KALAMAZOO COUNTY
DRAIN COMMISSIONER

SITE DEVELOPMENT RULES

Procedures and Design Standards for Storm Water Management

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LETTER OF INTENT

KALAMAZOO COUNTY DRAIN COMMISSIONER
PURSUANT TO SECTION 105
OF ACT 288 OF PUBLIC ACTS
OF MICHIGAN OF 1967

The Land Division Act, formerly known as the Subdivision Control Act (Act 288 of the Public Acts of Michigan of 1967, as amended by Act 591 of the Public Acts of 1996), requires the County Drain Commissioner to publish rules governing the internal drainage of proposed subdivisions and outlets for drainage. The rules are intended to assist land developers by providing uniform procedures to be followed in the processing of preliminary and final plats, construction drawings, and establishment of county drains and their branches within and without of these subdivisions.

A resolution acknowledging and recognizing the Kalamazoo County Drain Commissioner Site Development Rules, promulgated and published by the Kalamazoo County Drain Commissioner, and to authorize the fee schedule set forth therein pursuant to the authority granted in the Land Division Act, was adapted by the Kalamazoo County Board of Commissioners on September 30, 2004.

IT IS HEREBY ORDERED that the Kalamazoo County Drain Commissioner Site Development Rules, promulgated pursuant to Section 105 of Act 288 of the Public Acts of Michigan of 1967, as amended by Act 591 of the Public Acts of 1996, are hereby adopted and shall be followed in the processing of all subdivision plats, and all other land developments (such as condominiums, planned unit developments, manufactured housing communities, and other residential, commercial, industrial, or institutional developments) which impact established county or intercounty drains under the jurisdiction of the Kalamazoo County Drain Commissioner pursuant to the Michigan Drain Code (Act 40 of the Public Acts of 1956, as amended), or for which the Kalamazoo County Drain Commissioner provides support to other state, county, or local reviewing agencies.

IT IS HEREBY FURTHER ORDERED that the effective dates of the following rules shall be the 1st day of October, 2011.

Patricia A.S. Crowley, Ph.D.
Kalamazoo County Drain Commissioner

ABBREVIATIONS

A. Acronyms

ASTM – American Society for Testing and Materials
BMP – Best Management Practice
CAD – Computer Aided Design
CN – Curve Number
ET - Evapotranspiration
GASB – Governmental Accounting Standards Board
HSG – Hydrologic Soil Group
LID – Low Impact Development
MDNR – Michigan Department of Natural Resources
MDOT – Michigan Department of Transportation
MS4 – Municipal Separate Storm Sewer System
NAISC – North American Industry Classification System
NAVD 88 – North American Vertical Datum of 1988
NPDES – National Pollutant Discharge Elimination System
NRCS – Natural Resource Conservation Service
PA – Public Act
SEMCOG – Southeast Michigan Council of Governments
SESC – Soil Erosion and Sedimentation Control
SWPPI – Storm Water Pollution Prevention Initiative
TMDL – Total Maximum Daily Load
TR-55 – Technical Release 55
TSS – Total Suspended Solids
USDA – United States Department of Agriculture
US EPA – United States Environmental Protection Agency
USGS – United States Geological Survey

B. Units

′ – feet
″ – inches
cfs – cubic feet per second
mg/L – milligrams per liter

DEFINITIONS

Drain Commissioner: The Drain Commissioner of the County of Kalamazoo, State of Michigan.

Engineer: The engineer appointed by the Drain Commissioner to review the drainage of a plat or any other land development.

Proprietor: Any person, landowner, firm, association, partnership, corporation, or combination of any of them, who submits a site plan for drainage review (may also be referred to as the Developer).

Health Department: The Kalamazoo County Health and Community Services Department.

County Register of Deeds: The Kalamazoo County Register of Deeds.

County Road Commission: The Kalamazoo County Road Commission.

AUTHORITY

A. Land Division Act (formerly Subdivision Control Act)

1. All plats recorded with the Register of Deeds must conform to the Land Division Act (Act 288, PA 1967, as amended by Act 591, PA 1996). Under this Act, the Drain Commissioner is responsible for ensuring that the drainage or storm water management system of a subdivision is adequate to address storm water management needs within the proposed subdivision and for protecting downstream landowners. The procedures and standards set forth in these rules are designed for these purposes.
2. In accordance with the provisions of The Land Division Act, the Drain Commissioner has the authority, through the subdivision review process, to require that county drains, both inside and outside of a plat, be improved to the standards established by the Drain Commissioner when necessary for the proper drainage of a proposed subdivision.
3. As specified in the Land Division Act, the Drain Commissioner may acquire jurisdiction over the drainage systems within subdivisions as deemed necessary for adequate operation and maintenance.

