3, rev 2006, for City of Bloomington, Indiana. (values for intermediate durations can be logarithmically interpolated.) (All rainfall intensities are based on Annual Maximum series)

Table 3-7 Rainfall Depths (Inches) for Various Return Periods

Duration	*Return Period (Years)*						
	1	2	5	10	25	50	100
24 Hrs.	2.56	3.07	3.83	4.44	5.31	6.04	6.81

Source: NOAA, National Weather Service, "Precipitation-Frequency Atlas of the United States", NOAA Atlas 14, Volume 2, Version 2, rev 2006, for [your location], Indiana. (Rainfall depths for 2- through 100-year storm are based on annual maximum series. 1-year rainfall depth is based on partial duration series)

Table 3-8 NRCS Type II Rainfall Distribution Ordinates

Cumulative Storm Time (hr)	*Cumulative Percent of Storm Depth*	*Cumulative Storm Time (hr)*	*Cumulative Percent of Storm Depth*	*Cumulative Storm Time (hr)*	*Cumulative Percent of Storm Depth*
0.00	0	8.25	12.6	16.50	89.3
0.25	0.2	8.50	13.3	16.75	89.8
0.50	0.5	8.75	14	17.00	90.3
0.75	0.8	9.00	14.7	17.25	90.8
1.00	1.1	9.25	15.5	17.50	91.3
1.25	1.4	9.50	16.3	17.75	91.8
1.50	1.7	9.75	17.2	18.00	92.2
1.75	2	10.00	18.1	18.25	92.6
2.00	2.3	10.25	19.1	18.50	93
2.25	2.6	10.50	20.3	18.75	93.4
2.50	2.9	10.75	21.8	19.00	93.8
2.75	3.2	11.00	23.6	19.25	94.2
3.00	3.5	11.25	25.7	19.50	94.6
3.25	3.8	11.50	28.3	19.75	95
3.50	4.1	11.75	38.7	20.00	95.3
3.75	4.4	12.00	66.3	20.25	95.6
4.00	4.8	12.25	70.7	20.50	95.9
4.25	5.2	12.50	73.5	20.75	96.2
4.50	5.6	12.75	75.8	21.00	96.5
4.75	6	13.00	77.6	21.25	96.8
5.00	6.4	13.25	79.1	21.50	97.1
5.25	6.8	13.50	80.4	21.75	97.4
5.50	7.2	13.75	81.5	22.00	97.7
5.75	7.6	14.00	82.5	22.25	98
6.00	8	14.25	83.4	22.50	98.3
6.25	8.5	14.50	84.2	22.75	98.6
6.50	9	14.75	84.9	23.00	98.9
6.75	9.5	15.00	85.6	23.25	99.2
7.00	10	15.25	86.3	23.50	99.5
7.25	10.5	15.50	86.9	23.75	99.8
7.50	11	15.75	87.5	24.00	100
7.75	11.5	16.00	88.1		
8.00	12	16.25	88.7		

Source: National Resources Conservation Service (NRCS), "TR-20 Computer Program for Project Formulation Hydrology", page F9, May 1982.

NOTE: For use only when SCS Type II rainfall distribution is not a default option in the computer program.

3.3.1 Management of Off-site Runoff

Runoff from all upstream tributary areas (off-site land areas) may be bypassed around the retention/detention facility without attenuation. Such runoff may also be routed through the detention/retention facility, provided that a separate outlet system or channel is incorporated for the safe passage of such flows, i.e., not through the primary outlet of a detention facility.

Note that the efficiency of the retention/detention facility in controlling the on-site runoff may be severely affected if the off-site area is considerably larger than the on-site area. As a general guidance, on-line detention may not be effective in controlling on-site runoff where the ratio of off-site area to on-site area is larger than 5:1. Additional detention (above and beyond that required for on-site area) may be required by *CBU* when the ratio of off-site area to on-site area is larger than 5:1.

3.3.2 Downstream Restrictions

In the event the downstream receiving channel or storm sewer system is inadequate to accommodate the post-developed release rate provided above, then the allowable release rate shall be reduced to that rate permitted by the capacity of the receiving downstream channel or storm sewer system. Additional detention, as determined by CBU, shall be required to store that portion of the runoff exceeding the capacity of the receiving sewers or waterways. When such downstream restrictions are suspected, CBU may require additional analysis to determine the receiving system's limiting downstream capacity.

If the proposed development makes up only a portion of the undeveloped watershed upstream of the limiting restriction, the allowable release rate for the development shall be in direct proportion to the ratio of its drainage area to the drainage area of the entire watershed upstream of the restriction.

At their discretion, CBU may require the applicant to improve conveyance in the downstream receiving system. The applicant would be responsible for obtaining all permits and consents required and for incurring all expenses involved in such an undertaking.

CHAPTER 4 - HYDRAULICS

4.1 Purpose

All storm sewers, whether private or public, and whether constructed on private or public property shall conform to the design standards and other requirements contained herein. Proposed storm sewer systems must be sized and designed to convey at least the 10-year frequency on-site stormwater runoff, as well as the anticipated 10-year frequency tributary off-site stormwater runoff based on the future developed condition.

An analysis of the emergency routing of stormwater runoff through the subject development must be provided to confirm that the development will not obstruct the free flow of floodwaters from the tributary off-site property in its current condition and after development.

4.2 Hydraulic Methodology

4.2.1 Determination Of Hydraulic Capacity for Storm Sewers

Determination of hydraulic capacity for storm sewers must be done using Manning's Equation where:

$$V = (1.486/n)(R^{2/3})(S^{1/2})$$

Then:

$$Q=(V)(A)$$

Where:

Q = capacity in cubic feet per second
V = mean velocity of flow in feet per second
A = cross sectional area in square feet
R = hydraulic radius in feet
S = slope of the energy grade line in feet per foot
n = Manning's "n" or roughness coefficient

The hydraulic radius, R, is defined as the cross-sectional area of flow divided by the wetted flow surface or wetted perimeter. Allowable "n" values and full-flow maximum permissible velocities for storm sewer materials are listed in Table 4-2.

Table 4-1 Typical Values of Manning's "n" and Maximum Velocities

Material	*Manning's "n"*	*Maximum Velocities (feet/second)*
Closed Conduits		
Concrete	0.013	10
Vitrified Clay	0.013	10
HDPE & Polypropylene	0.012	10
PVC	0.012	10
Corrugated Metal Pipe	0.024	7
Open Channels		
Concrete, Trowel Finish	0.013	10
Concrete, Broom Finish	0.015	10
Gunite	0.018	10
Riprap Placed	0.030	10
Riprap Dumped	0.035	10
Gabion	0.028	10
New Earth **(1)**	0.025	4
Existing Earth **(2)**	0.030	4
Dense Growth of Weeds	0.040	4
Dense Weeds and Brush	0.040	4
Swale with Grass	0.035	4

Source of manning "n" values: HERPICC Stormwater Drainage Manual, July 1995.

(1) New earth (uniform, sodded, clay soil)
(2) Existing earth (fairly uniform, with some weeds).
(3) Values assume good condition.

4.2.2 Inlet Sizing and Spacing

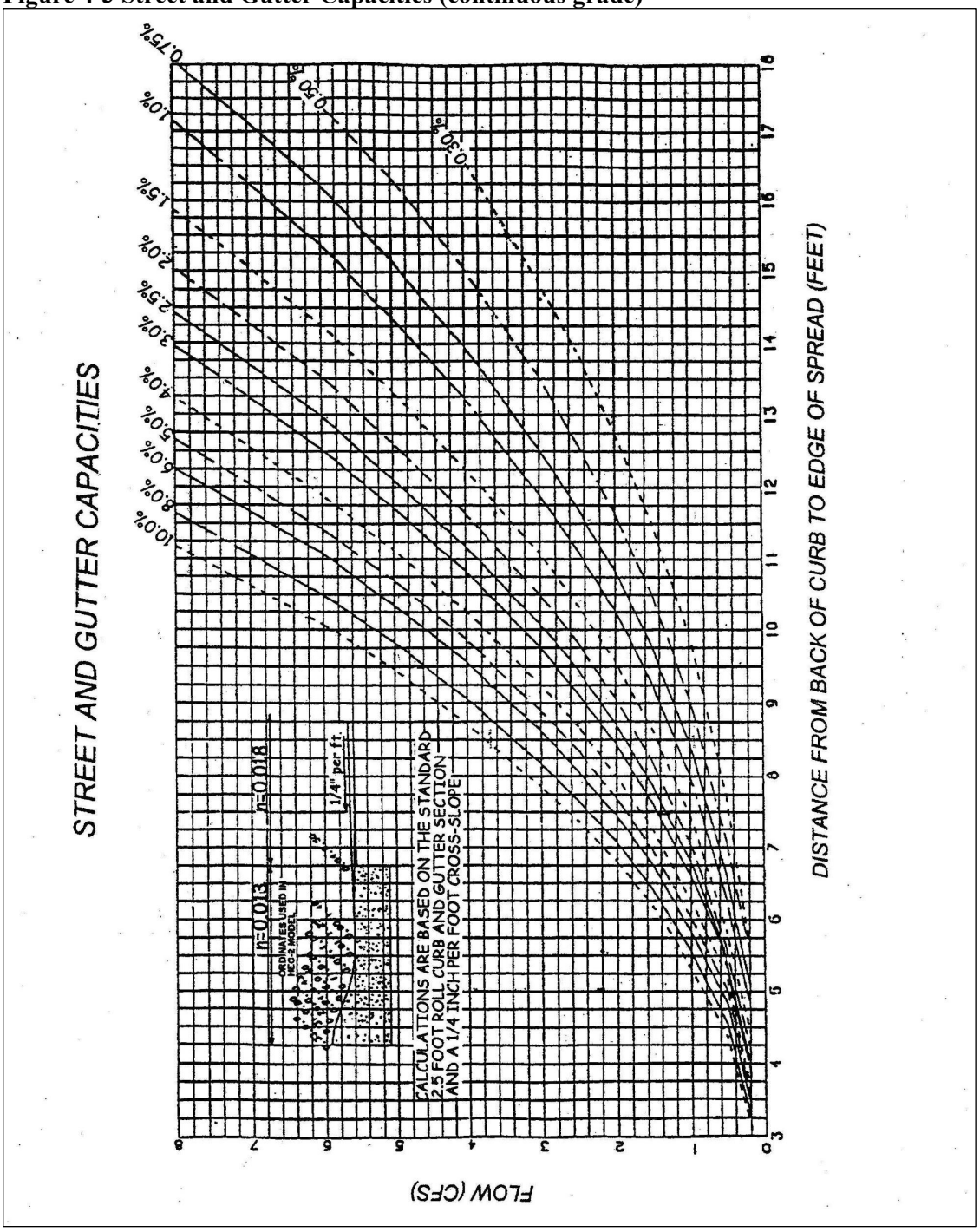
Inlets or drainage structures shall be utilized to collect surface water through grated openings and convey it to storm sewers, channels, or culverts. The inlet grate opening provided shall be adequate to pass the design 10-year flow with 50% of the sag inlet areas clogged. Inlets shall be provided so that surface water is not carried across or around any intersection nor for a distance greater than five hundred (500) feet. An overflow channel from sag inlets to the overflow channel or basin shall be provided at sag inlets. Inlet design and spacing may be done using the hydraulic equations by manufacturers' or orifice/weir equations.

CBU requires the use of an 18-inch gutter pan where curb and gutter is utilized. The minimum longitudinal slope of the gutter shall be 0.50%, unless waived by CBU.

Gutter spread on continuous grades may be determined using the Manning's equation, or by using Figure 4-3. Further guidance regarding gutter spread calculation may be found in the latest edition of LTAP Stormwater Drainage Manual, available from the Local Technical Assistance Program (LTAP). At the time of printing of this document, contact information for LTAP was:

Indiana LTAP
Purdue University
Email: inltap@ecn.purdue.edu
Website: www.purdue.edu/INLTAP/

Figure 4-3 Street and Gutter Capacities (continuous grade)



4.2.3 Pavement Encroachment

Local streets shall be designed so that one clear 8.0-foot travel lane is maintained during the 10-

year storm. Arterials and Collectors shall be designed so that runoff does not reduce the clear travel lane to less than 8.0 feet for any lane. Bicycle lanes and on street parking spaces may be fully encroached with stormwater runoff during the 10-year storm. Deviation from these requirements may be granted by City of Bloomington Engineering Department.
Roadway classifications may be found in the City of Bloomington Transportation Plan.

4.2.4 Adequate Outlet

If an adequate outlet is not located on site, then off-site drainage improvements may be required. Those improvements may include, but are not limited to, extending storm sewers, clearing, dredging and/or removal of obstructions to open drains or natural water courses, and the removal or replacement of undersized culvert pipes as required by the CBU.

4.2.5 Special Hydraulic Structures

Special hydraulic structures required to control the flow of water in storm runoff drainage systems include junction chambers, drop manholes, stilling basins, and other special structures. The use of these structures shall be limited to those locations justified by prudent planning and by careful and thorough hydraulic engineering analysis. Certification of special structures by a certified Structural Engineer may also be required.

4.2.6 Non-Gravity Flow Stormwater Systems

Stormwater facilities shall be designed to convey stormwater runoff by gravity flow unless otherwise approved by CBU. In the case that a stormwater facility, such as a lift station, is required, the developer shall coordinate with CBU.

4.3 General Hydraulic Requirements

1. The minimum design frequency refers to the design requirements that must be maintained to keep a facility serviceable. In addition to the minimum design frequency, critical structures such as buildings or bridges must be protected from flooding during larger storm events.

2. All storm sewers, inlets, catch basins, and street gutters (subject to the "allowable spread" provisions discussed later in this Section) shall accommodate, as a minimum, peak runoff from a 10-year return frequency. Storm sewers shall be designed to convey the 10-year peak flow without surcharge. Any tributary offsite areas must be considered in all design calculations.

3. Driveway culvert capacities shall be the same as required for the street classification to which the driveway connects.

4. Greater culvert capacity shall be required to protect the finished floor elevation of buildings from the post-developed 100-year frequency storm when, in the opinion of the design engineer or CBU, the finished floor elevation is threatened. If the street or road provides the only access

to or from any portion of any commercial or residential development, the crossing shall be designed for a minimum of 100-year frequency storm.

5. To ensure access to buildings and allow the use of the roadway by emergency vehicles during storms larger than the design storm, an overflow channel/swale between sag inlets and overflow paths or basin shall be provided at sag inlets so that the maximum depth of water that might be ponded in the street sag shall not exceed 7 inches measured from elevation of gutter. All water shall be contained in the right-of-way for a 100-year storm.

6. New drain tiles and pipes smaller than 24 inches in diameter shall be placed in a 20-foot easement (10 feet from centerline on each side) and shall be designated on the record plat as 20-foot Drainage Easement. Pipes that are 24 inches or larger in diameter, shall be placed in a 30-foot easement (15 feet from centerline on each side) and shall be designated on the record plat as 30-foot Drainage Easement. Wider easements may be required by the CBU or designee when the depth of pipe is greater than 6 feet.
7. Driveway approaches shall not block flow along the curb. If new developments utilize roll curb the approach should be lowered to the street level.
8. When an existing line is extended, the full segment shall be replaced with like material at the same slope and diameter as the existing.
9. When road widening occurs, existing inlets need removed and replaced at the curb line or left left in traffic paths.

4.3.1 Connections To Storm Sewer System

To allow any connections to the storm sewer system, provisions for the connections shall be shown in the drainage calculations for the system. Specific language shall be provided in the protective covenants, on the record plat, or with the parcel deed of record, noting the ability or inability of the system to accommodate any permitted connections, for example, sump pumps and footing drains.

1. **Sump pumps** installed to receive and discharge groundwater or other stormwater shall be connected to a sub-surface drain provided by the developer. Sump pumps installed to receive and discharge floor drain flow or other sanitary sewage shall be connected to the sanitary sewers. A stormwater sump pump shall only be used for the discharge of stormwater.
2. **Footing drains and perimeter drains** shall be connected to the sub-surface drain provided by the developer.
3. All **roof downspouts**, roof drains, or roof drainage piping shall not be directly connected to the storm drainage system. Variation from this requirement may be requested and granted by the CBU in special circumstances. No downspouts or roof drains shall be connected to the public sanitary sewers.
4. Commercial, industrial, and institutional buildings that have their own private storm sewers may direct such drains directly to their systems.
5. **Garage and Basement floor drains** shall not be connected to the storm sewers.

6. **Swimming Pool drains** shall not be connected to the storm sewers unless the water is dechlorinated prior to being connected to the storm sewer.
7. **INDOT Connections** shall be coordinated and approved by INDOT.

In addition, none of the above-mentioned drains shall be connected to any road sub-drain/street underdrains, unless requested as a variance and specifically authorized by the CBU.

4.3.2 Side Slopes

Side slopes of swales, overland flow and banks shall be designed to prevent erosion and promote plant growth on the slopes. The following requirements shall be followed:

1. Side-slopes shall be no steeper than 3 (horizontal) to 1 (vertical).
2. Vegetated areas steeper than 4 (horizontal) to 1 (vertical) shall be stabilized by plugs.
3. Non-vegetated side slopes such as rock riprap and concrete paving will be approved only in special circumstances. CBU reserves the right to reject proposals for non-vegetated side slopes for any reason.
4. Retaining walls shall be considered for use in open channels where side slopes exceed 1-1/2 (horizontal) to 1 (vertical). Weep holes shall be installed along all channels with paved side slopes and retaining walls to relieve hydrostatic pressure from groundwater.