B. Condominium Act

The general standards set forth herein will be applied by the Drain Commissioner in review of site condominium plans prepared under the Condominium Act (Act 59, PA 1978, as amended.) A notice of proposed action is required to be provided to the Drain Commissioner.

C. Mobile Home Commission Act

The general standards set forth herein will be applied by the Drain Commissioner in review for plans for mobile home parks prepared under the Mobile Home Commission Act (Act 96, PA 1987.) The Drain Commissioner has jurisdiction to review and approve outlet drainage, and internal drainage only if the streets or drains are dedicated to the public.

D. Michigan Drain Code

All developments within an established drainage district under the Michigan Drain Code (Act 40, PA 1956, as amended) shall conform to the requirements herein.

E. Soil Erosion and Sedimentation Control (SESC) Section of the Natural Resource and Environmental Protection Act

Earth changes requiring a soil erosion permit (Part 91, Act 451, PA 1994, as amended), and are part of a development approved pursuant to these rules, shall be reviewed for compliance with the block grading plan.

F. Review Authority Granted by Local Municipalities

All developments in townships, cities, or villages, where review according to these rules is required, shall conform to the requirements herein. The Drain Commissioner's review of private drainage systems will focus on the discharge of storm water offsite, and the accommodation of surface water from upstream areas drained by the private system.

G. Provisions for Requirements in Addition to Minimum Standards

1. These rules provide minimum standards to be complied with by Proprietors and in no way limit the authority of the municipality in which the development is situated to adopt or publish and enforce higher standards as a condition of approval of the final plat or site plan.
2. The Drain Commissioner reserves the right to determine site-specific requirements other than those herein, based upon review of the plans.
3. Any deviations from these standards shall be subject to approval by the Drain Commissioner.

APPLICABILITY

A. Exemptions

The following development activities are exempt from these standards:

- Construction of individual single and two-family residential structures.
- Additions or modifications to existing single and two-family residential structures.
- Parcel divisions along an existing county road (no common private drives).

B. Redevelopment

Redevelopment and additions requiring either a building permit or a soil erosion and sedimentation control permit shall comply with the current standards for the redeveloped or newly constructed portion of the site.

The Drain Commissioner reserves the right to require that the entire site be brought up to the current standards in known problem areas.

C. Local Unit Review

In general, site plan review shall be performed by the Drain Commissioner or the Engineer to avoid:

- Non-uniformity in drainage review between local units.
- Local unit priorities, such as reviewing plans for compliance of water and sewerage systems with local codes, result in drainage view having a lower priority.
- Approval of developments without adherence to the Drain Commissioner's standards and subsequent drainage problems resulting in the Drain Commissioner mediating the drainage disputes.

However, the Drain Commissioner will accept a drainage review from a local unit if the following conditions are satisfied:

- The drainage system for the development is not proposed to be dedicated to the Drain Commissioner under the applicable provisions of the Michigan Drain Code.
- The drainage system for the development does not directly outlet to a county drain.
- The road system in the development is intended to be private.
- The local unit has a storm water management ordinance, or has passed a resolution that requires all developments within the local unit be designed to the minimum standards outlined herein.
- The engineering review letter prepared on behalf of the local unit and submitted to the Drain Commissioner must state that a professional engineer, licensed in the State of Michigan, reviewed the plans for conformance with these standards.

SEVERABILITY CLAUSE

If any part of these rules is found to be invalid, such invalidity shall not affect the remaining portions of the rules which can be given effect without the invalid portion, and to this end the rules are declared to be severable.

FEES

The fees for reviewing a plat or site development under the provisions of the Kalamazoo County Drain Commissioner Site Development Rules are set forth in the Schedule of Fees. As of September 30, 2004, fees for submittals are as follows:

SCHEDULE OF FEES	
REVIEW FEES	
Preliminary Plat or Site Plan Review:	
Preliminary Plat Review (submittal fee):	$250.00
Construction Plan Review / Storm Water System Plans (submittal fee):	$250.00 first acre; $35.00 each additional acre
Resubmittal Fee	$150.00
Final Plat Review (submittal fee):	$105.00 first lot; $5.00 each additional lot
Deposit for engineering review and inspection:	$1,000.00
Submittal fees and deposit shall be paid at the time preliminary plat or site plan submittal is made to the Drain Commissioner for administration and review. Inspection fee shall be paid prior to issuance of a grading (SESC) permit and construction.	
PERMIT FEES	
County Drain Use Permit:	
Permit Fee:	$150.00
A permit is required to occupy an easement, connect to or cross a county drain with utilities, roads, drives, etc., or modify a county drain. Fees shall be paid with the permit application submittal prior to construction drawing approval. The Drain Commissioner reserves the right to adjust the fee amount if the project is minor in nature.	

SCHEDULE OF FEES (continued)

DEDICATION AGREEMENT FEES

<u>425 or 433 Agreement:</u>	
Maintenance Fee (required by Michigan Drain Code):	Lesser of $2,500.00 or 5% of construction
Recording Deposit:	$1,500.00
Surety for Work Completed after Final Plat Approval:	130% of uncompleted project
Repair Bond:	Lesser of $5,000.00 or 10% of the cost of the storm water system

Fees shall be paid at the time construction drawing submittal is made to the Drain Commissioner. Surety shall be posted prior to final plat approval. Bond shall be posted upon completion of construction. The deposit will be returned to the Proprietor after one (1) year if the storm water system is in good working order.

Total charges incurred by the Drain Commissioner's office for engineering services deemed necessary to perform reviews and inspections shall be charged in addition to the above fees. Engineering services will be based on current hourly billing rates for actual time and reimbursable expenses.

Charges are to be paid by the Proprietor within thirty (30) days of invoice by the Drain Commissioner. Payment of all fees is prerequisite to approval.

Failure to make timely payment constitutes a violation, permits will be revoked, and the deposit will be forfeited.

Deposits will be returned to Proprietors of good standing upon receipt of construction record drawings (as-builts). No interest will be paid on deposit funds.

PART 1:
PROCEDURES FOR PLAN SUBMISSION AND APPROVAL

I. PRELIMINARY PLAT OR SITE PLAN REQUIREMENTS

A. Submission Requirements

A Site Plan Review Checklist for information required on the drawings is included in ***Appendix 1***.

1. Submittal

a. Two (2) prints and one (1) electronic file in .pdf format of the preliminary plat or site plan.

b. Application for Drain Commissioner's Approval in ***Appendix 1***.

c. Location and site feature information listed on the Site Plan Review Checklist in ***Appendix 1.***

d. Design Calculation Package with information included on the Site Plan Review Checklist in ***Appendix 1***. (Upstream watershed calculations, BMP design calculations and design summary notes may be submitted with construction drawings if a two-step review process is used by the Proprietor.)

2. Staged Development

a. Should the Proprietor plan to develop a given area but wish to begin with only a portion of the total area, the original preliminary plat or site plan shall include the proposed general layout for the entire area. The first phase of the development shall be clearly superimposed upon the overall plat or site plan in order to illustrate clearly the method of development that the Proprietor intends to follow. Each subsequent plat or site plan shall follow the same procedure until the entire area controlled by the Proprietor is developed.

b. Each phase shall be self sufficient from the standpoint of drainage.

c. Final acceptance by the Drain Commissioner of only one portion or phase of a development does not ensure final acceptance of any subsequent phases or the overall general plat or site plan for the entire area; nor does it mandate that the overall general plat or site plan be followed as originally proposed, if deviations or modifications acceptable to the Drain Commissioner are proposed.

B. Storm Water Discharge Requirements

1. Drainage Patterns

Proposed drainage for the development shall conform to existing watershed boundaries, natural drainage patterns within the site, or any established county drainage districts.

2. Local Requirements

Proposed drainage shall complement any local storm water master plans that may exist and/or comply with any ordinance in effect in the municipalities where the site development is located.

3. Discharge of Storm Water Offsite

The rate, volume, concentration, or constitution of storm water discharged from a site shall not create adverse impacts to downstream property owners and watercourses.

a. Post-development discharge shall not exceed the capacity of the existing infrastructure.

b. Post-development discharge shall not cause adverse impact to offsite property due to concentrated runoff or ponded water of greater height, area, and duration.

c. Discharge shall not cause downstream erosion.

d. For a downstream drainage system that is inadequate to handle the proposed design discharge from the site development, it is the Proprietor's responsibility to:

   (1) Stabilize or upsize the existing conveyance system, or establish a county drain to provide the needed design level of flood protection.
   (2) Obtain flooding easements for measurable increases in water levels determined to cause an adverse impact.
   (3) Provide additional onsite storm water controls.

e. Additional impacts (such as increased temperature, pollutant load, or groundwater recharge) may also need to be mitigated.

f. It is the Proprietor's obligation to meet this standard. Should a storm water system, as built, fail to comply with the rules herein, it is the Proprietor's responsibility to have constructed at their expense, any necessary additional and/or alternative storm water management facilities. Such additional facilities will be subject to the Drain Commissioner's review and approval.