4.3.3 Riprap

Riprap shall be limited to those areas at the inlet and outlet below the water surface elevation produced by the 10-year storm event. In no case will riprap be allowed as a material for the floor of the culvert. The use of riprap in open channels and on side slopes will be permitted by CBU only in the case that other stabilization methods, such as vegetation matting or geogrids, are not adequate.

4.4 Storm Sewer Requirements

4.4.1 Minimum Size for Storm Sewers

The minimum diameter of all storm sewers shall be 12 inches. When the minimum 12-inch diameter pipe will not limit the rate of release to the required amount, the rate of release for detention storage shall be controlled by an orifice plate or other device, subject to acceptance of the CBU.

4.4.2 Pipe Cover, Grade, And Separation from Sanitary Sewers

Pipe grade shall be such that, in general, a minimum of 2.0 feet of cover is maintained over the top of the pipe. If the pipe is to be placed under pavement, or within 5 feet of the pavement, then the minimum pipe cover shall be 2.5 feet from top of pavement to top of pipe. Uniform slopes shall be maintained between inlets, manholes and inlets to manholes. Final grade shall be set with full consideration of the capacity required, sedimentation problems, and other design parameters.

A minimum of 18-inches of vertical separation and 10 feet horizontal separation between storm sewers and sanitary sewers shall be required. When this is not possible, the sanitary sewer must be encased in concrete or ductile iron within 5 feet, each side, of the crossing centerline.

4.4.3 Storm Sewer Slope

Minimum and maximum allowable slopes shall be those capable of producing velocities of between 2.5 and 10 feet per second, respectively, when the sewer is flowing full. Maximum permissible velocities for various storm sewer materials are listed in Table 4-1. Alignment
Storm sewers shall be straight between manholes and/or inlets.

4.4.4 Manholes/Inlets

Manholes and/or inlets shall be installed to provide human access to continuous underground storm sewers for the purpose of inspection and maintenance. The casting access minimum inside diameter shall be no less than 22 inches or a rectangular opening of no less than 22 inches by 22 inches. Steps shall be provided in structures deeper than 4 feet, with the first step at the depth of 2 feet and the following steps spaced every 1 foot until the bottom is reached. When grade adjustments of manholes and inlets are required in the field to meet finish design or existing curb grade, adjustment rings with a maximum height of 12 inches may be used. Manholes shall be provided at the following locations:

1. Where two or more storm sewers converge.
2. Where pipe size or the pipe material changes.
3. Where a change in horizontal alignment occurs.
4. Where a change in pipe slope occurs.
5. At intervals in straight sections of sewer, not to exceed the maximum allowed. The maximum distance between storm sewer manholes shall be as shown in Table 4-2.

Table 4-2 Maximum Distance Between Manholes

Size of Pipe (Inches)	*Maximum Distance (Feet)*
12 through 42	400
48 and larger	600

Manhole/inlet inside sizing shall be according to the CBU Construction Specification for Wastewater, Water, and Storm Projects.

When changing pipe size, match crowns of pipes unless detailed modeling of hydraulic grade line shows that another arrangement would be as effective. Pipe slope shall not be so steep that inlets

surcharge (i.e. hydraulic grade line shall remain below rim elevation).

Plans shall note that all inlets castings must be pre-stamped with "Dump no waste, drains to waterways".

4.4.5 Materials, Installation and Workmanship

Materials, installation, and workmanship are specified in the CBU Construction Specifications for Wastewater, Water, and Storm Projects. (most current version). https://bloomington.in.gov/engineering/resourceshttps://bloomington.in.gov/engineering/resources

4.5 Swales and Overland Flow Requirements

4.5.1 Drainage Of Swales

All swales shall meet the following requirements and the specifications of the CBU or designee:

1. Minimum swale flow line slopes are 1%.
2. The side slopes of swales shall follow requirements set in Section 4.9.
3. Maximum swale flow line slopes are 7%.
4. All flow shall be confined to the specific easements associated with each rear and side lot swale that are part of the minor drainage system.
5. A minimum of 20 feet along the swale (10 feet from each side of the centerline) must be designated on the recorded plat as Drainage Easement.

4.5.2 Drainage System Overflow Design

The overflow path and ponding areas shall be calculated with the storm system assumed to be plugged and including all flows from any contributing drainage areas, on-site, and off-site with their proposed anticipated land use. The centerline of this 100-year overflow path shall be clearly shown as a distinctive line symbol on the plans, and a minimum width of 30 feet flow width along the centerline of the flow path (15 feet from centerline on each side) designated as permanent drainage easements.

A continuous flood route from the sag inlets to the final outfall shall be shown and the minimum 30-feet along the centerline contained within an easement or road right-of-way regardless of the 100-year storm event ponding elevation. This overflow path/easement area shall be shown on the plans as hatched area or another distinctive symbol. No fences or landscaping shall be constructed within the easement areas. These areas are easements that are to be maintained by the property owners or be designated as common areas to be maintained by the appropriate homeowner's association.

The minimum adjacent grade of the portion of any residential, commercial, or industrial building (the ground elevation next to the building after construction is completed that sits adjacent to the emergency flood route or may be subject to flooding by the emergency flood route) shall be a

minimum of 1 foot above the estimated 100-year elevation of the emergency flood route assuming that all stormwater pipes are fully clogged. The required minimum adjacent grade of buildings adjacent to an overflow path is provided in Table 4-2 or as alternatively calculated as discussed below.

Table 4-3 Minimum Building Adjacent Grade with Respect to Overflow Path Invert Elevations

Drainage Area (Acres)	*Minimum Building adjacent Grade Above Overflow Path Invert (Feet)[1]*	*Minimum Building Adjacent Grade Above Overflow Path Invert, if Overflow Path is in the Street (Feet)[1]*
Up to 5	2.50	1.50
6-10	3.00	1.50
11-15	3.25	1.75
16-20	3.50	1.75
21-30	4.00	2.00
30-50	4.25	2.00

Notes: [1] The overflow path Invert refers to the elevation of the flow line of the emergency flow route (typically in the form of a channel, swale, or gutter) nearest to the upstream end of a building

As an alternative to using default values in Table 4-3, the overflow path/ponding may be modeled as successive series of natural ponds and open channel segments. For simplification, occasional ponding along the overflow path may be ignored. The calculations for determining the 100-year overflow path/ponding elevations may be based on hand calculation methods utilizing normal depth calculations and storage routing techniques or performed by computer models.

Simply using the values in Table 4-3 is preferred over the much more complicated detailed modeling of the overflow/ponding areas. However, regardless of the methodology used, CBU reserves the right to require independent calculations to verify that the proposed building minimum adjacent grade facing the flood route or the portion of building having a potential to be subject to flooding by the flood route provide adequate freeboard above the anticipated overflow path/ponding elevations.

In case there are more than one flooding sources applicable to a building site, the highest calculated value from Table 4-3 for the building shall govern the placement of the building on that site

In the case of existing upstream detention, an allowance equivalent to the reduction in flow rate provided may be made for upstream detention only when: (1) such detention and release rate have previously been accepted by the CBU or other official charged with the approval authority at the time of the acceptance, and (2) evidence of its construction and maintenance can be shown.

4.6 Culvert Requirements

4.6.1 Culverts Minimum Diameter

The minimum diameter for culverts in public right-of-way shall be 12 inches.

4.6.2 Culvert Minimum Velocity

The minimum design flow velocity in all culverts shall be 3 ft/sec. The maximum velocity at the inlet and outlet shall be limited by the proposed and existing characteristics and conditions affected by erosion and scour.

Energy dissipaters shall be required at outfall locations that are expected to experience erosion.

4.6.3 Maximum Allowable Headwater Elevation

The maximum allowable design headwater for new culverts shall comply with the most stringent of the following:

1. Two feet below the lowest ground elevation adjacent to a permanent structure (storage sheds excluded) for a 100-year storm event.
2. 0.3 feet below the outside edge of travel lane for the design flow.
3. Net increase over existing headwater elevation of no more than 1 foot.

4.6.4 End Treatments

All pipes and culverts in open channels shall have end treatments. Acceptable treatments are summarized below:

1. Metal or Concrete Pipe End Section – To be used for all pipes 36 inches or less in diameter, when the skew of the pipe is less than 10 degrees, and when the opening is outside of the roadway clear zone.
4. Grated Box End Section – To be used for unprotected pipe ends in the roadway clear zone, when the pipe is greater than 36 inches in diameter, or when a pipe of any size is skewed more than 10 degrees.
5. Headwall – Can be used with any pipe opening located outside of the roadway clear zone in lieu of a pipe end section.

CHAPTER 5 - DETENTION REQUIREMENTS

5.1 Purpose

This chapter defines the operational and physical requirements for storage facilities that are to control runoff.

Detention facilities shall be constructed to retain and/or temporarily detain the stormwater runoff that exceeds the maximum peak release rate authorized by the Ordinance and these technical standards. The required volume of storage provided in these detention facilities, together with such storage as may be authorized in other on-site facilities, shall be sufficient to control excess runoff from the 10-year or 100-year storm as explained in Chapter 3. Also, detention facilities shall be constructed to provide adequate capacity to allow for sediment accumulation resulting from development and to permit the facilities to function for reasonable periods between cleanings.

5.2 Types of Runoff Storage Facilities

5.2.1 Storage Basins

Storage basins can be a dry bottom detention basin or wet bottom retention basin and may be incorporated with GI. A dry detention basin is designed with an outlet at an elevation such that runoff completely drains over 48 hours or less. A wet bottom retention basin is constructed to retain a permanent volume of water, to store runoff received from storm events above the normal water surface level of the basin, and to drain the volume over a period of time to return the pond to the normal water surface level. The design of storage facilities shall always account for recreational and multipurpose uses.

5.2.2 Other Types of Storage

Other methods of stormwater storage and release may be considered. Alternative types of storage may be considered including, but not limited to, underground storage, non-gravity systems, and rooftop storage. These methods may be beneficial for small watersheds with high percentages of impervious surface and where only a small percentage of the project site is available for the storage of runoff.

5.3 General Requirements for Detention

1. The design shall ensure that a minimum 90% of the original retention/detention capacity is restored within 48 hours from the end of the design 100-year storm.
2. The extents of the 100-year above-ground water surface elevation of stormwater retention/detention facilities shall be separated by not less than 25 feet from any building or structure to be occupied. The Lowest Adjacent Grade (including walkout basement floor elevation) for all residential, commercial, or industrial buildings shall be set a minimum of 2 feet above the 100-year above-ground water elevation or 2 feet above the emergency

overflow weir elevation, whichever is higher. In addition to the Lowest Adjacent Grade requirements, any basement floor must be at least a foot above the normal water level of any wet-bottom pond or the local groundwater table, whichever is higher, to avoid the overuse of sump pumps and frequent flooding of the basement.

3. Above -ground electrical facilities shall not be placed within the extents of the 100-year above-ground water elevation. Detention facilities adjacent to parking lots and roadways shall be separated by an appropriately-selected and designed method of safety barrier, such as guard rails, bollards, or other physical barriers capable of deterring the passage of a vehicle into the pond.
4. Slopes no steeper than 4 (horizontal) to 1 (vertical) shall be permitted.
5. Safety screens having a maximum opening of six (6) inches shall be provided for any pipe or opening end sections 12-inch in diameter or larger. Storm drain pipes discharging into the pond shall not be submerged.
6. Outlet control structures shall be designed to operate as simply as possible and shall require little to no maintenance for proper operation. For maintenance purposes, the outlet from the pond (if any) shall be a minimum of 0.5 foot above the normal water level of the receiving water body. They shall limit discharges into existing or planned downstream channels or conduits so as not to exceed the predetermined maximum authorized peak flow rate. If an outlet control structure includes an orifice to restrict the flow rate, such orifice shall be 6 inches in diameter at minimum.
7. Emergency overflow facilities such as a weir or spillway shall be provided for the release of exceptional storm runoff or in emergency conditions shall the normal discharge devices become totally or partially inoperative. The overflow facility shall be of such design that its operation is automatic and does not require manual attention.
8. Emergency overflow facilities shall be designed to convey the peak inflow to the basin resulting from the 100-year design storm event runoff from the entire tributary area with 1-foot of freeboard to the top of berm. Peak flow shall be developed assuming post-development condition on-site and existing condition off-site. Depth of water over the spillway (high water level in the basin) shall be determined using the broad-crested weir equation:

$$Q = 3LH^{\frac{3}{2}}$$

where;

Q = 100-year runoff (peak inflow to basin),
L = Length of weir in feet, and
H = Depth of water over spillway.

9. The emergency overflow routing from the emergency overflow facility to an adequate receiving system must be positive (by gravity) and shown on the construction plans. It must be sized to accommodate the design flow of the pond's emergency overflow weir. A minimum of thirty (30) feet width along the centerline of this emergency overflow route or the flow width required to accommodate the emergency spillway design flow, whichever is greater, shall be designated as permanent drainage easement. This emergency overflow path/easement area shall be shown on the plans as hatched area or another distinctive symbol. No fences or landscaping can be constructed within the easement areas. The

lowest adjacent grade of all residential, commercial, or industrial buildings along this emergency overflow route shall be set a minimum of 2 feet above the flood elevation along the route, calculated based on the pond's emergency overflow weir design discharge.

10. Grass or other suitable vegetative cover shall be provided along the banks of the retention/detention storage basin. Vegetative cover around detention facilities shall be maintained as appropriate.
11. Debris and trash removal and other necessary maintenance shall be performed on a regular basis to assure continued operation in conformance to design.
12. No residential lots or any part thereof shall be used for any part of a detention basin assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher. Detention basins, assumed full to the 100-year water surface elevation or the emergency overflow weir elevation, whichever is higher, shall be placed within a common area either platted or legally described and recorded as a perpetual drainage easement.
13. A minimum of twenty (20) feet horizontally from the top of bank of the facility, or the 100-year pool if no defined top of bank is present, shall be dedicated as permanent drainage easement if the above-noted boundary of the common area does not extend that far. Within this easement area, no trees shall be planted within 50 feet of any pipe outlet entering the pond or the outlet for the pond.
14. In addition, an exclusive easement to assure access to the pond from an adjacent public street/road right of way shall be required. No above-ground utilities or other obstruction that may hinder access shall be allowed within this exclusive access easement. Additional access easements may be required for larger ponds.
15. Side slopes shall be completely seeded or sodded, with a minimum of 6 inches of topsoil. Seed and sod shall be designed such that it will be capable of withstanding periodic flooding.
16. Outlets which discharge overland or to open channels shall be designed to eliminate the potential for erosion.
17. Whenever possible, the basin shall be designed to serve secondary or multipurpose functions. Recreational facilities, aesthetic qualities (open spaces) or other types of uses shall be considered in detention facility planning.
18. Landscaping shall be native vegetation. Acceptable planting species can be found in Appendix C.

5.4 Additional Requirements for Wet Bottom Basins

Where part of a detention facility will contain a permanent pool of water, all the items required for detention storage shall apply. Also, a controlled positive outlet will be required to maintain the design water level in the wet bottom facility and provide required detention storage above the design water level. However, the following additional conditions shall apply:

1. Facilities designed with permanent pools or containing permanent lakes shall have a water area of at least one-half (0.5) acre with a minimum depth of six (6) feet. The remaining pond area shall have no extensive shallow areas, except as required to install the safety

ramp, safety ledge, and BMPs as required below. Construction trash or debris shall not be placed within the permanent pool.

2. All wet detention/retention ponds must be constructed in as natural a shape (footprint) as possible and have a vegetated safety ledge (approximately 6 inches below normal pool) and/or have native vegetation planted on the pond banks to create a riparian buffer (minimum 10 feet wide). Native vegetation can be installed as container grown plants or as seed at the time of construction. If native vegetation is planted on the pond banks, signage must be provided indicating that it is a natural "Do Not Mow" area. The vegetation shall be planted in a manner so as not to hide or disguise the ponds edge. Maintenance of the vegetated barrier shall be the responsibility of the owner or the homeowners' association. All pond slopes shall follow requirements set in Section 4.24.
3. A maintenance ledge six (6) feet in width is required and shall be installed approximately 12 inches above the permanent water level and a non-vegetated safety ledge ten (10) feet in width is required and shall be installed approximately 18 inches below normal pool. The slope between the two ledges shall be stable and protected from erosion.
4. The maintenance ledge may be waived if pond side slopes above normal water are 6:1 or flatter. Retention/detention basins shall be designed with an additional ten (10) percent of available capacity to allow for sediment accumulation resulting from development and to permit the pond to function for reasonable periods between cleanings. Basins shall be designed to collect sediment and debris in specific locations, such as a forebay, so that removal costs are kept to a minimum. For wet-bottom ponds, the sediment allowance may be provided below the permanent pool elevation. No construction trash or debris shall be allowed to be placed within the permanent pool. If the pond is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the pond and elevations and grades have been reestablished as noted in the accepted plans.
5. When the allowable runoff is released in an area that is susceptible to flooding or erosion, the developer may be required to construct appropriate storm drains through such area to avert increased flood hazard caused by the concentration of allowable runoff at one point instead of the natural overland distribution. The requirement of diffused outlet drains shall be at the discretion of CBU.
6. Prior to final acceptance of construction and release of bonds, danger signs warning of deep water, possible flood conditions during storm periods, or other dangers, shall be installed at an interval of 400 feet around the perimeter of wet-bottom facilities without a vegetated safety ledge, riparian buffer, or a security fence. Maintenance of the warning signs shall be the responsibility of the owner or the homeowners' association.
7. If a retaining wall is used below the normal pool of wet detention pond, the wall shall have either steps or a ladder incorporated into the construction at the center of the wall span.
8. A safety ramp exit from the lake shall be required in all cases and shall have a minimum width of twenty (20) feet and exit slope of 6 horizontal to 1 vertical (6:1). The safety ramp shall be constructed of suitable material to prevent structural instability due to vehicles or wave action. Adequate access to the safety ramp shall be provided by locating it adjacent to public right-of-way or by providing a clear route recorded within an access easement or a common area.