4. Adequate Outlet

a. The Proprietor's engineer shall include a sealed and dated statement attesting to the adequacy of receiving drains, waterways or waterbodies when storm water is proposed to be discharged offsite. A Certification of Adequate Outlet form is included in ***Appendix 3***.

C. Preliminary Plat or Site Plan Approval

1. Approval

a. The Drain Commissioner will approve or reject a preliminary plat or site plan within thirty (30) days of its submittal. If the preliminary plat or site plan is not approved as originally submitted, the Commissioner will notify the Proprietor in writing, setting forth the reasons for withholding approval. If the preliminary plat or site plan as submitted meets all requirements, one approved copy will be returned to the Proprietor. Approval of the preliminary plat or site plan is required before the Drain Commissioner will proceed with review of final construction plans.

b. Payment of all fees is prerequisite to approval (refer to section entitled "Fees"). Payment of an engineering review deposit is required by the Drain Commissioner at the time of preliminary plat or site plan submittal.

2. Changes and Resubmission

a. Approval of the preliminary plat or site plan by the local governing body is also required under the Land Division Act. Further, the approval of federal and state agencies may also be required. Should the approval of the local unit of government, federal, or state agencies require changes to the proposed layout or the proposed storm water management plan, such changes shall be incorporated in a new layout and a new preliminary plat or site plan shall be resubmitted for review by the Drain Commissioner.

b. If the Proprietor finds it advantageous to make changes in the preliminary plat or site plan, they shall be incorporated in the plan and a new preliminary plat or site plan shall be resubmitted for approval.

c. Resubmission is required even though the original layout may have already been approved by the Drain Commissioner.

3. Expiration of Preliminary Approvals

If the Proprietor does not present the final plat to the Drain Commissioner for approval within a period of two (2) years after receiving approval of the tentative layout, it will be necessary to resubmit the layout for review. The preliminary layout is no longer valid and a new submittal is required.

II. CONSTRUCTION DRAWING REQUIREMENTS

A. Submission Requirements

1. Submittal

a. Two (2) complete sets of construction drawings and one (1) electronic file in .pdf format.

b. Application for Drain Commissioner's Approval in ***Appendix 1***.

c. Additional information listed on the Site Plan Review Checklist in ***Appendix 1*.**

d. Specifications for construction of storm water management systems to be turned over to the Drain Commissioner (publicly owned).

2. Location of Storm Water Facilities

Storm water facilities for private drainage systems with multiple land ownership shall be located on dedicated outlots, within road rights-of-way, or have separate easements granted to the appropriate governing body.

3. Restrictive Covenants

A copy of restrictive covenants or master deed language related to drainage shall be provided to the Drain Commissioner prior to construction drawing approval and recorded prior to final plat approval or release of recording deposit.

a. Block Grading Plan

A block grading plan shall be incorporated in the restrictive covenants of the plat or master deed of the site development to ensure proper drainage of individual lots. The block grading plan shall state:

> "The block grading plan shows the direction of flow for the surface drainage for all lots. It is the lot owner's responsibility to ensure that the final grading of the lot is in accordance with the block grading plan. During the final lot grading and landscaping, the owner shall take care to ensure that the installation of fences, planting, trees, and shrubs do not interfere with nor concentrate the flow of surface drainage."

b. Minimum Floor and Opening Elevations

Minimum building floor and opening elevations shall be established to eliminate the potential of structural damage and flooding of building interiors. Minimum floor and opening elevations shall be incorporated in the restrictive covenants of the plat, including bench mark references. It is the responsibility of the Proprietor to provide a bench mark (NAVD 88 datum) within 400 feet of any lot to use as a reference for establishment of minimum floor and opening elevations.

The restrictive covenant shall state:

> "The lowest allowable floor elevations are set at 2-feet or more above the highest known ground water elevation. The lowest allowable floor and/or opening elevations are set 1-foot or more above the 100-year floodplain or design hydraulic grade line of the storm system. These elevations are set to reduce the risk of structural damage and the flooding of building

interiors. A waiver from the set elevations may be granted by the Kalamazoo County Drain Commissioner following receipt of a certification for a professional engineer, licensed in the State of Michigan, demonstrating that the proposed elevation does not pose a risk of flooding. Minimum building floor and opening elevations including bench mark locations and elevations are indicated on the Block Grading Plan."

c. Footing Drains and Sump Pumps

Provide direction in the restrictive covenants of the plat or condominium master deed for footing drain and sump pump outlets. If proposed to be directed to the storm sewer system, the restrictive covenant shall state:

> "Laundry facilities or other similar features shall not be connected to a footing drain or sump pump system discharging to footing laterals and the storm sewer system. Laundry facilities and sewage lift pumps must discharge into the sanitary sewage disposal system."

d. Easements for Side Yard and Surface Drainage

Private easements for enclosed yard drains and surface drainage are for the benefit of upland lots within the development or upland sites that currently drain across the proposed plat or site. Language shall be included within the restrictive covenants of the plat or condominium master deed that clearly notifies property owners of the location and purpose of private easements for side yard and surface drainage, as well as restrictions on use or modification of these areas. A separate, recordable easement form is not required. The restrictive covenant shall state:

> "Private easements for side yard and surface drainage are for the benefit of upland lots within the subdivision and any improper construction, development or grading that occurs within these easements will interfere with the drainage rights of those upland lots. Private easements for surface drainage are for the continuous passage of surface water and each lot owner will be responsible for maintaining the surface drainage system across their property. No construction is permitted within a private easement for side yard and surface drainage. This includes swimming pools, sheds, garages, patios, decks, or any other permanent structure or landscaping feature that may interfere with drainage or the maintenance of the drainage system."

4. Maintenance Plan and Agreement

a. Private Development

A Maintenance Plan shall be submitted with construction drawings for all private developments and be included with an executed Maintenance Agreement with provisions for local unit intervention in the legally binding documents such as the property deed or condominium master deed. A Maintenance Plan template and Maintenance Agreement are included in ***Appendix 2***.

B. Construction Drawing Approval

1. Approval

a. For plats, review of construction drawings by the Drain Commissioner will not proceed until preliminary plat approval has been granted.

b. After the drawings have been reviewed by the Drain Commissioner, approval or rejection will be provided to the Proprietor in writing within thirty (30) days.

c. Payment of all fees is prerequisite to approval (refer to section entitled "Fees"). Payment of an engineering review deposit is required by the Drain Commissioner at the time of construction drawing submittal unless previously required for preliminary review.

2. Changes and Resubmission

If the Proprietor finds it advantageous or necessary to make design changes, or if the information given to the Drain Commissioner does not represent the conditions as they exist on the ground, and revisions be required as a result, such revisions shall be made by the Proprietor and the drawings resubmitted to the Drain Commissioner for approval.

3. Expiration of Approval

Approval of construction drawings by the Drain Commissioner's office is valid for one (1) calendar year, or up to two (2) calendar years if allowed by the local governing body. If an extension beyond this period is needed, the Proprietor shall submit a written request to the Drain Commissioner for an extension. The Drain Commissioner may grant one-year extensions of the approval and may require updated or additional information, if needed. Should modifications be made to the drawings, a new review may be required subject to the appropriate review fees.

C. Submission of Construction Record Drawings

Two (2) complete sets of construction record drawings (paper copies), one (1) electronic file in .pdf format, and one (1) set of AutoCAD drawing files meeting Kalamazoo County Department of Planning & Community Development digital submission standards shall be submitted to the Drain Commissioner with a letter of transmittal for all developments reviewed under these rules. At a minimum, the following "as-built" information is required to be included on construction record drawings:

a. Horizontal location of all drainage structures and footing drain connection points relative to a coordinate point or lot corner. Alternately, locations may be shown by road stationing with offsets.

b. Final grading and volume of all detention/retention facilities and integrated BMPs with verification that they meet or exceed approved storage capacities.

c. Pipe inverts, length and slope, manhole and catch basin rims, top of berm, and spillway elevations.

d. Details of inlet structures (including opening areas and elevations).

III. FINAL PLAT REQUIREMENTS

A. Submission Requirements

A Submittal Checklist for Section 425 and 433 Agreements is included in ***Appendix 3***.

1. True Plat

The Land Division Act requires that a true plat be delivered to the Drain Commissioner for review. Such final plats must be prepared in accordance with the requirements of the Land Division Act.

2. Preliminary Plat Approval

a. The preliminary plat must be approved by the municipal governing body in which the proposed development is located. Evidence of this approval shall be submitted to the Drain Commissioner's office with the final plat.

b. If the Proprietor does not present the final plat to the Drain Commissioner for approval within two (2) years after preliminary plat approval, resubmittal of the preliminary plat and/or construction plans may be required in light of new information which may become available in the interim.