9. In parks, playgrounds, and athletic fields shall be separated from all stormwater detention facilities by no less than 100 feet, measured from the extents of the 100-year pool of the pond. Trails and sidewalks shall be separated from all stormwater detention facilities by no less than 25 feet, measured from the 100-year pool of the pond.
10. Periodic maintenance is required in lakes to control weed and larval growth. The facility shall also be designed to provide for the easy removal of sediment that will accumulate during periods of reservoir operation. A means of maintaining the designed water level of the lake during prolonged periods of dry weather may also be required.
11. For maintenance purposes, the outlet of storm sewers entering the pond shall be a minimum of 0.5 foot above the normal pool level.
12. Methods to prevent pond stagnation, including but not limited to surface or sub-surface aeration or destratification facilities that can, at the minimum, achieve one complete pond volume turnover per day shall be considered
13. Design calculations to substantiate the effectiveness of proposed aeration facilities shall be submitted with final engineering plans. Design calculations shall, at a minimum, indicate that the device and/or series of devices are providing a minimum volume turnover of once per 24 hours over the majority of the pond volume (i.e. pump radius of influence calculations, etc.). Agreements for the perpetual operation and maintenance of aeration facilities by the property owner or the HOA and included in the O&M manual.
14. If the detention pond is also proposed to be for water quality, alternative means of aeration (such as diffuser aeration systems) shall be used that would not result in re-suspension of sediment particles and would not prevent the efficient settling of sediment particles.
15. If the facility is being located near an airport, a minimum horizontal separation distance between the airport property and the pond will need to be provided in accordance to Federal Aviation Administration (FAA) advisory Circular 150/5200-33, titled “Hazardous Wildlife Attractions On or Near Airports” and dated 8/28/2007, or the latest update of the same.
16. No detention facilities are allowed within FEMA regulatory floodplains.
17. Any construction in the floodway of a stream with a drainage area of one square mile or more must satisfy IDNR permit requirements.
18. Around the top of the basin, a drivable area shall be constructed with a flat embankment, minimum 10 feet in width to allow access by maintenance vehicles.
19. A 10-foot wide earthen safety ledge shall be installed within the outer periphery of the pond between 9 inches and 15 inches below the normal pool elevation. The ledge must be designed such that an individual can walk to a traversable exit point.
20. No wet bottom detention basins shall be constructed within a one-mile radius of an airport property.
21. Flow length shall be maximized between the primary inflow structure and the outflow structure. Use baffles if short-circuiting cannot be prevented with inflow-outflow placement.
22. Provide a sediment forebay or other pretreatment upstream of the inflow structure.
    a) The forebay must be sized to contain 0.1 inches of runoff per each impervious acre of contributing drainage. The forebay storage volume counts toward the total water quality storage requirements (see Chapter 6).
    b) Exit velocities from the forebay must be non-erosive.

c) Direct maintenance access for appropriate equipment must be provided to the forebay.
d) The bottom of the forebay may be hardened (e.g., using concrete, paver blocks, etc.) to make sediment removal easier.
e) A permanent vertical sediment depth measurement system must be installed in the forebay to measure sediment deposition over time. The system must be designed such that it remains intact during the forebay cleanings.

5.5 Additional Requirements For Dry-Bottom Facilities

In addition to general design requirements, retention/detention facilities that will not contain a permanent pool of water shall comply with the following requirements:

1. Provisions shall be incorporated into facilities for complete interior drainage of dry bottom facilities, including the provisions of natural grades to outlet structures (if any), longitudinal and transverse grades to perimeter drainage facility. Unless designed as a retention facility, a dual-walled 6-inch underdrain with a minimum of 1.5 feet of cover shall be provided within all dry-bottom ponds.
2. For residential developments, unless the facility is fully fenced in and gated, the maximum planned depth of stormwater stored shall not exceed four (4) feet.
3. Maximum design storage depth shall be 6 feet.
4. Around the top of the basin, a drivable area shall be constructed with a flat embankment, minimum 10 feet in width.
5. Provisions shall be incorporated to facilitate complete interior drainage and dewatering of dry bottom basins, unless the basin is constructed as green infrastructure..
6. Basins shall include minimum longitudinal grades of 1.0% to outlet structures and 2% transverse grades from perimeter areas.

5.6 Additional Requirements For Stormwater Wetland

Stormwater wetlands are artificial wetlands created for the purposes of stormwater pollutant removal and quantity control. It is the intent of CBU to encourage regional stormwater wetlands.

Prior to stormwater management plan approval, the following design and site considerations must be followed:

1. A water balance must be performed to demonstrate that a stormwater wetland could withstand a thirty-day drought at summer evaporation rates without completely drawing down. Inflow of water must be greater than that leaving the basin by infiltration or exfiltration. The following water balance equation shall be used in calculations:

$$S = Qi + R + Inf - Qo - ET$$

Where:

S = net change in storage
Q_i = stormwater runoff inflow
R = contribution from rainfall
I_{nf} = net infiltration (infiltration – exfiltration)

Q_o = surface outflow
ET = evapotranspiration

2. The wetland must be designed for an extended detention time of 48 hours for the WQv. The orifices used for extended detention will be vulnerable to blockage from plant material or other debris that will enter the basin with stormwater runoff. Therefore, some form of protection against blockage must be installed (such as some type of non-corrodible wire mesh).
3. The frequently flooded zone surrounding the wetland must be located within the permanent easement.
4. The surface area of the wetland must account for a minimum of 1 percent of the area of the watershed draining into it (1.5 percent for a shallow marsh design). The length to width ratio must be at least 2:1.
5. The design must incorporate long flow paths through the wetland, as appropriate.
6. A forebay shall be established at the pond inflow points to capture larger sediments and shall be 4 to 6 feet deep. The depth of the forebay shall contain approximately 10 percent of the total volume of the normal pool. Direct maintenance access to the forebay must be provided with access 25 feet wide minimum and 5:1 slope maximum. Permanent sediment depth markers must be provided.
7. If high water velocity is a potential problem, some type of energy dissipation device must be installed.
8. Site preparation: Soil types conducive to wetland vegetation shall be used during construction. The wetland must be designed to allow slow percolation of the runoff through the substrate (add a layer of clay for porous substrates). Ensure that the substrate, once flooded, is soft enough to permit relatively easy insertion of the plants.
9. Planting: The designer must maximize use of existing- and post-grading pondscaping design to create both horizontal and vertical diversity and habitat. A minimum of two aggressive wetland species of vegetation shall be established in quantity on the wetland. Three additional wetland species of vegetation shall be planted on the wetland, although in far less numbers than the two primary species. 30 to 50 percent of the shallow (12 inches or less) area of the basin shall be planted with wetland vegetation. The optimal depth requirements for several common species of emergent wetland plants are often six inches of water or less. Approximately 50 individuals of each secondary species must be planted per acre; set out in 10 clumps of approximately five individuals and planted within six feet of the edge of the pond in the shallow area leading up to the ponds edge; spaced as far apart as possible, but there is no need to segregate species to different areas of the wetland. Wetland mulch, if used, shall be spread over the high marsh area and adjacent wet zones (-6 to +6 inches of depth) to depths of 3 to 6 inches. A minimum 25 foot buffer, for all but pocket wetlands, must be established and planted with riparian and upland vegetation (50 foot buffer if wildlife habitat value required in design). In addition, the wetland must be located within a 40-foot wide easement. A list of wetland species indigenous to and commercially available in Indiana in Appendix C.
10. Surrounding slopes must be stabilized by planting to aid in trapping pollutants and preventing them from entering the wetland.

11. Maintain the wetland to prevent loss of area of ponded water available for emergent vegetation due to sedimentation and/or accumulation of plant material.
12. Obtain local assistance for specifications on plants to be used, planting schedule, soil requirements, mulch requirements, etc.
13. Construction debris cannot be disposed of in the facility or used as fill in the embankment.
14. If the wetland area or sediment forebay is used as a sediment control measure during active construction, the performance sureties will not be released until sediment has been cleaned out of the wetland or forebay and elevations and grades have been reestablished as noted in the approved stormwater management plan for post-construction runoff control.
15. Stormwater wetlands must be designed with the recommended proportion of depths. The four basic depths and descriptions are:
    a) Deepwater: 1.5 – 6 feet below normal pool elevation. This includes the outlet micropool and deep water channels through the wetland. This zone supports little emergent wetland vegetation but may support floating or submerged vegetation.
    b) Low marsh: 6-18 inches below normal pool elevation or water surface elevation. This zone is suitable for the growth of several emergent wetland species.
    c) High marsh: 6 inches or less below normal pool elevation. This zone will support a greater density and diversity of wetland vegetation than the low marsh. The high marsh area shall have a greater surface area to volume ratio than the low marsh area.
    d) Semi-wet zone: Areas above normal pool elevation inundated by larger storm events. This area supports vegetation that can survive periodic flooding.

5.7 Parking Lot Storage

Stormwater runoff storage in parking lots and adjacent areas shall conform to the following requirements:

1. Storage areas in parking lots shall be restricted to remote locations which cause the least inconvenience to users. Multistage storage may be considered in parking lot areas.
2. The parking lot shall be graded such that pedestrians may travel to and from their vehicles without having to walk through water more than 2 inches in depth.
3. The maximum depth of water shall be 6 inches.
4. Emergency overland flow routes shall be established for flood events which fill the storage volume.

5.8 Operation and Maintenance

General O&M requirements that apply to all BMPs is provided in chapter 2. Each detention facility must have information in the operations and maintenance plan submitted to CBU for approval and maintained and updated by the BMP owner.

1. Periodic maintenance is required in ponds, to control weed and larval growth and to control woody vegetation. A plan for maintaining water quality and the designed water level of the pond during prolonged periods of dry weather shall be maintained by the pond owner.

2. Stilling/sedimentation basins/sediment forebays shall be cleaned on at 75% capacity. This interval will vary depending upon size of basin and storm event history.
3. Facilities shall be provided, or plans shall be developed for auxiliary equipment, to permit draining of permanent pool ponds for emergency purposes, basin cleaning, or shoreline maintenance.
4. A stormwater management easement and maintenance agreement is required for each facility. The maintenance covenant must require the owner of the wetland to annually clean the facility and outlet structure. The maintenance agreement must provide for ongoing inspection and maintenance, with more intense activity for the first three years after construction. The easement must include the BMP, all outlet structures and access to the BMP. A copy of the easement shall be included in the digital copy of the BMP operations and maintenance manual.
5. The wetland must be maintained to prevent loss of area of ponded water available for emergent vegetation due to sedimentation and/or accumulation of plant material.
6. Sediment forebays must be cleaned when 50% full. Pocket wetlands without forebays must be cleaned after a six-inch accumulation of sediment.
7. The ponded water area may be maintained by raising the elevation of the water level in the permanent pond, by raising the height of the orifice in the outlet structure, or by removing accumulated solids by excavation.
8. Water levels may need to be supplemented or drained periodically until vegetation is fully established.

CHAPTER 6 - STORMWATER QUALITY REQUIREMENTS

6.1 Purpose

This chapter also sets minimum standards for design, maintenance, application, and construction of BMPs and performance criteria for stormwater quality management.

6.2 Types of Green Infrastructure

Table 6-1 describes acceptable GI practices for meeting the water quality performance standards described in Chapter 2. Note permeable pavement is not an acceptable GI practice but does aid in lowering overall runoff from the site by reducing the impervious amount.

Table 6-1 Types of Green Infrastructure

BMP Type	Description
Bioretention	A plant-filled structure that stores and infiltrates stormwater through engineered soil media.
Sand Filter (Bed Filter)	A large regional structure that uses granular media (e.g., sand, activated alumina, or proprietary media) to actively filter stormwater to remove stormwater pollutants. Filtration is controlled by the flow rate through the media and discharge via an underdrain or outlet.
Vegetated Swale (Bioswale)	A plant-filled structure that ponds, holds, and filters stormwater through a specialized soil media. It has a permeable base designed to let water soak in, reducing stormwater volume.
Filter Strip (Biofilter)	A vegetated area where stormwater flows spread naturally, with no outlet structure, using gentle slopes and dense vegetation for runoff filtration. Water treatment involves vegetation absorption and infiltration.
Green Roof	A vegetated layer on the roof of a building where rainwater is passively filtered through a specialized soil media. Effluent discharges via an underdrain. Designs vary from shallow soil layers and simple plant cover to intensive green roofs with deep soil and a more diverse plant selection.

Note: GI projects have specific requirements for geospatial data attribute tables. Please see the geospatial data template at https://bloomington.in.gov/utilities/stormwater.

6.3 General Requirements for Green Infrastructure

The following requirements apply to green infrastructure practices in this Chapter:

1. Operation and Maintenance: Green infrastructure and pre-treatment devices must be included in the O&M Manual submittal. O&M requirements must be site specific.
2. Parking Lot Drainage: Parking improvements 1500 square feet or more of new or redeveloped parking spaces shall include bioretention.
3. Utility Easement: Proposed green infrastructure not adjacent to public right-of-way shall have a Utility Easement as provided by 20.05.040(e)(4). The Utility Easement shall be a minimum of 10 feet wide with adequate room to turn around a pickup truck and provide access to key maintenance areas.
4. Horizontal Separation: GI shall be located at least 10 feet horizontally from all existing underground utilities. This distance helps prevent any interference between the GI system and the utilities, reducing the risk of damage or operational issues.
5. Vertical Separation: GI shall maintain a minimum vertical separation of 2 feet from existing utilities. This ensures that the GI and utilities operate independently without risking structural damage or service disruptions.
6. Floodplain: GI shall not be located in a floodplain.
7. Drainage Easement: Proposed green infrastructure shall be located within a Drainage Easement as provided by 20.05.040(e)(3).
8. Buffer Distance: GI (except hydrodynamic separators) shall be offset 100-feet from any water supply well and 50-feet from septic facilities
9. Impermeable Liner.: GI installed on a site with contaminated soil or treating runoff from land uses likely to increase stormwater pollutant loading shall include an impermeable liner.
10. Perforated underdrains shall have a minimum diameter of 6 inches and be dual wall. Underdrains shall be wrapped in permeable filter fabric to inhibit migration of fines from surrounding bedding.
11. Damage to GI: When GI is damaged, the standard requirement is to restore it to its original condition using original or approved materials, following a thorough assessment and coordination with CBU to ensure compliance with the SMO and this manual.

6.4 Bioretention

Bioretention GI are plant-filled structures that store and filter stormwater through a specialized soil media. It relies upon a combination of physical, chemical, and biological processes to improve effluent water quality.

6.4.1 Design Elements and Criteria

The following design elements and criteria shall be incorporated into the GI design:

1. The drainage area tributary to each bioretention feature shall be no more than 2 acres.
2. Average slope of drainage area flow path shall be no more than 6%.
3. Bioretention is considered to have a length to width ratio between 2:1 (length to width) or greater than 3:1. GI designed with a longer length to width ratio shall be considered a vegetated swale.
4. Ponding Depth: Maximum of 12-inches.
5. A filter strip of 5 feet minimum length must be provided around perimeter of bioretention feature.
6. Side Slope: Shall be 5:1 or flatter.
7. Engineered Soil (Filter Media) Cross Section
   a) Mulch 2 to 3-inch depth
8. Filter Media/planting soil minimum depth shall be 4-feet and consist of sandy loam, loamy sand or loam with the following properties
   - 85% to 88% sand
   - 8% to 12% fines
   - 3% to 5% organic matter
   - Less than 6% clay
   - pH between 5.5 and 6.5
   - Minimum infiltration rate of 0.5 inches/hour
   - Maximum soluble salt concentration of 500ppm
9. Permeable filter fabric.
10. 2-inch minimum depth AASHTO No. 8 choking course.
11. 12-inch minimum depth AASHTO No. 57 stone aggregate, clean and washed.
12. Underdrains are required unless a infiltration rate test is provided that determines the native soil infiltration to be more than 1-inch/hour.
    - Underdrains shall be installed within the No. 57 stone aggregate layer and have the following requirements:
    - 6-inch diameter perforated PVC pipe.
    - 3/8-inch perforations, spaced on 6-inch centers with a minimum of 4 holes per row.
    - Pipes shall be spaced at a maximum of 10-feet on center.
    - Minimum grade of 1%.
13. Pre-treatment: Shall be required depending on flow type entering bioretention:
    - Forebay (channel flow): Constructed for channel flow into the bioretention area. Shall be sized for the expected rate of discharge. Shall have a storage volume equivalent to at least 15% of WQv with a 2:1 length-to-width ratio. The material shall be wooden or stone check dam or an earthen or rock berm. Underlying engineered soil media is not required.
    - Gravel Diaphragms (sheet flow): A gravel diaphragm located at the edge of the pavement shall be oriented perpendicular to the flow path of impervious

runoff, with a 2 to 4 inch drop. Gravel shall not be mobilized by the expected rate of discharge.

14. Gravel Flow Spreaders (concentrated flow): A gravel flow spreader shall be located at curb cuts, downspouts, or other concentrated inflow points, and shall have a 2 to 4-inch elevation drop from impervious surface into a gravel diaphragm.
15. Overflow Structure: An overflow structure protected from erosion shall be constructed to convey the exceeded capacity of the BMP.