3. Completed Work

Prior to approval of the final plat, the Drain Commissioner shall require that one of the following provisions is met:

a. Work Completed Prior to Final Approval

Certification from the Proprietor's engineer that the county drains and watercourses shown on the plat have been improved in accordance with the approved construction drawings; or

b. Work Completed After Final Plat Approval

A Proprietor who desires to expedite the formal platting procedure shall enter into an agreement with the Drain Commissioner and post surety for faithful performance of the agreement. Failure to fulfill terms of an agreement executed under this provision will result in appointment of a Board of Determination to rule on necessity for the drain(s). Expenses incurred subsequent to said appointment will be assessed against lands within the plat still owned by the Proprietor.

(1) Surety

The surety shall consist of a cash deposit, a certified check or an irrevocable letter of credit drawn on a bank licensed in the State of Michigan in the amount of 130% of the uncompleted portion of the project. An Irrevocable Commercial Letter of Credit is included in ***Appendix 3***.

(a) Construction Contract as Basis for Required Surety

Valid existing contracts for construction of the storm water management system and soil erosion control measures executed between the Proprietor and Proprietor's contractor shall be the basis for establishing the portion of the contract to be covered by surety.

(b) Engineer's Estimate as Basis for Required Surety

In the event the Proprietor has not contracted for the construction of the storm water management system and SESC measures (e.g., Proprietor is the contractor), the Proprietor's engineer shall estimate the cost of said construction. The estimate of cost, as reviewed and approved by the Drain Commissioner, shall be the basis for the amount of surety.

(c) Rebate

A rebate to the Proprietor shall be made as the work progresses, in the amount of the ratio of work completed to the entire said construction cost. The percentage of work complete shall be determined by the Drain Commissioner.

(d) Release of Surety

If, upon completion of the final inspection, all punch list items are addressed and the Drain Commissioner determines the proposed drain practical, the Drain Commissioner may issue a letter granting final acceptance and shall subsequently release the balance of any surety deposit to the developer. If the Drain Commissioner determines the proposed drain impractical, pursuant to Section 52 of the Michigan Drain Code, the Drain Commissioner shall notify the developer in writing, provide the reasons for determining the proposed drain impractical, and refund the balance of any funds remaining from deposits by the developer.

B. Final Plat Approval

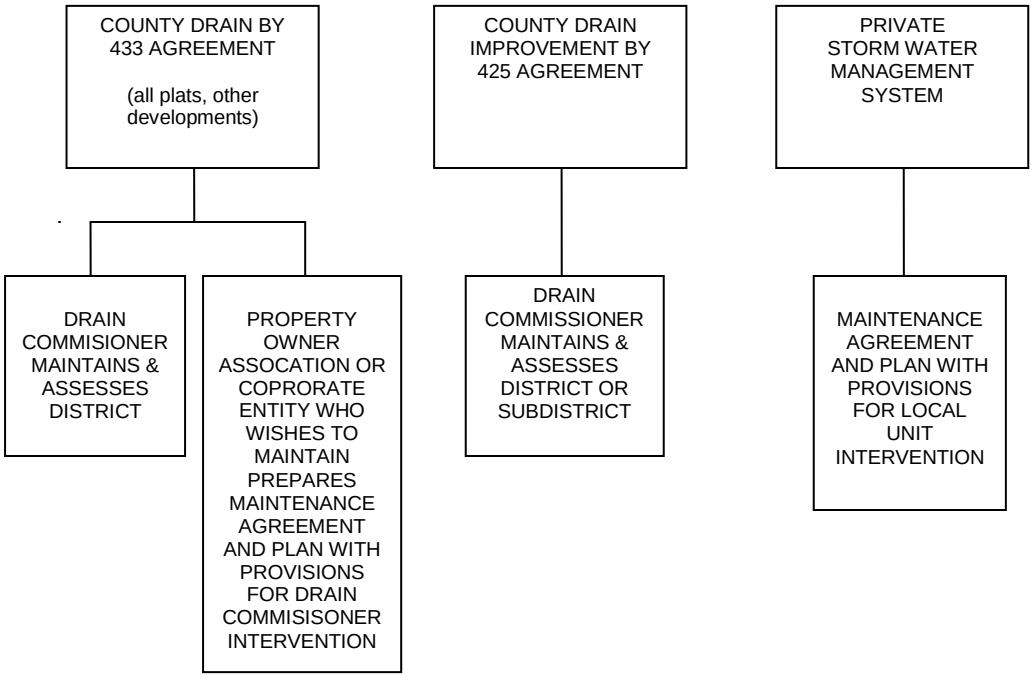
Final subdivision plat review will be completed by the Drain Commissioner's office within ten (10) days of submission by the Proprietor. If the plat is not acceptable, written notice of rejection and the reasons therefore will be given to the Proprietor and the clerk of the related municipality. Upon approval, the Drain Commissioner will sign the plat, and the plat will be executed.