6.4.2 Landscaping

Landscaping is critical to the performance and function of the bioretention area.

1. Green infrastructure plantings shall be plugs.
2. Trees are not permitted in bioretention features but can be incorporated in landscaping islands and other designs beside the bioretention.
3. Use native plants, selected based upon hardiness and hydric tolerance. See Appendix C for acceptable species.
4. Trees shall not be within 10 feet of underdrains, storm structures, and pipes.

6.5 Sand Filters (Bed Filter)

Sand filters are structural stormwater controls that temporarily store stormwater and pass it through a filter bed of sand.. The filtered runoff is typically collected and returned to the conveyance system, though it can be partially or fully exfiltrated into the surrounding soil in areas with porous soils. Sand filters are primarily designed as off-line structures for stormwater quality and shall not be used for detention.

6.5.1 Design Elements and Criteria

The following design elements and criteria shall be incorporated into the BMP:

1. The drainage area of sand filters shall be no more than 10 acres.
2. Shall drain within 36 hours after the end of rainfall.
3. Maximum allowable design head of 6 feet.
4. Engineered Soil (Filter Media) Cross Section
   - Minimum depth of 18-inches sand, 0.04 inch diameter maximum.
   - A layer of permeable filter fabric shall separate the sand and aggregate layers.
   - Minimum 8-inch depth of No. 57 stone aggregate. If trenches are used for underdrains, filter fabric shall surround the trench in the trench bottom and sides.
5. Underdrains are not required when an infiltration rate test determines native soil infiltration to be more than 1-inch/hour. Underdrains shall be installed within the No. 57 stone aggregate layer and have the following requirements:
   - 6-inch diameter dual-walled pipe.
   - 3/8-inch perforations, spaced on 6-inch centers with a minimum of 4 holes per row.
   - Pipes shall be spaced at a maximum of 10-feet on center.
   - Minimum grade of 1%.

6. A pretreatment structure shall be installed and constructed so that flow is spread across the surface of filter media.
   - A presetting basin and/or biofiltration swale is recommended to pretreat runoff discharging to the sand filter.

6.5.2 Acceptable Sand Filter Variations

There are two primary sand filter system designs, the surface sand filter and the perimeter sand filter. A third variation is an underground system designed for space-limited sites.

1. **Surface Sand Filter** - The surface sand filter is a ground-level open-air structure that consists of a pretreatment sediment forebay and a filter bed chamber. This system can treat drainage areas up to 10 acres in size and is typically located off-line. Surface sand filters can be designed as an excavation with an earthen embankment or as a concrete structure.
2. **Perimeter Sand Filter** - The perimeter sand filter is an enclosed filter system typically constructed just below grade in a vault along the edge of an impervious area such as a parking lot. The system consists of a sedimentation chamber and a sand bed filter. Runoff flows into the structure through a series of inlet grates located along the top of the control.
3. **Underground Sand Filter** - The underground sand filter is intended primarily for extremely space-limited and high-density areas.

6.5.3 Maintenance

Specific O&M requirements for sand filters are listed below:

1. Sediment layer buildup shall be scraped off during dry periods using steel rakes or other devices.
2. Replace some or all of the sand when permeability of the filter media is reduced to unacceptable levels, which shall be specified in the design of the facility. A minimum infiltration rate of 0.5 inches per hour shall be used for all infiltration designs.

6.6 Vegetated Swale (Biofiltration)

Vegetated swales are designed to convey stormwater runoff and filter and trap pollutants.

6.6.1 Water Quality Volume

Credit for treatment of water quality volume will be given for the volume of infiltrated runoff calculated using Darcy's Law assuming a hydraulic conductivity value of 0.5-feet/day. The duration of infiltration shall be determined from runoff hydrograph calculations.

6.6.2 Design Requirements

The following design elements and criteria shall be followed:
1. Maximum drainage area of 5 acres.

2. Maximum longitudinal slope of 4%. Swales with longitudinal slopes exceeding 4% will be permitted for conveyance but not credited for water quality volume.
3. The maximum design flow depth is 1 foot for 100% AEP flows. A maximum ponding depth of 18 inches is permitted at the downstream end.
4. Maximum side slope of 3H:1V.
5. Bottom channel width minimum 2 feet and maximum 8 feet.
6. Minimum length of 100 feet.
7. Maximum duration of ponding 24 hours. 48 hours ponding time will be permitted with wet-tolerant vegetation.

6.7 Filter Strip (Biofilter)

Filter strips are uniformly graded and densely vegetated sections of land, designed to treat runoff and remove pollutants through vegetative filtering and infiltration.

6.7.1 Water Quality Volume

Credit for treatment of water quality volume will be given for the volume of infiltrated runoff calculated using Darcy's Law assuming a hydraulic conductivity value of 0.5-feet/day. The duration of infiltration shall be determined from runoff hydrograph calculations.

6.7.2 Design Requirements

1. The minimum length (in the direction of flow) of a filter strip are as follows:
   a) Treatment of impervious area = 20 feet
   b) Treatment of pervious area = 15 feet
   c) Buffer for bioretention = 5 feet
2. Slope (in the direction of flow) between 2% and 6%
3. Uniform sheet flow must be maintained over the filter strip. A level spreader may be designed to ensure sheet flow into strip.
4. Filter strips shall be protected from flows exceeding design capacity.

6.7.3 Level Spreader

1. Level Spreader: The grade of a level spreader shall be 0%. The channel grade for the last 20 feet of the dike or diversion entering the level spreader must be less than or equal to 1% and designed to provide a smooth transition into spreader. The depth of a level spreader as measured from the lip must be at least 6 inches. The level spreader lip must be constructed on undisturbed soil (not fill material) to uniform height and zero grade over the length of the spreader. The maximum drainage area to the level spreader shall be 10 acres or less with the optimal size being less than 5 acres. The maximum flow rate into the level spreader is 30 cfs.
2. Appropriate length, width, and depth of level spreaders shall be selected from the following table:

Table 6-2 Sizing for level spreaders

Design Flow (cfs)	*Inlet Width (ft)*	*Depth (ft)*	*End Width (ft)*	*Length (ft)*
0-10	10	0.5	3	10
10-20	16	0.6	3	20
20-30	24	0.7	3	30

3. Capacity of the level spreader shall be determined by estimating the volume of flow that is diverted to the spreader for water quality control.
4. The released runoff to the outlet shall be on undisturbed stabilized areas in sheet flow and not allowed to re-concentrate below the structure.
5. Slope of the filter strip from a level spreader must not exceed 10 percent.

6.8 Green Roofs

A green roof is a vegetated layer on the roof of a building where rainwater is passively filtered through an engineered soil media before discharging to ground level.
The design and construction of green roofs shall meet the Monroe County Building Code and applicable sections of Indiana State Building Code.This section does not replace or alter aforementioned building codes or define a singular code-compliant green roof design.

6.8.1 Water Quality Volume

Credit for treatment of water quality volume will be given for the volume of rainfall infiltrated through soil media. It may be assumed that the full depth of 1-inch rainfall over the area of the green roof will be infiltrated.

6.8.2 Design Elements and Criteria

1. Green roof assembly.
   a. A root repellent system
   b. A drainage system
   c. A growing medium
   d. Vegetation
   e. A waterproof membrane
2. Gravity Loads.
   a. Green roof gravity loads shall be calculated following the protocol provided by the ASTM standard: “ASTM E2397.05 – Standard Practice for Determination of Dead Loads and Live Loads Associated with Green Roof Systems.”
3. The density of the growing media shall be determined:
   i. In accordance with “ASTM E2399.05 – Standard Test Method for Maximum

Media Density for dead Load Analysis of Green Roof Systems", or alternatively

ii. The designer may use an un-factored, saturated density of the growing media of 125 lb/ft3

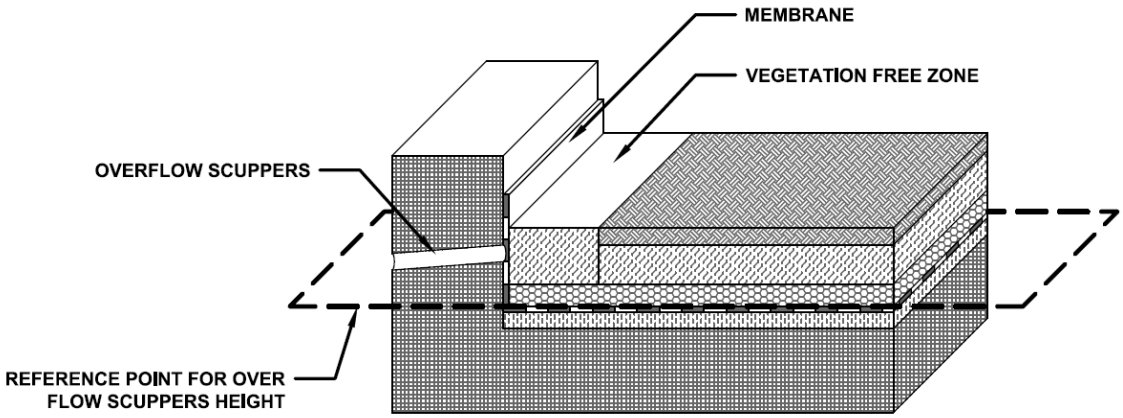
b. The applicant shall include design loads definition as part of the Stormwater Permit Application and application for building permit.

4. Slope stability
   a. All roofs with slopes in excess of 10 degrees (17%) that support green roof assemblies shall incorporate anti-shear measures.
5. Parapet height and/or overflow scupper locations
   a. Parapets and scuppers shall be specified in the design, as required, to limit retained rain water loads to within structural limits in the event of obstructed internal drains.
   b. Analysis shall be done in conformance with Monroe County Building Code..The referenced point for the overflow scuppers height must be clearly indicated to avoid the possibility of confusing the overflow scupper height as being measured above the finished green surface or other layer above the waterproofing resulting in higher water load than accounted for by the design as indicated in the sketch below.
6. Wind uplift
   a. The applicant shall provide a report, stamped by an engineer, providing wind uplift pressures being designed for (including a description of how the pressures were determined), and describing how the design addresses these pressures.
7. Fire safety
   a. Where roof penetrations, intersecting walls, parapets, upturns or mechanical equipment are clad with combustible materials the design shall include a vegetation-free zone abutting such features and the vegetation-free border shall be equal to the vegetation height at maturity but in no case be less than 3-feet.
8. Occupancy and safety
   a. The applicant shall state, in a green roof declaration form and the green roof application, the use of the roof and whether or not it will be accessible to the public.
9. Waterproofing
   a. The design and construction shall include the installation of a root barrier in all vegetated roofing systems
   b. Immediately prior to installation of the green roof, the applicant shall cause to be conducted one of the following leakage testing protocols:
      i. Flood test;
      ii. Electric field vector mapping;
      iii. Impedance test;
      iv. Infrared (IR) thermal imaging;
      v. Low voltage resting;
      vi. High voltage testing;
      vii. Moisture sensors;
   c. And a report documenting a successful test, signed by an architect or engineer, shall be provided to the Chief Building Official.
10. Drainage.

a. The design hydraulic load shall be evaluated assuming that the green roof system is fully saturated prior to the design rainfall.
b. Positive slope to drain shall be provided at the level of the waterproofing membrane.
c. The system shall permit effective drainage beneath the growth media.
d. Vegetation-free zones shall be provided around all drains.

11. Water retention.
    a. Water retention mats or equivalent materials shall be employed as required to promote vegetation growth.
    b. The drainage layer shall be appropriate for storm water retention and must be selected following "ASTM E2398-05 Standard Test Method for Water capture and Media Retention of Geo-composite Drain Layers for Green Roof Systems."
12. Vegetation performance.
    a. In order to support plant survivability:
    b. When structurally possible, the growing media shall be at a minimum depth of4-inches; or
    c. The applicant shall provide a report confirming that the engineered system as designed provides plant survivability comparable to that of an un-irrigated system with growing media at minimum depth of4-inches.
13. Plant selection
    a. Vegetation on a green roof shall not include any invasive species.
    b. The plant selection and design shall be such that within three years of the planting date the selected plants shall cover no less than 80% of the vegetated roof
    c. Compliance with the plant coverage required in the preceding sentence can be satisfied by a design that will provide one or more of the following:
        i. That seeds for groundcover plantings shall be sown at a rate not less than 30/ft2;
        ii. That cuttings shall be distributed not less than 2lb/9ft2; and
        iii. Either that pre-grown plugs shall be installed not less than 118/ft2 or a report from the designer that describes how the design fulfills this coverage requirements shall be provided with the application.
14. Irrigation.
    a. Adequate measures shall be provided to permit irrigation necessary to initiate and sustain the vegetation during the service life of the green roof.
15. Maintenance plan.
    a. The maintenance plan shall address the requirements of the specified growth media and vegetation for vegetation survival.
    b. The maintenance plan shall address re-planting, in the event that re-planting shall become necessary, and assure that complete coverage at canopy level is achieved within three growing seasons and maintained for the service life of the green roof
    c. The maintenance plan shall be submitted with the application for a permit for a

green roof.



6.9 Flow Through BMPs

Flow-through BMPs are designed to treat runoff at a calculated water quality treatment flow rate through the system. Examples of flow through BMPs include catch basin inserts, sand filters, and grassed channels. Another flow through BMP is a manufactured treatment device such as a hydrodynamic separator, manufactured infiltration chambers, or other similar type of device discussed in the Water Quality Devices Fact Sheet (https://www.in.gov/ocra/2367.htm)

6.9.1 Calculating the Required Treatment Flow Rate (Qwq)

The following procedure shall be used to estimate peak discharges for flow through BMPs (adopted from Maryland, 2000). It relies on the volume of runoff computed using the Small Storm Hydrology Method (Pitt, 1994) and utilizes the NRCS, TR-55 Method.

Using the WQv methodology, a corresponding Curve Number (CNwq) is computed utilizing the following equation:

$$CNwq = \frac{1000}{\left[10 + 5P + 10Qa - 10\sqrt{Qa^2 + 1.25QaP}\right]}$$

where:

CNwq = curve number for water quality storm event
P = 1-inch (rainfall for water quality storm event)
Qa = runoff volume, in inches = 1-inch×Rv = Rv (inches)
Rv =volumetric runoff coefficient (see previous section)

Due to the complexity of the above equation, the water quality curve number is represented as a function of percent imperviousness in Figure 6-1.

The water quality curve number, CNwq, is then used in conjunction with the standard calculated time-of-concentration, tc, and drainage area as the basis input for TR-55 calculations. Using the SCS Type II distribution for 1 inch of rainfall in 24-hours, the water quality treatment rate, Qwq, can then be calculated.

6.9.2 Selection of Manufactured Treatment Devices

Stormwater Manufactured Treatment Devices (MTD), also known as Hydrodynamic separators are proprietary, and usually include a pollutant-water separation component. The MTD shall be sized to treat flows up to, and including, the Water Quality Treatment Rate (Qwq) calculated for each project site outlet. To be acceptable, the MTD shall meet the following criteria:

- The MTD must be offline and located upstream of detention facilities (if any).
- The MTD must provide complete and unobstructed access to the entire bottom of the system from grade level, if applicable, for ease of maintenance.
- The MTD, or the treatment train (if applicable) that includes the MTD as one of its components, must have the ability to capture or skim pollutants including but not limited to: floating oils / immiscible materials.
- The MTD, or the treatment train (if applicable) that includes the MTD as one of its components, must have the ability to capture both floating and suspended solid material (trash, organic material, etc.) and other pollutants.
- The MTD shall be a manufactured system currently certified by the New Jersey Department of Environmental Protection (NJDEP). A list of NJDEP- MTDs certified for 50% and 80% TSS removal are provided in a table located at http://www.nj.gov/dep/stormwater/treatment.html.

To obtain the maximum flow rate for various models of a MTD that is listed in the NJDEP-certified list, the latest verification report from NJCAT Verification Database must be used. A link to the database is provided right above the NJDEP-certified list table.

In summary, the following steps shall be used to determine whether a proposed MTD unit is NJDEP-certified and to determine the accepted maximum flow rate for that unit.

Step 1: Determine if the MTD is NJDEP-certified for 50% treatment rate (when the MTD will be used in a treatment train) or 80% treatment rate (when the MTD will be used alone):

a) Go to http://www.nj.gov/dep/stormwater/treatment.html
b) Look up the name of the MTD in the first column of the table
c) Look up the Certified TSS Removal Rate of that MTD in the fourth column

Step 2: Determine the maximum accepted flow rate:

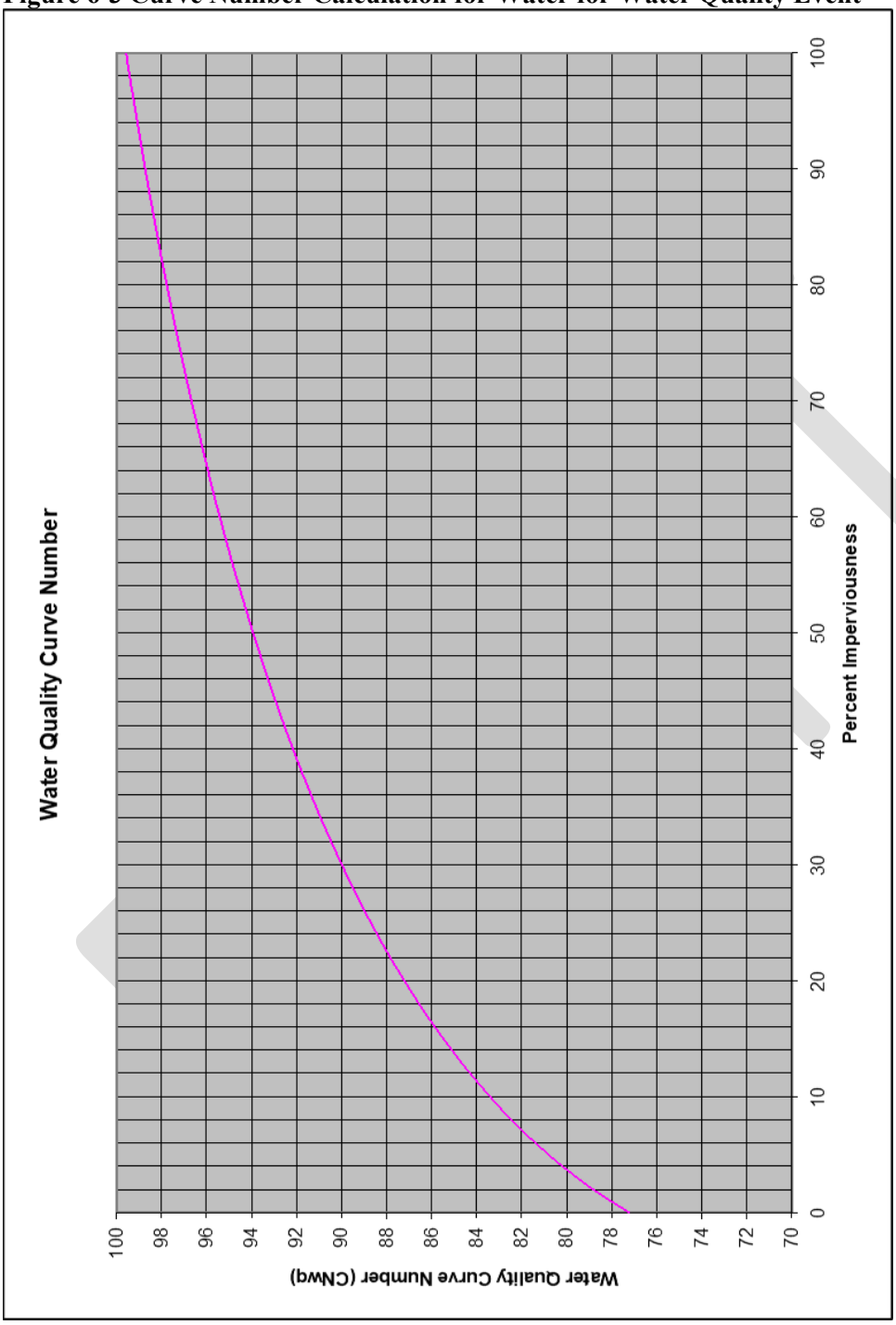
a) Click the link "Certification" in the second column of the NJDEP-certified list table referenced in Step 1. In some cases, a table of MTD model versus the NJDEP-certified maximum flow rate is included in the certification letter. In that case, skip to sub-step "g)" (below). If not continue to the sub-step "b)" (below)
b) Click the "Click here" link above the NJDEP-certified list table to access NJCAT Verification Database
c) Find the name of the MTD manufacturer of interest in first column

d) Find the latest entry (one with the latest verification date shown in third column) for that particular MTD
e) Click the report download link in the fourth column
f) Find the Table in the report (typically towards the end of the report) that lists various MTD model sizes along with the NJDEP 50% (or 80%, if appropriate) TSS Maximum Treatment Flow Rate
g) The selected model shall have a maximum flow rate that is equal or larger than the site's required treatment flow rate in the previous section.

Note that the NJDEP-certified manufactured system treatment rates for units not equipped with special filters reflect a standard certified 50% TSS reduction at the listed certified treatment flow rate. Therefore, to achieve the 80% TSS removal requirement, either a treatment train with a conventional listed in Table 8-1 (except for another MTD or a sand filter) must be used or a filtration system must be used instead in accordance with the NJDEP methodology. The treatment train shall not include more than one MTD.

Also, note that multiple inlet or units in series configurations are not accepted unless the NJCAT certification and NJDEP verification is specifically done for such an arrangement.

Figure 6-3 Curve Number Calculation for Water for Water Quality Event



APPENDIX A –

ABBREVIATIONS AND DEFINITIONS

ABBREVIATIONS

BFE	Base Flood Elevation
BMP	Best Management Practice
CFS	Cubic Feet Per Second
CLOMR	Conditional Letter of Map Revision (from FEMA)
CLOMR-F	Conditional Letter of Map Revision Based on Fill (from FEMA)
CN	Curve Number
COE	United States Army Corps of Engineers
CSMP	Comprehensive Stormwater Management Program
CSO	Combined Sewer Overflow
CWA	Clean Water Act
ERM	Elevation Reference Mark
E&SC	Erosion and Sediment Control
EPA	Environmental Protection Agency
ETJ	Extraterritorial Jurisdiction
FBFM	Flood Boundary and Floodway Map
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FPG	Flood Protection Grade

FPS	Feet Per Second
GIS	Geographical Information System
GPS	Global Positioning System
HGL	Hydraulic Grade Line
HHW	Household Hazardous Waste
HUC	Hydrologic Unit Code
IDEM	Indiana Department of Environmental Management
IDNR	Indiana Department of Natural Resources
INDOT	Indiana Department of Transportation.
LAG	Lowest Adjacent Grade
LID	Low Impact Development
LOMA	Letter of Map Amendment (from FEMA)
LOMR	Letter of Map Revision (from FEMA)
LOMR-F	Letter of Map Revision Based on Fill (from FEMA)
MCM	Minimum Control Measure
MS4	Municipal Separate Storm Sewer System
NAVD	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NGVD 1929	National Geodetic Vertical Datum of 1929
NRCS	USDA-Natural Resources Conservation Service
NPDES	National Pollutant Discharge Elimination System

NPS	Non-point source
POTW	Publicly Owned Treatment Works
SFHA	Special Flood Hazard Area
SWCD	Soil and Water Conservation District
SWPPP	Stormwater Pollution Prevention Plan
SWQMP	Stormwater Quality Management Plan
Tc	Time of Concentration
TMDL	Total Maximum Daily Load
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service

DEFINITIONS

Additional definitions are provided in the stormwater management ordinance.

Acre-Foot (AF). A measure of water volume equal to the inundation of a flat one-acre area to a depth of one foot (43,560 cubic feet).
Administering authority. The designated unit of government given the authority to issue permits.
Agricultural land disturbing activity. Tillage, planting, cultivation, or harvesting operations to produce agricultural or nursery vegetative crops. The term also includes pasture renovation and establishment, the construction of agricultural conservation practices, and the installation and maintenance of agricultural drainage tile. For purposes of this rule, the term does not include land disturbing activities for the construction of agricultural related facilities, such as barns, buildings to house livestock, roads associated with infrastructure, agricultural
Agricultural land use conservation practices. Use of land for the production of animal or plant life, including forestry, pasturing or yarding of livestock, and planting, growing, cultivating, and harvesting crops for human or livestock consumption. Practices that are constructed on agricultural land for the purposes of controlling soil erosion and sedimentation. These practices include grass waterways, sediment basins, terraces, and grade stabilization structures.
Amortization Period. The length of time used to repay a debt or mortgage or to depreciate an initial cost.
Antecedent Runoff Condition. The index of runoff potential before a storm event. The index, developed by the Soil Conservation Service (SCS), is an attempt to account for the variation of the SCS runoff curve number (CN) from storm to storm.
Backflow Preventer. Device that allows liquids to flow in only one direction in a pipe. Backflow preventers are used on sewer pipes to prevent a reverse flow during flooding situations.
Backwater. The rise in water surface elevation caused by some obstruction such as a narrow bridge opening, buildings or fill material that limits the area through which the water shall flow.
Base Flood Elevation. The water surface elevation corresponding to a flood having a one percent probability of being equaled or exceeded in a given year.
Base Flood. See "Regulatory Flood".
Base Flow. Stream discharge derived from groundwater sources as differentiated from surface runoff. Sometimes considered to include flows from regulated lakes or reservoirs.
Basement. A building story that is all or partly underground but having at least one-half of its height below the average level of the adjoining ground. A basement shall not be counted as a story for the purpose of height regulations.
Benchmark. A marked point of known elevation from which other elevations may be established.
Best Management Practice(s) (BMP). Design, construction, and maintenance practices and criteria for stormwater facilities that minimize the impact of stormwater runoff rates and volumes, prevent erosion, and capture pollutants. **Buffer Strip.** An existing, variable width strip of vegetated land intended to protect water quality and habitat.
Building. See “structure”.
Capacity (of a storm drainage facility). The maximum flow that can be conveyed or

stored by a storm drainage facility without causing damage to public or private property.

Catch Basin. A chamber usually built at the curb line of a street for the admission of surface water to a storm drain or subdrain, having at its base a sediment sump designed to retain grit and detritus below the point of overflow.

CBU. The City of Bloomington, Indiana acting through its Utilities Service Board.

Centerline of Channel. The thalweg of a channel.

Channel. A portion of a natural or artificial watercourse which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. It has a defined bed and banks which serve to confine the water.

Channel Improvement. Alteration, maintenance, or reconstruction of the channel area for the purpose of improving the channel capacity or overall drainage efficiency. The noted "improvement" does not necessarily imply water quality or habitat improvement within the channel or its adjacent area.

Channel Modification. Alteration of a channel by changing the physical dimensions or materials of its bed or banks. Channel modification includes damming, rip-rapping or other armoring, widening, deepening, straightening, relocating, lining, and significant removal of bottom or woody vegetation. Channel modification does not include the clearing of dead or dying vegetation, debris, or trash from the channel. Channelization is a severe form of channel modification typically involving relocation of the existing channel (e.g., straightening).

Channel Stabilization. Protecting the sides and bed of a channel from erosion by controlling flow velocities and flow directions using jetties, drops, or other structures and/or by fining the channel with vegetation, riprap, concrete, or other suitable lining material.

Channelized Runoff. Water runoff that would have naturally flowed over and through the soil, deflected to and moved through an artificial open channel or waterway that eventually makes its way to surface water resources.

City. The City of Bloomington, Indiana

Class V injection well. A type of well, which typically has a depth greater than its largest surface dimension, emplaces fluids into the subsurface, and does not meet the definitions of Class I through Class IV wells as defined under 40 CFR 146.5. While the term includes the specific examples described in 40 CFR 144.81, septic systems that serve more than one (1) single-family dwelling or provide service for non-domestic waste, dug wells, bored wells, improved sinkholes, french drains, infiltration sumps, and infiltration galleries, it does not include surface impoundments, trenches, or ditches that are wider than they are deep.

Closed Conduit. A pipe, tube, or tile used for transmitting water.

Combined Sewer Overflow. A system designed and used to receive and transport combined sewage so that during dry periods the wastewater is carried to a treatment facility. During storm events, the excess water is discharged directly into a river, stream, or lake without treatment.

Common Area. Any portion of a development that meets the definition listed in Section

20.07 of the BMC. Maintenance of any such area is not the responsibility of CBU.

Compensatory Storage. An artificial volume of storage within a floodplain used to balance the loss of natural flood storage capacity when artificial fill or substructures are placed within the floodplain.

Compost. Organic residue (or a mixture of organic residue and soil) that has undergone biological decomposition until it has become relatively stable humus.

Comprehensive Stormwater Management Program. A comprehensive stormwater program for effective management of stormwater quantity and quality throughout the community.

Constructed Wetland. A manmade shallow pool that creates growing conditions suitable for wetland vegetation and is designed to maximize pollutant removal.

Construction activity. Land disturbing activities, and land disturbing activities associated with the construction of infrastructure and structures. This term does not include routine ditch or road maintenance or minor landscaping projects.

Construction plan. A representation of a project site and all activities associated with the project. The plan includes the location of the project site, buildings and other infrastructure, grading activities, schedules for implementation and other pertinent information related to the project site. A storm water pollution prevention plan is a part of the construction plan.

Construction site. The same as "Project site"

Construction site access. A stabilized stone surface at all points of ingress or egress to a project site, for the purpose of capturing and detaining sediment carried by tires of vehicles or other equipment entering or exiting the project site.

Construction Sequence. The planned construction chronology by plan designers, contractors, and/or developers that describes the relationship between implementation of

stormwater quality measures in relation to land disturbance.

Construction Support Activities. Include but are not limited to the following: concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas. Such activities must not support multiple, unrelated projects, be a commercial/industrial operation, or continue to operate beyond the completion of the construction activity for the project it supports.

Contiguous. Adjoining or in actual contact with.

Contour Line. Line on a map which represents a contour or points of equal elevation.

Contour. An imaginary line on the surface of the earth connecting points of the same elevation.

Contractor or subcontractor. An individual or company hired by the project site or individual lot owner, their agent, or the individual lot operator to perform services on the project site.

Control Structure. A structure designed to control the rate of flow that passes through the structure, given a specific upstream and downstream water surface elevation.

Conveyance. Any structural method for transferring stormwater between at least two points. The term includes piping, ditches, swales, curbs, gutters, catch basins, channels, storm drains, and roadways.

Convolution. The process of translating precipitation excess into a runoff hydrograph.

Crawl Space. Low space below first floor of a house where there has not been excavation deep enough for a basement, usually less than seven (7) feet in depth, but where there is access for pipes, ducts, utilities and similar equipment.

Critical Duration Analysis. The process of testing different rainfall durations to find that "critical duration", which produces the highest peak runoff or the highest storage volume.

Cross-Section. A graph or plot of ground elevation across a stream valley or a portion of it, usually along a line perpendicular to the stream or direction of flow.

Crown of Pipe. The elevation of top of pipe.

Cubic Feet Per Second (CFS). Used to describe the amount of flow passing a given point in a stream channel. One cubic foot per second is equivalent to approximately 7.5 gallons per second.

Culvert. A closed conduit used for the conveyance of surface drainage water under a roadway, railroad, canal or other impediment.

Curve Number (CN). The Soil Conservation Service index that represents the combined hydrologic effect of soil, land use, land cover, hydrologic condition and antecedent runoff condition.

Dam. A barrier to confine or impound water for storage or diversion, to prevent gully erosion, or to retain soil, sediment, or other debris.

Damage. Measurable rise in flood heights on buildings currently subject to flooding, flooding of buildings currently not subject to flooding and increases in volume or velocity to the point where the rate of land lost to erosion and scour is substantially increased.

Datum. Any level surface to which elevations are referred, usually Mean Sea Level.

Dechlorinated swimming pool discharge. Chlorinated water that has either sat idle for seven (7) days following chlorination prior to discharge to the MS4 conveyance, or, by analysis, does not contain detectable concentrations (less than five-hundredths (0.05) milligram per liter) of chlorinated residual.

Depressional Storage Areas. Non-riverine depressions in the earth where stormwater collects. The volumes are often referred to in units of acre-feet.

Design Storm. A selected storm event, described in terms of the probability of occurring once within a given number of years, for which drainage or flood control improvements are designed and built.

Detention Basin. A facility constructed or modified to restrict the flow of storm water to a prescribed maximum rate, and to detain concurrently the excess waters that accumulate behind the outlet.

Detention Facility. A facility designed to detain a specified amount of stormwater runoff assuming a specified release rate. The volumes are often referred to in units of acre-feet.

Detention Storage. The temporary detaining of storage of stormwater in storage facilities, on rooftops, in streets, parking lots, school yards, parks, open spaces or other areas under predetermined and controlled conditions, with the rate of release regulated by appropriately installed devices.

Detention Time. The theoretical time required to displace the contents of a tank or unit at a given rate of discharge (volume divided by rate of discharge).

Detention. Managing stormwater runoff by temporary holding and controlled release.

Detritus. Dead or decaying organic matter; generally contributed to stormwater as fallen leaves and sticks or as dead aquatic organisms.

Developer. Any person financially responsible for construction activity, or an owner of property who sells or leases, or offers for sale or lease, any lots in a subdivision.

Development. Construction and site preparation work involving structures or improvements of any kind, and all land disturbing activities including, but not limited to, digging, drilling, excavating, grading, clearing, earth moving, filling, or performing any subsurface work and shall not be any more restrictive than the same definition in Section 20.07 of the BMC.

Direct Release. A method of stormwater management where runoff from a part or the entire development is released directly to the receiving stream without providing detention.

Discharge. In the context of water quantity provisions, usually the rate of water flow, i.e., a volume of fluid passing a point per unit time commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, or millions of gallons per day. In the context of water quality provisions, the discharge means any addition of liquids or solids to a water body or a flow conveyance facility.

Disposal. The discharge, deposit, injection, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land/or water so that the solid waste or hazardous waste, or any constituent of the waste, may enter the environment, be emitted into the air, or be discharged into any waters, including

Ditch. A man-made, open drainageway in or into which excess surface water or groundwater drained from land, stormwater runoff, or floodwaters flow either continuously or intermittently.

Drain. A buried slotted or perforated pipe or other conduit (subsurface drain) or a ditch (open drain) for carrying off surplus groundwater or surface water.

Drainage Area. The area draining into a stream at a given point. It may be of different sizes for surface runoff, subsurface flow and base flow, but generally the surface runoff area is considered as the drainage area.