Payment of all fees is prerequisite to approval (refer to section entitled "Fees").

IV. DRAINS UNDER THE JURISDICTION OF THE DRAIN COMMISSIONER

A. Responsibility for Storm Water System Ownership and Maintenance

A summary flow chart is shown below.



System Ownership and Operation Flowchart

1. Plats

All plats shall be established as public drainage under the jurisdiction of the Drain Commissioner.

2. Other Developments

All other developments with public roads shall be established as public drainage under the jurisdiction of the Drain Commissioner.

The Drain Commissioner will not accept jurisdiction of the drainage system for other multi-lot/multi-unit developments with private roads without a petition.

3. Roadside Ditches

Storm water drainage systems located in the right-of-way of a county (public) road will be owned and operated by the County Road Commission.

4. Maintenance

a. By Drain Commissioner

The Drain Commissioner shall be responsible for maintenance of all established county drains, including storm water BMPs dedicated as part of the county drain system. The costs for maintenance shall be assessed to the drainage district.

The Drain Commissioner will not accept ownership and maintenance of many decentralized storm water BMPs (i.e. rain barrels for individual houses, green roofs, pervious pavement) as part of the county drain system.

b. By Private Entity

A maintenance plan shall be submitted for property owner associations or corporate entities that desire to perform the routine maintenance required on the drainage system internal to the plat or development, which is established as a county drain. The maintenance plan shall be included with an executed Maintenance Agreement in the subdivision agreement or legally binding documents such as the property deed or condominium master deed. A maintenance plan template and Maintenance Agreement are included in ***Appendix 3***.

B. Easements

1. Existing Easements

The liber and page reference of all recorded easements shall be shown on final plats and construction drawings. Drainage easements obtained prior to 1956 were not required by statute to be recorded. Therefore, it may be necessary to check the permanent record of the Drain Commissioner's office to see if a drain easement is in existence on the subject property. Existing county drain easements will be indicated on the plans and designated as (insert name) Drain.

2. Proposed Easements

An easement (or release of right-of-way), not land ownership, is the approved method of providing access to, and protection of, public storm drainage facilities. Transfer of land ownership to an established drainage district is not allowed unless permitted in writing by the Drain Commissioner or other applicable authorities.

a. Location

(1) Within a Plat or Multi-Lot Site Development

All established county drains located within the plat or multi-lot site development, shall have granted easements.

(a) Drainage Easements

Private (exclusive) easements for the drainage and storage of storm water shall be granted to the appropriate drainage district and must be shown on the final plat or site plan. Related easement language shall be depicted on final plats and/or Exhibit B condominium drawings as follows:

> "Easement for [Drainage] [Storm Water Storage] to the (insert development name) Drain Drainage District."

Separate, recordable easements must be provided in a form acceptable to the Drain Commissioner. Acceptable easement forms are included in ***Appendix 3***. Recordable drainage easements shall be submitted to the Drain Commissioner prior to construction drawing approval and recorded prior to final plat approval and the sale of any lots which are to be encumbered by easements. If lots are sold prior to the Developer releasing an easement to the drainage district, the Developer shall obtain all necessary easements on said lots for completion of the project. Any lots sold on land contract must have the signature of both land contract vendor and vendee on the easement.

(2) Outside the Plat or Site Development

(a) County Drain Easements

Private (exclusive) easements shall be required downstream of a plat or site development when the discharge is to a watercourse or an open or enclosed drainage way that requires improvements and maintenance to continue to serve as a viable outlet for the plat or site development. An acceptable release of right-of-way form for county drains is included in ***Appendix 3***. Recordable drain easements shall be submitted to the Drain Commissioner prior to construction drawing approval and recorded prior to final plat approval. Easements will not be required through public rights-of-way (i.e. county roads).

(b) Flooding Easements

When additional volume of storm water is proposed to be discharged over, onto, or across private property (other than that owned by the developer), and no watercourse or drainage way exists or is proposed to be constructed, an agreement between the owners must be executed relieving the drainage district of any and all responsibility for damage that might occur. An acceptable Flooding Easement form is included in ***Appendix 3***. Such an agreement shall be submitted to the Drain Commissioner prior to construction drawing approval and recorded prior to final plat approval.

b. Easement Width

Minimum easement widths for new storm water systems are provided below. These easements shall be situated in such a way as to allow maximum maintenance access (for example, by offsetting them from the centerline if required). In general, easement widths shall conform to the following:

(1) Open Channels

Open channels shall have a minimum of 15 feet on each side of the top of bank and a total minimum width of 40 feet.