Drainage Classification (soil). As a natural condition of the soil, drainage refers to both the frequency and duration of periods when the soil is free of saturation. Soil drainage conditions are defined as:

- *Well-drained*--Excess water drains away rapidly, and no mottling occurs within 36 inches of the surface.
- *Moderately well drained*--Water is removed from the soil somewhat slowly resulting in small but significant periods of wetness, and mottling occurs between 18 and 36 inches.
- *Poorly drained*--Water is removed so slowly that it is wet for a large part of the time, and mottling occurs between 0 and 8 inches.
- *Somewhat poorly drained*--Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time, and mottling occurs between 8 to 18 inches. *Very poorly drained*--Water is removed so slowly that the water table remains at or near the surface for the greater part of the time; there may also be periods of surface ponding; the soil has a black to gray surface layer with mottles up to the surface.

Drainage. The removal of excess surface water or groundwater from land by means of ditches or subsurface drains. Also see Natural drainage.

Drop Manhole. Manhole having a vertical drop pipe connecting the inlet pipe to the outlet pipe. The vertical drop pipe shall be located immediately outside the manhole.

Dry Well. A type of infiltration practice that allows stormwater runoff to flow directly into the ground via a bored or otherwise excavated opening in the ground surface.

Dry-Bottom Detention Basin. A basin designed to be completely dewatered after having provided its planned detention of runoff during a storm event.

Duration. The time period of a rainfall event.

Earth Embankment. A man-made deposit of soil, rock, or other material often used to form an impoundment.

Elevation Certificate. A form published by the Federal Emergency Management Agency that is used to certify the 100-year or base flood elevation and the lowest elevation of usable space to which a building has been constructed.

Elevation Reference Mark (ERM). Elevation benchmark tied to the National Geodetic Vertical Datum of 1929 and identified during the preparation of a Flood Insurance Study prepared for the Federal Emergency Management Agency.

Emergency Spillway. Usually, a vegetated earth channel used to safely convey flood discharges around an impoundment structure.

Encroachment. Any private temporary or permanent structure or landscaping element

that intrudes into an easement.

Energy Dissipater. A device to reduce the energy of flowing water.

Environment. The sum total of all the external conditions that may act upon a living organism or community to influence its development or existence.

Erosion and sediment control measure. A practice, or a combination of practices, to control erosion and resulting sedimentation. and/or off-site damages.

Erosion and sediment control system. The use of appropriate erosion and sediment control measures to minimize sedimentation by first reducing or eliminating erosion at the source and then as necessary, trapping sediment to prevent it from being discharged from or within a project site.

Erosion control plan. A written description and site plan of pertinent information concerning erosion control measures designed to meet the requirements of the Ordinance or these Standards.

Erosion. The wearing away of the land surface by water, wind, ice, gravity, or other geological agents. The following terms are used to describe different types of water erosion:

- *Accelerated erosion* -- Erosion much more rapid than normal or geologic erosion, primarily as a result of the activities of man.
- *Channel erosion* -- An erosion process whereby the volume and velocity of flow wears away the bed and/or banks of a well-defined channel.
- *Gully erosion* --An erosion process whereby runoff water accumulates in narrow channels and, over relatively short periods, removes the soil to considerable depths, ranging from 1-2 ft. to as much as 75-100 ft.
- *Rill erosion*--An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils (see Rill).
- *Splash erosion*--The spattering of small soil particles caused by the impact of raindrops on wet soils; the loosened and spattered particles may or may not be subsequently removed by surface runoff.
- *Sheet erosion*--The gradual removal of a fairly uniform layer of soil from the land surface by runoff water.

Extraterritorial Jurisdiction (ETJ). Areas located outside the corporate limits of a community over which the community has statutory development authority.

Farm or Field Tile. A pipe installed in an agricultural area to allow subsurface drainage of farmland for the purpose of agricultural production.

FEMA. The Federal Emergency Management Agency.

Filter Strip. Usually a long, relatively narrow area (usually, 20-75 feet wide) of undisturbed or planted vegetation used near disturbed or impervious surfaces to filter stormwater pollutants for the protection of watercourses, reservoirs, or adjacent properties.

Final stabilization. The establishment of permanent vegetative cover or the application of a permanent non-erosive material to areas where all land disturbing activities have been completed and no additional land disturbing activities are planned under the current permit.

Floatable. Any solid waste that will float on the surface of the water.

Flood (or Flood Waters). A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow, the unusual and rapid accumulation, or the runoff of surface waters from any source.

Flood Boundary and Floodway Map (FBFM). A map prepared by the Federal Emergency Management Agency the depicts the FEMA designated floodways within a community. This map also includes delineation of the 100-year and 500-year floodplain boundaries and the location of the Flood Insurance Study cross-sections.

Flood Crest. The maximum stage or elevation reached or expected to be reached by the waters of a specific flood at a given time.

Flood Duration. The length of time a stream is above flood stage or overflowing its banks.

Flood Easement. Easement granted to identify areas inundated by the 100-year flood and prohibit or severely restrict development activities.

Flood Elevation. The elevation at all locations delineating the maximum level of high waters for a flood of given return period.

Flood Fighting. Actions taken immediately before or during a flood to protect human life and to reduce flood damages such as evacuation, emergency sandbagging and diking.

Flood Forecasting. The process of predicting the occurrence, magnitude and duration of an imminent flood through meteorological and hydrological observations and analysis.

Flood Frequency. A statistical expression of the average time period between floods equaling or exceeding a given magnitude. For example, a 100-year flood has a magnitude expected to be equaled or exceeded on the average of once every hundred years; such a flood has a one-percent chance of being equaled or exceeded in any given year. Often used interchangeably with "recurrence interval".

Flood Hazard Area. Any floodplain, floodway, floodway fringe, or any combination thereof which is subject to inundation by the regulatory flood; or any flood plain as delineated by Zone X on a Flood Hazard Boundary Map.

Flood Hazard Boundary Map (FHBM). A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas as a Zone A within a community. There are no study text, base flood elevations, or floodways associated with this map.

Flood Insurance Rate Map (FIRM). A map prepared by the Federal Emergency Management Agency that depicts Special Flood Hazard Areas within a community. This map also includes the 100-year or Base Flood Elevation at various locations along the watercourses. More recent versions of the FIMR may also show the FEMA designated floodway boundaries and the location of the Flood Insurance Study cross-sections.

Flood Insurance Study (FIS). A study prepared by the Federal Emergency Management agency to assist a community participating in the National Flood Insurance Program in its application of the program regulations. The study consists of a text which contains community background information with respect to flooding, a floodway data table, summary of flood discharges, flood profiles, a Flood Insurance Rate Map, and a Flood Boundary and Floodway Map.

Flood Profile. A graph showing the relationship of water surface elevation to a specific location, the latter generally expressed as distance above the mouth of a stream of water flowing in a channel. It is generally drawn to show surface elevation for the crest or a specific magnitude of flooding, but may be prepared for conditions at any given time or stage.

Flood Protection Grade (FPG). The elevation of the regulatory or 100-year flood plus two (2) feet of freeboard if the flooding source is a lake, pond, stream, or an open channel/ditch (or 1 foot of freeboard if the flooding source is an overflow path/ponding area provided that the elevation of the overflow path/ponding area is calculated based on the assumption of fully plugged storm pipe system).

Flood Resistant Construction (Flood Proofing). Additions, changes or adjustments to structures or property that are designed to reduce or eliminate the potential for flood damage.

Flood Storage Areas. Depressions, basins, or other areas that normally stand empty or partially empty, but fill with rainfall runoff during storms to hold the runoff and reduce downstream flow rates. The volumes are often referred to in units or acre-feet.

Floodplain Management. The operation of a program of corrective and preventive measures for reducing flood damage, including but not limited to flood control projects, floodplain land use regulations, flood proofing of buildings, and emergency preparedness plans.

Floodplain Regulations. General term applied to the full range of codes, ordinances and other regulations relating to the use of land and construction within floodplain limits. The term encompasses zoning ordinances, subdivision regulations, building and housing codes, encroachment laws and open area (space) regulations.

Floodplain. The channel proper and the areas adjoining the channel which have been or hereafter may be covered by the regulatory or 100-year flood. Any normally dry land area that is susceptible to being inundated by water from any natural source. The floodplain includes both the floodway and the floodway fringe districts.

Floodway Fringe. That portion of the flood plain lying outside the floodway, which is inundated by the regulatory flood.

Floodway. The channel of a river or stream and those portions of the floodplains adjoining the channel which are reasonably required to efficiently carry and discharge the peak flow of the regulatory flood of any river or stream.

Footing Drain. A drain pipe installed around the exterior of a basement wall foundation to relieve water pressure caused by high groundwater elevation.

Forebay (or Sediment Forebay). A small pond placed in front of a larger retention/detention structure such as a wet pond, dry pond, or wetland to intercept and concentrate a majority of sediment that is coming into the system before it reaches the larger structure.

Freeboard. An increment of height added to the base flood elevation to provide a factor of safety for uncertainties in calculations, unknown local conditions, wave actions and unpredictable effects such as those caused by ice or debris jams. (See Flood Protection Grade).

French Drain. A drainage trench backfilled with a coarse, water-transmitting material; may contain a perforated pipe.

Gabion. An erosion control structure consisting of a wire cage or cages filled with rocks.

Garbage. All putrescible animal solid, vegetable solid, and semisolid wastes resulting from the processing, handling, preparation, cooking, serving, or consumption of food or food materials.

Gasoline Outlet. An operating gasoline or diesel fueling facility whose primary function

is the resale of fuels.

Geographical Information System. A computer system capable of assembling, storing, manipulation, and displaying geographically referenced information. This technology can be used for resource management and development planning.

Geotextile Fabric. A woven or non-woven, water-permeable synthetic material used to trap sediment particles, prevent the clogging of aggregates with fine grained soil particles, or as a separator under road aggregate.

Geotextile Liner. A synthetic, impermeable fabric used to seal impoundments against leaks.

Global Positioning System. A system that provides specially coded satellite signals that is processed by a receiver, which determines position, velocity, and time. The system is funded and controlled by the U.S. Department of Defense.

Grade. (1) The inclination or slope of a channel, canal, conduit, etc., or natural ground surface usually expressed in terms of the percentage the vertical rise (or fall) bears to the corresponding horizontal distance. (2) The finished surface of a canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared to a design elevation for the support of construction, such as paving or the laying of a conduit. (3) To finish the surface of a canal bed, roadbed, top of embankment, or bottom of excavation, or other land area to a smooth, even condition.

Grading. The cutting and filling of the land surface to a desired slope or elevation.

Grass. A member of the botanical family Graminae, characterized by blade-like leaves that originate as a sheath wrapped around the stem.

Grassed swale. A type of vegetative practice used to filter stormwater runoff via a vegetated, shallow-channel conveyance.

Grassed Waterway. A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses and used to conduct surface water from an area.

Green Infrastructure. The range of measures that use plant or soil systems or other permeable surfaces or substrates, stormwater harvest and reuse, or landscaping to store, infiltrate, or evapotranspirate stormwater and reduce flows to sewer systems or to surface waters.

Green Infrastructure Fund. An account held by CBU which project owners may pay into, with the authorization of CBU, in lieu of constructing green infrastructure. The fund will be used to finance detention and water quality projects at CBU's discretion.

Ground Cover (horticulture). Low-growing, spreading plants useful for low-maintenance landscape areas.

Groundwater Recharge. The infiltration of water into the earth. It may increase the total amount of water stored underground or only replenish supplies depleted through pumping or natural discharge.

Groundwater. Accumulation of underground water, natural or artificial. The term does not include

Habitat. The environment in which the life needs of a plant or animal are supplied.

Hard Surface. See "Impervious Surface."

Hazardous Materials. A substance or material that has been determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has been so designated. This includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials or any item or chemical which can cause harm to

people, plants, or animals when exposed by spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping.

High Water. Maximum designed permitted, or regulated water level for an impoundment.

Highly Erodible Soil. Soil that has an erodibility index of eight or more using the erodibility index.

Household Hazardous Waste. Solid waste generated by households that is ignitable, toxic, reactive, corrosive, or otherwise poses a threat to human health or the environment.
Hydraulic Grade Line (HGL). For Channel flow, the HGL is equal to the water surface whereas for pressure flow it is the piezometric surface.
Hydraulics. A branch of science that deals with the practical application of the mechanics of water movement. A typical hydraulic study is undertaken to calculate water surface elevations.
Hydrodynamic Loads. Forces imposed on structures by floodwaters due to the impact of moving water on the upstream side of the structure, drag along its sides, and eddies or negative pressures on its downstream side.
Hydrograph. For a given point on a stream, drainage basin, or a lake, a graph showing either the discharge, stage (depth), velocity, or volume of water with respect to time.
Hydrologic Unit Code. A numeric United States Geologic Survey code that corresponds to a watershed area. Each area also has a text description associated with the numeric code.
Hydrology. The science of the behavior of water in the atmosphere, on the surface of the earth, and underground. A typical hydrologic study is undertaken to compute flow rates associated with specified flood events.
Hydrometeorologic. Water-related meteorological data such as rainfall or runoff.
Hydrostatic Loads. Those loads or pressures resulting from the static mass of water at any point of floodwater contact with a structure. They are equal in all direction and always act perpendicular to the surface on which they are applied. Hydrostatic loads can act vertically on structural members such as floors, decks and roofs, and can act laterally on upright structural members such as walls, piers, and foundations.
IDEM. Indiana Department of Environmental Management.
IDNR. Indiana Department of Natural Resources.
Illicit Discharge. Any discharge to a conveyance that is not composed entirely of stormwater except naturally occurring floatables, such as leaves or tree limbs.
Impact Areas. Areas defined or mapped that are unlikely to be easily drained because of one or more factors including but not limited to any of the following: soil type, topography, land where there is not adequate outlet, a floodway or floodplain, land within 75 feet of each bank of any regulated drain or within 75 feet from the centerline of any regulated tile ditch.
Impaired Waters. Waters that do not or are not expected to meet applicable water quality standards, as included on IDEM's CWA Section 303(d) List of Impaired Waters.
Impervious surface. Surfaces, such as pavement and rooftops, which prevent the infiltration of stormwater into the soil.
Individual building lot. A single parcel of land within a multi-parcel development.
Individual lot operator. A contractor or subcontractor working on an individual lot.
Individual lot owner. A person who has financial control of construction activities for an individual lot.
INDOT. Indiana Department of Transportation. Generally used here to refer to specifications contained in the publication "INDOT Standard Specifications."
Infiltration practices. Any structural BMP designed to facilitate the percolation of run-off through the soil to ground water. Examples include infiltration basins or trenches, dry wells, and porous pavement.

Infiltration. Passage or movement of water into the soil.
Infiltration Swales. A depressed earthen area that is designed to promote infiltration.
Inlet. An opening into a storm drain system for the entrance of surface storm water runoff, more completely described as a storm drain inlet.
Intermittent Stream. A stream which carries water a considerable portion of the time, but which ceases to flow occasionally or seasonally because bed seepage and evapotranspiration exceed the available water supply.
Invert. The inside bottom of a culvert or other conduit.
Junction Chamber. A converging section of conduit, usually large enough for a person to enter, used to facilitate the flow from one or more conduits into a main conduit.
Land Surveyor. A person licensed under the laws of the State of Indiana to practice land surveying.
Land-disturbing Activity. Any man-made change of the land surface, including removing vegetative cover that exposes the underlying soil, excavating, filling, transporting and grading.
Larger common plan of development or sale. A plan, undertaken by a single project site owner or a group of project site owners acting in concert, to offer lots for sale or lease; where such land is contiguous, or is known, designated, purchased or advertised as a common unit or by a common name, such land shall be presumed as being offered for sale or lease as part of a larger common plan. The term also includes phased or other construction activity by a single entity for its own use.
Lateral Storm Sewer. A drain that has inlets connected to it but has no other storm drain connected.
Life Cycle Cost. Cost based on the total cost incurred over the system life including research, development, testing, production, construction, operation, and maintenance. Costs are normally determined on present worth or equivalent annual cost basis.
Low Entry Elevation. The elevation in a structure where overbank flooding can enter the structure.
Lowest Adjacent Grade. The elevation of the lowest grade adjacent to a structure, where the soil meets the foundation around the outside of the structure (including structural members such as basement walkout, patios, decks, porches, support posts or piers, and rim of the window well.
Lowest Floor. Refers to the lowest of the following:

1. The top of the basement floor;
2. The top of the garage floor, if the garage is the lowest level of the building;
3. The top of the first floor of buildings constructed on a slab or of buildings elevated on pilings or constructed on a crawl space with permanent openings; or
4. The top of the floor level of any enclosure below an elevated building where the walls of the enclosure provide any resistance to the flow of flood waters unless:

a] The walls are designed to automatically equalize the hydrostatic flood forces on the walls by allowing for the entry and exit of flood waters, by providing a minimum of two opening (in addition to doorways and windows) having a total area of one (1) square foot for every two (2) square feet of enclosed area subject to flooding. The bottom of all such openings shall be no higher than one (1) foot above grade.
b] Such enclosed space shall be usable only for the parking of vehicles or building access.

Low Impact Development. LID is a land planning and engineering design approach with a goal of replicating the pre-development hydrologic regime of urban and developing watersheds. The primary goal of LID is to mimic a site's predevelopment hydrology by reducing the impervious surface, infiltrating, filtering, storing, evaporating, and detaining runoff close to its source.

Major Drainage System. Drainage system carrying runoff from an area of one or more square miles.

Manhole. Storm drain structure through which a person may enter to gain access to an underground storm drain or enclosed structure.

Manning Roughness Coefficient or Manning's "n" Value. A dimensionless coefficient ("n") used in the Manning's equation to account for channel wall frictional losses in steady uniform flow.

Measurable storm event. A precipitation event that results in a total measured precipitation accumulation equal to, or greater than, one-half (0.5) inch of rainfall.

Minimum Control Measure. Minimum measures required by the NPDES Phase II program. The six (6) MCMs are: Public education and outreach, Public participation and involvement, Illicit discharge detection and elimination, Construction site runoff control, Post-construction runoff control, and Pollution prevention and good housekeeping.

Minor Drainage Systems. Drainage system carrying runoff from an area of less than one square mile.

Minor Subdivision. See Subdivision, Minor.

Mulch. A natural or artificial layer of plant residue or other materials covering the land surface which conserves moisture, holds soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.

Multi-Family. Any structure which contains three or more dwelling units. A dwelling unit is any structure, or part of a structure, which is constructed to a house a family.

Municipal Separate Storm Sewers. An MS4 meets all the following criteria: (1) is a conveyance or system of conveyances owned by the state, county, City, or other public entity; (2) discharges to waters of the U.S.; (3) is designed or used for collecting or conveying stormwater; (4) is not a combined sewer; and, (5) is not part of a Publicly Owned Treatment Works (POTW).

Municipal, state, federal, or institutional refueling area. An operating gasoline or diesel fueling area whose primary function is to provide fuel to either municipal, state, federal, or institutional equipment or vehicles.

Mutual Drain. A drain that: (1) Is located on two or more tracts of land that are under different ownership; (2) was established by the mutual consent of all the owners; and (3) was not established under or made subject to any drainage statute.

National Flood Insurance Program (NFIP). The NFIP is a federal program enabling property owners to purchase flood insurance. The Federal Emergency Management Agency administers the NFIP in communities throughout the Unites States. The NFIP is based on an agreement between local communities and the Federal government which states that if a community will implement floodplain management measures to reduce future flood risks to new construction and substantially improved structures in flood hazard areas, the Federal government will make flood insurance available within the community as a financial protection against flood losses that do occur.

National Geodetic Vertical Datum of 1929. The nationwide, Federal Elevation datum used to reference topographic elevations to a known value.
National Pollution Discharge Elimination System (NPDES). A permit developed by the U.S. EPA through the Clean Water Act. In Indiana, the permitting process has been delegated to IDEM. This permit covers aspects of municipal stormwater quality.
Natural Drainage. The flow patterns of stormwater run-off over the land in its pre-development state.
Nonagricultural land use. Commercial use of land for the manufacturing and wholesale or retail sale of goods or services, residential or institutional use of land intended primarily to shelter people, highway use of land including lanes, alleys, and streets, and other land uses not included in agricultural land use.
Nonpoint Source Pollution. Pollution that enters a water body from diffuse origins on the watershed and does not result from discernable, confined, or discrete conveyances.
Normal Depth. Depth of flow in an open conduit during uniform flow for the given conditions.
North American Vertical Datum of 1988 (NAVD 1988). The nationwide, Federal Elevation datum used to reference topographic elevations to a known value.
Nutrient(s). (1) A substance necessary for the growth and reproduction of organisms. (2) In water, those substances (chiefly nitrates and phosphates) that promote growth of algae and bacteria.
Off-site. Everything not located at or within a particular site.
Off-site Land Areas. Those areas that by virtue of existing topography naturally shed surface water onto or through the developing property.
100-Year Frequency Flood. See "regulatory flood".
On-Site. Located within the controlled or urbanized area where runoff originates.
Open Drain. A natural watercourse or constructed open channel that conveys drainage water.
Open Space. Any land area devoid of any disturbed or impervious surfaces created by industrial, commercial, residential, agricultural, or other manmade activities.
Orifice. A device which controls the rate of flow from a detention basin.
Outfall scouring. The deterioration of a streambed or lakebed from an outfall discharge to an extent that the excessive settling of solid material results and suitable aquatic habitat is diminished.
Outfall. The point, location, or structure where a pipe or open drain discharges to a receiving body of water.
Outlet. The point of water disposal from a stream, river, lake, tidewater, or artificial drain.
Overland Flow. Consists of sheet flow, shallow concentrated flow and channel flow.
Peak Discharge (or Peak Flow). The maximum instantaneous flow from a given storm condition at a specific location.
Percolation. The movement of water through soil.
Perennial Stream. A stream that maintains water in its channel throughout the year.
Permanent stabilization. The establishment, at a uniform density of seventy percent (70%) across the disturbed area, of vegetative cover or permanent non-erosive material that will ensure the resistance of the soil to erosion, sliding, or other movement.
Permeability (soil). The quality of a soil that enables water or air to move through it. Usually expressed in inches per hour or inches per day.
Person. Any individual, partnership, copartnership, firm, company, corporation,

association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns. This definition includes all federal, state, and local governmental entities.

Pervious. Allowing movement of water.

Pesticides. Chemical compounds used for the control of undesirable plants, animals, or insects. The term includes insecticides, herbicides, algicides, rodenticides, nematicides, fungicides, and growth regulators.

pH. A numerical measure of hydrogen ion activity, the neutral point being 7.0. All pH values below 7.0 are acid, and all above 7.0 are alkaline.

Phasing of construction. Sequential development of smaller portions of a large project site, stabilizing each portion before beginning land disturbance on subsequent portions, to minimize exposure of disturbed land to erosion.

Phosphorus (available). Inorganic phosphorus that is readily available for plant growth.

Piping. The formation of "pipes" by underground erosion. Water in the soil carries the fine soil particles away, and a series of eroded tubes or tunnels develop. These openings will grow progressively larger and can cause a dam failure.

Planimetric Data. Horizontal measurements involving distances or dimensions on a diagram, map, Plat of Survey or topographic map. Normally in units of feet.

Plat of Survey. A scaled diagram showing boundaries of a tract of land/or subdivision. This may constitute a legal description of the land and be used in lieu of a written description.

Point Source. Any discernible, confined, and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, or container from which pollutants are or maybe discharged (P.L. 92-500, Section 502[14]).

Pollutant. Dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, munitions, medical wastes, chemical wastes, dissolved and particulate metals, floatables, pesticides, herbicides, fertilizers, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, municipal, agricultural and industrial wastes, animal waste, and certain characteristics of wastewater (e.g., pH, temperature,

TSS, turbidity, color, BOD, COD, toxicity, or odor).

Pollutant of concern. Any pollutant that has been documented via analytical data as a cause of impairment in any waterbody.

Porosity. The volume of pore space in soil or rock.

Porous pavement. A type of infiltration practice to improve the quality and reduce the quantity of storm water run-off via the use of manmade, pervious pavement which allows run-off to percolate through the pavement and into underlying soils

Private Drain. A drain that: (1) Is located on land owned by one person or by two or more persons jointly; and (2) was not established under or made subject to any drainage statute.

Professional Engineer. A person licensed under the laws of the State of Indiana to practice professional engineering.

Programmatic Indicator. Any data collected by an MS4 entity that is used to indicate implementation of one (1) or more minimum control measures.

Project site. The entire area on which construction activity is to be performed.

Project site owner. The person required to submit a stormwater permit application and required to comply with the terms of the ordinance or these Technical Standards, including a developer or a person who has financial and operational control of construction activities, and project plans and specifications, including the ability to make modifications to those plans and specifications.

Probable Maximum Flood. The most severe flood that may be expected from a combination of the most critical meteorological and hydrological conditions that are reasonably possible in the drainage basin. It is used in designing high-risk flood protection works and citing of structures and facilities that shall be subject to almost no risk of flooding. The probable maximum flood is usually much larger than the 100-year flood.

Publicly Owned Treatment Works (POTW). A municipal operation that breaks down and removes contaminants in the wastewater prior to discharging to a stream through primary and/or secondary treatment systems.

Qualified professional. An individual who is trained and experienced in storm water treatment techniques and related fields as may be demonstrated by state registration, professional certification, experience, or completion of coursework that enable the individual to make sound, professional judgments regarding storm water control or treatment and monitoring, pollutant fate and transport, and drainage planning.

Radius of Curvature. Length of radius of a circle used to define a curve.

Rain garden. A vegetative practice used to alter impervious surfaces, such as roofs, into pervious surfaces for absorption and treatment of rainfall.

Rainfall Intensity. The rate at which rain is falling at any given instant, usually expressed in inches per hour.

Reach. Any length of river, channel or storm drain.

Receiving Stream or Receiving Water. The body of water into which runoff or effluent is discharged. The term does not include private drains, unnamed conveyances, retention and detention basins, or constructed wetlands used as treatment.

Recharge. Replenishment of groundwater reservoirs by infiltration and transmission from the outcrop of an aquifer or from permeable soils.

Recurrence Interval. A statistical expression of the average time between floods equaling or exceeding a given magnitude.

Redevelopment. Alterations of a property that change a site or building in such a way that there is disturbances of one (1) acre or more of land. The term does not include such activities as exterior remodeling.

Refueling Area. An operating gasoline or diesel fueling area whose primary function is to provide fuel to equipment or vehicles.

Regional Detention. Stormwater storage with a controlled release rate that is provided for a specific watershed and benefits multiple sites and/or rights–of-way areas.

Regional Pond. A detention/retention basin sized to detain/retain the runoff from the entire watershed, on-site and off-site, tributary to the pond's outlet.

Regulated Area. Area under the stormwater regulatory jurisdiction of the *CBU*.

Regulated Drain. A drain subject to the provisions of the Indiana Drainage Code, I.C.-36-9-27.

Regulatory or 100-Year Flood. The discharge or elevation associated with the 100-year flood as calculated by a method and procedure which is acceptable to and approved by the Indiana Department of Natural Resources and the Federal Emergency Management Agency. The "regulatory flood" is also known as the "base flood".

Regulatory Floodway. See Floodway.

Release Rate - The amount of storm water release from a storm water control facility per unit of time.

Reservoir. A natural or artificially created pond, lake or other space used for storage, regulation or control of water. May be either permanent or temporary. The term is also used in the hydrologic modeling of storage facilities.

Responsible Party. Any person who is the property owner, has possessory interest in the

property, and/or any person who has caused a violation.

Retail gasoline outlet. An operating gasoline or diesel fueling facility whose primary function is the resale of fuels. The term applies to facilities that create five thousand (5,000) or more square feet of impervious surfaces, or generate an average daily traffic count of one hundred (100) vehicles per one thousand (1,000) square feet of land area.

Retention basin. A type of storage practice, that has no positive outlet, used to retain storm water run-off for an indefinite amount of time. Runoff from this type of basin is removed only by infiltration through a porous bottom or by evaporation.

Retention. The storage of stormwater to prevent it from leaving the development site. May be temporary or permanent.

Retention Facility. A facility designed to completely retain a specified amount of stormwater runoff without release except by means of evaporation, infiltration or pumping. The volumes are often referred to in units of acre-feet.

Return Period - The average interval of time within which a given rainfall event will be equaled or exceeded once. A flood having a return period of 100 years has a one percent probability of being equaled or exceeded in any one year.

Revetment. Facing of stone or other material, either permanent or temporary, placed along the edge of a stream to stabilize the bank and protect it from the erosive action of the stream. Also see Revetment riprap.

Right-of-Way for a County Drain. The statutory right of way as defined by Indiana Code for a regulated drain.

Riparian habitat. A land area adjacent to a waterbody that supports animal and plant life associated with that waterbody.

Riparian zone. Of, on, or pertaining to the banks of a stream, river, or pond.

Riprap. Broken rock, cobble, or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream, for protection against the action of water (waves). Revetment riprap is material graded such that: (1) no individual piece weighs more than 120 lbs. and (2) 90-100% will pass through a 12-inch sieve, 20-60% through a 6-inch sieve, and not more than 10% through a 12-inch sieve.

River Restoration. Restoring the channel of a stream or ditch to its perceived original, non-obstructed capacity by means of clearing & snagging, obstruction removal, and inexpensive streambank protection measures. The term "restoration", as noted, does not necessarily imply restoration or improvement of water quality or habitat within the channel or its adjacent area.

Riverine. Relating to, formed by, or resembling a stream (including creeks and rivers).

Runoff Coefficient - A decimal fraction relating the amount of rain which appears as runoff and reaches the storm drain system to the total amount of rain falling. A coefficient of 0.5 implies that 50 percent of the rain falling on a given surface appears as storm water runoff.

Runoff. That portion of precipitation that flows from a drainage area on the land surface, in open channels, or in stormwater conveyance systems.

Sand. (1) Soil particles between 0.05 and 2.0 mm in diameter. (2) A soil textural class inclusive of all soils that are at least 70% sand and 15% or less clay.

Sanitary Backup. The condition where a sanitary sewer reaches capacity and surcharges into the lowest area.

Scour. The clearing and digging action of flowing water.
Sediment. Solid material (both mineral and organic) that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity, or ice and has come to rest on the earth's surface.
Sediment Forebay. See "Forebay".
Sedimentation. The process that deposits soils, debris and other unconsolidated materials either on the ground surfaces or in bodies of water or watercourses.
Seepage. The passage of water or other fluid through a porous medium, such as the passage of water through an earth embankment or masonry wall.
Sensitive Area. An area with highly erodible soils, wetlands, threatened or endangered species habitat, outstanding waters, impaired waters, recreational waters, and surface drinking water sources. Includes waterbodies in need of priority protection or remediation based on its:
(1) Providing habitat for threatened or endangered species.
(2) Usage as a public water supply intake.
(3) Relevant community value.
(4) Usage for full body contact recreation.
(5) Limited use and outstanding State resource water classification as found in 327 IAC. 2-1-11

and 327 IAC. 2-1.5-19.

Sensitive Water. A water body in need of priority protection or remediation base on its:

- providing habitat for threatened or endangered species,
- usage as a public water supply intake,
- relevant community value,
- usage for full body contact recreation,

exceptional use classification as found in 327 IAC 2-1-11(b), outstanding state resource water classification as found in 327 IAC 2-1-2(3) and 327 IAC 2-1.5-19(b).

Settling Basin. An enlargement in the channel of a stream to permit the settling of debris carried in suspension.

Silt Fence. A fence constructed of wood or steel supports and either natural (e.g. burlap) or synthetic fabric stretched across area of non-concentrated flow during site development to trap and retain on-site sediment due to rainfall runoff.

Silt. (1) Soil fraction consisting of particles between 0.002 and 0.05 mm in diameter. (2) A soil textural class indicating more than 80% silt.

Siphon - A closed conduit or portion of which lies above the hydraulic grade line, resulting in a pressure less than atmospheric and requiring a vacuum within the conduit to start flow. A siphon utilizes atmospheric pressure to effect or increase the flow of water through a conduit. An inverted siphon is used to carry storm water flow under an obstruction such as a sanitary sewer.

Site. The entire area included in the legal description of the land on which land disturbing activity is to be performed.

Silvicultural. the practice of controlling the establishment, growth, composition, health, and quality of forests to meet diverse needs and values.

1. Nonpoint activities include source silvicultural activities such as nursery operations, site preparation, reforestation and subsequent cultural treatment, thinning, prescribed burning, pest and fire control, harvesting operations, surface drainage, or road construction and maintenance from which there is natural runoff. Some of these activities (such as stream crossing for roads) may involve the placement of dredged or fill material which may require a CWA section 404 permit and a 401 Water Quality Certification.
2. Point source activities include any discernible, confined and discrete conveyance related to rock crushing, gravel washing, log sorting, or log storage facilities which are operated in connection with silvicultural activities and from which pollutants are discharged into waters of the United States or the State.

Slope. Degree of deviation of a surface from the horizontal, measured as a numerical ratio or percent. Expressed as a ratio, the first number is commonly the horizontal distance (run) and the second is the vertical distance (rise)--e.g., 2:1. However, the preferred method for designation of slopes is to clearly identify the horizontal (H) and vertical (V) components (length (L) and Width (W) components for horizontal angles). Also note that according to international standards (Metric), the slopes are presented as the vertical or width component shown on the numerator--e.g., 1V:2H. Slope expressions in the Ordinance or these Technical Standards follow the common presentation of slopes--e.g., 2:1 with the metric presentation shown in parenthesis--e.g., (1V:2H). Slopes can also be expressed in "percent". Slopes given in percent are always expressed as (100*V/H) --e.g., a 2:1 (1V:2H) slope is a 50% slope.

Soil and Water Conservation District. A public organization created under state law as a special-purpose district to develop and carry out a program of soil, water, and related resource conservation, use, and development within its boundaries. A subdivision of state government with a local governing body, established under IC 14-32.
Soil. The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
Solid Waste. Any garbage, refuse, debris, or other discarded material.
Special Flood Hazard Area. An area that is inundated during the 100-Year flood.
Spill. The unexpected, unintended, abnormal, or unapproved dumping, leakage, drainage, seepage, discharge, or other loss of petroleum, hazardous substances, extremely hazardous substances, or objectionable substances. The term does not include releases to impervious surfaces when the substance does not migrate off the surface or penetrate the surface and enter the soil.
Spillway - A waterway in or about a hydraulic structure, for the escape of excess water.
Standard Project Flood. A term used by the U.S. Army Corps of Engineers to designate a flood that may be expected from the most severe combination of meteorological and hydrological conditions that are considered reasonable characteristics of the geographical area in which the drainage basin is located, excluding extremely rare combinations. The peak flow for a standard project flood is generally 40 – 60 percent of the probable maximum flood for the same location.
Stilling Basin - A basin used to slow water down or dissipate its energy.
Storage practices. Any structural BMP intended to store or detain stormwater and slowly release it to receiving waters or drainage systems. The term includes detention and retention basins.
Storm drain signing. Any marking procedure that identifies a storm sewer inlet as draining directly to a receiving waterbody so as to avoid dumping pollutants. The procedures can include painted or cast messages and adhesive decals.
Storm Duration. The length of time that water may be stored in any stormwater control facility, computed from the time water first begins to be stored.
Storm Event. An estimate of the expected amount of precipitation within a given period of time. For example, a 10-yr. frequency, 24-hr. duration storm event is a storm that has a 10% probability of occurring in any one year. Precipitation is measured over a 24-hr. period.
Storm Frequency. The time interval between major storms of predetermined intensity and volumes of runoff--e.g., a 5-yr., 10-yr. or 20-yr. storm.
Storm Sewer. A closed conduit for conveying collected storm water, while excluding sewage and industrial wastes. Also called a storm drain.
Stormwater. Water resulting from rain, melting or melted snow, hail, or sleet.
Stormwater Drainage System - All means, natural or man-made, used for conducting storm water to, through or from a drainage area to any of the following: conduits and appurtenant features, canals, channels, ditches, storage facilities, swales, streams, culverts, streets and pumping stations.
Stormwater Facility. All ditches, channels, conduits, levees, ponds, natural and manmade impoundments, wetlands, tiles, swales, sewers and other natural or artificial means of draining surface and subsurface water from land.
Stormwater Pollution Prevention Plan. A plan developed to minimize the impact of storm water pollutants resulting from construction activities.

Stormwater Quality Management Plan. A comprehensive written document that addresses stormwater runoff quality.
Stormwater Quality Measure. A practice, or a combination of practices, to control or minimize pollutants associated with storm water runoff.
Stormwater runoff. The water derived from rains falling within a tributary basin, flowing over the surface of the ground or collected in channels or conduits.
Stormwater. Water resulting from rain, melting or melted snow, hail, or sleet.
Stream Gauging. The quantitative determination of streamflow using gauges, current meters, weirs, or other measuring instruments at selected locations (see Gauging station').
Stream Length. The length of a stream or ditch, expressed in miles, from the confluence of the stream or ditch with the receiving stream to the upstream extremity of the stream or ditch, as indicated by the solid or dashed, blue or purple line depicting the stream or ditch on the most current edition of the seven and one-half (72) minute topographic quadrangle map published by the United States Geological Survey, measured along the meanders of the stream or ditch as depicted on the map.
Stream. See intermittent stream, Perennial stream, Receiving stream.
Streambanks. The usual boundaries (not the flood boundaries) of a stream channel. Right and left banks are named facing downstream.
Strip development. A multi-lot project where building lots front on an existing road.
Structure. Refers to a structure that is principally above ground and is enclosed by walls and a roof. The term includes but is not limited to, a gas or liquid storage tank, a manufactured home or a prefabricated building, and recreational vehicles to be installed on a site for more than 180 days.
Structural Engineer. A person licensed under the laws of the State of Indiana to engage in the designing or supervising of construction, enlargement or alteration of structures or any part thereof.
Structural Floodplain. Management Measures. Those physical or engineering measures employed to modify the way foods behave, (e.g., dams, dikes, levees, channel enlargements and diversions).
Subarea/Sub-basin. Portion of a watershed divided into homogenous drainage units which can be modeled for purposes of determining runoff rates. The subareas/sub-basins have distinct boundaries, as defined by the topography of the area.
Subdivision. Any land that is divided or proposed to be divided into lots, whether contiguous or subject to zoning requirements, for the purpose of sale or lease as part of a larger common plan of development or sale.
Subdivision, Minor. The subdivision of a parent parcel into any combination of not more than three (3) contiguous or non-contiguous new residential, commercial, or industrial building sites. The parcel shall front upon an existing street which is an improved right-of-way maintained byt eh County or other governmental entity and not involve any new street.
Subsoil. The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below which roots do not normally grow.
Subsurface Drain. A pervious backfield trench, usually containing stone and perforated pipe, for intercepting groundwater or seepage.
Subwatershed. A watershed subdivision of unspecified size that forms a convenient natural unit. See also Subarea.

Sump Failure. A failure of the sump pump that results in inundation of crawl space or basement.
Sump Pump. A pump that discharges seepage from foundation footing drains.
Surcharge. Backup of water in a sanitary or storm sewer system in excess of the design capacity of the system.
Surface Runoff. Precipitation that flows onto the surfaces of roofs, streets, the ground, etc., and is not absorbed or retained by that surface but collects and runs off.
Suspended Solids. Solids either floating or suspended in water.
Swale. An elongated depression in the land surface that is at least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and may provide some groundwater recharge.
SWCD. Soil and Water Conservation District
Tailwater. The water surface elevation at the downstream side of a hydraulic structure (i.e. culvert, bridge, weir, dam, etc.).
Temporary Stabilization. The covering of soil to ensure its resistance to erosion, sliding, or other movement. The term includes vegetative cover, anchored mulch, or other non-erosive material applied at a uniform density of seventy percent (70%) across the disturbed area.
Thalweg. The deepest point (or centerline) of a channel.
Tile Drain. Pipe made of perforated plastic, burned clay, concrete, or similar material, laid to a designed grade and depth, to collect and carry excess water from the soil.
Tile Drainage. Land drainage by means of a series of tile lines laid at a specified depth, grade, and spacing.
Time of Concentration (tc). The travel time of a particle of water from the most hydraulically remote point in the contributing area to the point under study. This can be considered the sum of an overland flow time and times of travel in street gutters, storm sewers, drainage channels, and all other drainage ways.
Topographic Map. Graphical portrayal of the topographic features of a land area, showing both the horizontal distances between the features and their elevations above a given datum.
Topography. The representation of a portion of the earth's surface showing natural and man-made features of a give locality such as rivers, streams, ditches, lakes, roads, buildings and most importantly, variations in ground elevations for the terrain of the area.
Topsoil. (1) The dark-colored surface layer, or a horizon, of a soil; when present it ranges in depth from a fraction of an inch to 2-3 ft. (2) Equivalent to the plow layer of cultivated soils. (3) Commonly used to refer to the surface layer(s), enriched in organic matter and having textural and structural characteristics favorable for plant growth.
Total Maximum Daily Load. Method used to establish allowable loadings for specified pollutants in a surface water resource to meet established water quality standards.
Toxicity. The characteristic of being poisonous or harmful to plant or animal life. The relative degree or severity of this characteristic.
TP-40 Rainfall. Design storm rainfall depth data for various durations published by the National Weather Service in their Technical Paper 40 dated 1961.

Trained individual. An individual who is trained and experienced in the principles of storm water quality, including erosion and sediment control as may be demonstrated by state registration, professional certification (such as CESSWI and/or CPESC certification), or other documented and applicable experience or coursework as deemed sufficient by the *CBU* that enable the individual to make judgments regarding storm water control or treatment and monitoring.

Transition Section. Reaches of the stream of floodway where water flows from a narrow cross-section to a wide cross-section or vice-versa.

Treatment Train. A series of stormwater measures designed to maximize the removal of

stormwater pollutants or control the volume of stormwater.
Tributary. Based on the size of the contributing drainage area, a smaller watercourse which flows into a larger watercourse.
Turbidity. (1) Cloudiness of a liquid, caused by suspended solids. (2) A measure of the suspended solids in a liquid.
Underdrain. A small diameter perforated pipe that allows the bottom of a detention basin, channel or swale to drain.
Unified Soil Classification System. A system of classifying soils that is based on their identification according to particle size, gradation, plasticity index, and liquid limit.
Uniform Flow. A state of steady flow when the mean velocity and cross-sectional area remain constant in all sections of a reach.
Unit Hydrograph. A unit hydrograph is the hydrograph that results from one inch of precipitation excess generated uniformly over the watershed at a uniform rate during a specified period of time.
Urban Drain. A drain defined as "Urban Drain" in Indiana Drainage Code.
Urbanization. The development, change or improvement of any parcel of land consisting of one or more lots for residential, commercial, industrial, institutional, recreational or public utility purposes.
Vegetative practices. Any nonstructural or structural BMP that, with optimal design and good soil conditions, utilizes various forms of vegetation to enhance pollutant removal, maintain and improve natural site hydrology, promote healthier habitats, and increase aesthetic appeal. Examples include grass swales, filter strips, buffer strips, constructed wetlands, and rain gardens.
Vegetative Stabilization. Protection of erodible or sediment producing areas with: permanent seeding (producing long-term vegetative cover), short-term seeding (producing temporary vegetative cover), or sodding (producing areas covered with a turf of perennial sod-forming grass).
Water Course. Any river, stream, creek, brook, branch, natural or man-made drainage way in or into which stormwater runoff or floodwaters flow either regularly or intermittently.
Water Quality. A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Resources. The supply of groundwater and surface water in a given area.
Water Table. (1) The free surface of the groundwater. (2) That surface subject to atmospheric pressure under the ground, generally rising and failing with the season or from other conditions such as water withdrawal.
Waterbody. Any accumulation of water, surface, or underground, natural or artificial.
Watercourse. Any river, stream, creek, brook, branch, natural or man-made drainageway in or into which stormwater runoff or floodwaters flow either continuously or intermittently.
Watershed Area. All land and water within the confines of a drainage divide. See also Watershed.
Watershed. The region drained by or contributing water to a specific point that could be along a stream, lake or other stormwater facilities. Watersheds are often broken down into subareas for the purpose of hydrologic modeling.
Waterway. A naturally existing or manmade open conduit or channel utilized for the conveyance of water.
Weir. A channel-spanning structure for measuring or regulating the flow of water.

Wellhead protection area. Has the meaning set forth at 327 IAC 8-4.1-1(27).
Wet-Bottom Detention Basin (Retention Basin) - A basin designed to retain a permanent pool of water after having provided its planned detention of runoff during a storm event.
Wetlands. Areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

APPENDIX B –

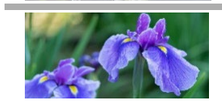
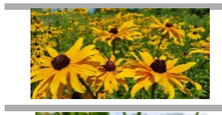
GREEN INFRASTRUCTURE DETAILS

Note: The development of green infrastructure details is currently ongoing. Developers are invited to request sample details or engage in discussions regarding potential green infrastructure configurations with the City of Bloomington Utilities (CBU).

APPENDIX C –

PREFERRED SPECIES LIST

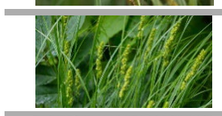
Green Infrastructure Plant List

	Common Name *Latin Name*	Soil Moisture Wet / Moist / Dry	Salt Tolerance	Sun Exposure Sun / Shade	Plant Height	Plant Width	Bloom Period	Plant Type	Flower Color	Notes
	**Common Milkweed** *Asclepias syriaca*	Dry	Medium	Sun	3-5 ft	1-2 ft	June-Aug	B		Rhizomatous. Can be aggressive.
	**Butterfly Milkweed** *Asclepias tuberosa*	Dry	None	Sun	1-3 ft	1-2 ft	June- Aug	B		Avoid soils that hold moisture in all seasons to prevent rot. The crown must be planted low enough or will frost heave and winter kill.
	**Heath Aster** *Aster ericoides*	Dry	Medium	Sun	1-3 ft	2-3 ft	Sept-Oct	B		Rhizomatous. Tolerates alkaline soils.
	**New England Aster** *Aster novae-angliae*	Moist	Medium	Sun	3-5 ft	1-3 ft	Sept-Oct	A		Rhizomatous. Can become aggressive. Older leaves yellow and drop as plant matures. Tends to get powdery mildew.
	**Purple Coneflower** *Echinacea purpurea*	Moist	Medium	Sun	3-4 ft	1 ft	June-Aug	B		Prefers moist soils.
	**Common Boneset** *Eupatorium perfoliatum*	Wet	Medium	Sun	2-4 ft	1-2 ft	July-Sept	A		Prefers organic soils. Tolerates temporary inundation.
	**Blue Flag Iris** *Iris virginica shrevei*	Wet	Medium	Sun	2-4 ft	1-2 ft	May-July	A		Less flowering in partial shade and dry conditions. Rhizomatous. Slow vegetative spread.
	**Marsh Blazing** *Star Liatris spicata*	Wet	Medium	Sun	3-5 ft	.5 ft	July-Aug	A		Corm can be divided. Drought tolerant. Excessive shading will cause the flower stems to fall over. Prefers moist soils.
	**Great Blue Lobelia** *Lobelia siphilitica*	Wet	Medium	Sun	1-3 ft	.5-1 ft	Aug-Sept	A		Plant size and vigor varies based on soil nutrients.
	**Monkeyflower** *Mimulus ringens*	Wet	Medium	Sun	2-5 ft	.5-1 ft	July-Sept	A		Rhizomatous. Slow vegetative spread. Plant size varies based on soil fertility.
	**Black-Eyed Susan** *Rudbeckia hirta*	Moist	Medium	Sun	1-2 ft	.5 ft	June-July	B		Rhizomatous.
	**Common Arrowhead** *Sagittaria latifolia*	Wet	Medium	Sun	1-3 ft	1-2 ft	July-Sept	A		Rhizomatous. Can become aggressive. Tolerates highly alkaline soils.
	**Grass-Leaved Goldenrod** *Solidago graminifolia*	Wet	Medium	Sun	3-4 ft	1-2 ft	Sept-Oct	A		Prefers organic soils. Dought tolerant. Can become aggressive.
	**Grey Goldenrod** *Solidago nemoralis*	Dry	Medium	Sun	1-2 ft	1 ft	Aug-Oct	B		Drough tolerant. Tolerates nutrient poor soils.

Green Infrastructure Plant List

	Common Name *Latin Name*	Soil Moisture Wet / Moist / Dry	Salt Tolerance	Sun Exposure Sun / Shade	Plant Height	Plant Width	Bloom Period	Plant Type	Flower Color	Notes
	**Stiff Goldenrod** *Solidago rigida*	Moist / Dry	Medium	Sun	3-4 ft	1-2 ft	Aug-Oct	B		Aggressive by seed.
	**Ohio Spiderwort** *Tradescantia ohienis*	Moist / Dry	Medium	Sun	2-4 ft	1-2 ft	May-July	B		Foliage dies back to ground after flowering. Flowers open only on cloudy days and sunny mornings.
	**Hoary Vervain** *Verbana stricta*	Wet / Moist	Medium	Sun	2-5 ft	.5-1 ft	June-Aug	A		Drought tolerant. Tolerates nutrient poor soils. Plant size and vigor varies based on soil nutrients.
	**Cardinal Flower** *Lobelia cardinalis*	Moist	Medium	Sun / Shade	1-2 ft	.5 ft	Aug-Sept	A		Short lived. Plant size and vigor varies based on soil nutrients.
	**Blue False Indigo** *Baptisia australis*	Moist / Dry	Medium	Sun / Shade	3-5 ft	3-4 ft	May-June	B		Nitrogen fixing legume. Drought tolerant. Tolerantes nutrient poor soils. Intolerant of alkaline soils.
	**White False Indigo** *Baptisia leucantha*	Moist / Dry	Medium	Sun	4-6 ft	3-4 ft	June-July	B		Nitrogen fixing legume. Slow to mature. Drought tolerant. Tolerates nutrient poor soils. Intolerant of alkaline soils.
	**Sawtooth Sunflower** *Helianthus grosseserratus*	Moist	Medium	Sun	1-3 ft	1-2 ft	Aug-Sept	A		Rhizomatous. Can become aggressive. Prefers moist organic soils.
	**Savanna Blazing Star** *Liatris scariosa nieuwlandii*	Moist / Dry	Low	Sun / Shade	2-3 ft	.5 ft	July-Aug	A		Nitrogen fixing legume. Drought tolerant. Tolerates nutrient poor soils.
	**Wild Lupine** *Lupinus perennis*	Dry	Medium	Sun / Shade	1-2 ft	1-2 ft	April-May	B		Nitrogen fixing legume. Slow to mature. Drought tolerant. Tolerates nutrient poor soils. Intolerant of alkaline soils.
	**Hairy Wild Petunia** *Ruellia humilis*	Moist / Dry		Sun / Shade	1.5-2ft	1.5-2 ft	May-Oct	A		Drought tolerant.

Green Infrastructure Plant List

	Common Name *Latin Name*	Soil Moisture Wet / Moist / Dry	Salt Tolerance	Sun Exposure Sun / Shade	Plant Height	Plant Width	Bloom Period	Plant Type	Flower Texture	Notes
	**Emory's Sedge** *Carex emoryi*	Wet, Moist	Medium	Sun	2-3 ft	2-3 ft	April-May	C	Fine	Rhizomatous and aggressive. Tolerates flowing water. Tolerates alkaline soils.
	**Frank's Sedge** *Carex frankii*	Moist	Medium	Sun / Shade	1-2 ft	1-2 ft	June-July	C	Coarse	Rhizomatous. Moderate vegetative growth. Spreads aggressively by seed.
	**Porcupine Sedge** *Carex hystericina*	Moist	Medium	Sun	1-2 ft	1-2 ft	May-June	C	Medium	Rhizomatous. Slow vegetative growth once established. Requires fertile soils.
	**Lakebank Sedge** *Carex lacustris*	Moist	Medium	Sun / Shade	2-4 ft	2-4 ft	April-May	C	Coarse	Rhizomatous and aggressive.
	**Fox Sedge** *Carex vulpinoidea*	Moist	Medium	Sun	1-2 ft	1-2 ft	May-July	C	Fine	Bunch type sedge. Can be aggressive with low competition from other plants.
	**Yellow Fox Sedge** *Carex annectens var xanthocarpa*	Wet, Moist	Medium	Sun	1-2 ft	1-2 ft	May-June	C	Fine	Bunch type sedge. Can be aggressive with little competition.