(2) Enclosed Drains

Easement widths for pipes shall conform to the following table. Burial depths are to the invert of the proposed pipe:

Burial (feet)	Easement Width
0-7	20 feet
7.1-12	30 feet
12.1-17	40 feet
>17.1	50 feet

(3) Detention and Retention Basins

A minimum of 15 feet of open space outside the high water level and around the perimeter of a public detention/retention basin, and an easement over the temporary spoil disposal area must be granted to access and maintain the facility. Ingress and egress easements shall also be provided. For basins located adjacent to county drains, a minimum of 15 feet open, flat space between the basin and the county drain must be granted as a drainage easement for access and maintenance of both.

(4) Other Storm Water BMPs

A minimum of 10 feet around the perimeter of storm water BMPs (i.e. bioswale / rain garden, infiltration trench) must be granted to access and maintain the BMP.

(5) Exceptions

(a) Generally, the above widths shall govern; however, if the engineer determines that additional right-of-way is required for proper construction, or because of special circumstances, such facts shall be made known to the Proprietor upon review by the engineer.

(b) Exceptions to the above requirements may be made only at the discretion of the Drain Commissioner.

C. Permits for County Drains

1. Utilities

If any utilities are to be located within the drainage easement of the proposed development, the Proprietor's engineer shall present plans detailing such utilities to the Drain Commissioner for approval as to location. Utility plans shall be presented at the same time as construction drawings so that all details of construction and location may be checked and properly oriented with each other. An Application and Permit for Utility to Cross or Parallel a County Drain is included in ***Appendix 4*** (refer to section entitled "Fees" for Drain Use Permit fees).

2. Modifications

a. General

A separate application is required for modifications (deepening, widening, relocation, etc.) to a county drain including installation of crossings, and shall be presented at the same time as construction drawings. An Application and Permit to Install a Crossing or Modify a County Drain is included in ***Appendix 4*** (refer to section entitled "Fees" for Drain Use Permit fees).

b. Tiling and Extensions

Agreements for tiling or adding a branch or extension to a county drain shall follow the procedures under Section 425 Application and Petition.

3. Tapping

a. General

A permit shall be obtained from the Drain Commissioner prior to tapping any open or enclosed county drain and shall be presented at the same time as construction drawings. An Application and Permit to Connect to a County Drain is included in ***Appendix 4***.

b. Footing Drains

Whenever building footing drains are required or utilized, footing drain leads shall be provided from a drainage structure to service each lot. The Proprietor shall also provide a marker or monument indicating the location of the footing drain lateral access point.

c. Floor Drains

Floor drains shall be connected to the sanitary sewer system. Where this is not possible, the Drain Commissioner shall review and approve connection of floor drains to a county drain on an individual basis. In all cases, connection of floor drains will not be allowed without adequate pretreatment meeting spill containment criteria.

D. Dedication Agreements

Developments proposed to have public drains must submit a completed Dedication Agreement. Two methods for establishing and dedicating drainage facilities are provided for by the Michigan Drain Code. Rules developed by the Drain Commissioner for each method are similar.

1. Section 425 Application and Petition

A Submittal Checklist for Section 425 and 433 Agreements is included in ***Appendix 3***.

a. Use

Section 425 of the Michigan Drain Code addresses the addition of branch drains to serve lands entirely within an existing drainage district and the enclosure or tiling of an existing drain. Under this paragraph, the Proprietor must petition the Drain Commissioner or Intercounty Drainage Board for permission to construct or improve the additional drainage for public use.

b. Submittals

(1) Application/Petition

The Proprietor shall submit an Application to Lay Out a Drainage District and a Petition to Locate, Establish, and Construct a Drain. An acceptable application/petition is included in ***Appendix 3***.

(2) Legal Descriptions

The Proprietor's engineer or surveyor shall provide centerline descriptions of the drains or branches and a complete legal description of the drainage area affected. The description shall list each parcel and the acreage located within the drainage subdistrict. In addition, the engineer shall complete an apportionment data sheet for the subdistrict.

(3) Certification

The Proprietor's engineer shall include a sealed and dated statement attesting to the adequacy of existing receiving drains. A Certification of Adequate Outlet form is included in ***Appendix 3***.

c. Costs

(1) Maintenance Fee

Prior to construction drawing approval, the Proprietor shall deposit into the maintenance account for the drain a non-refundable maintenance fee in the amount required by Section 433 of the Michigan Drain Code (refer to Part 1 section entitled "Section 433 Agreement").

(2) Recording Deposit

An additional recording deposit shall be submitted for administrative expenses of establishing a district, including legal review of documents, any recording fees incurred by the district, final inspection costs, and publication of the drainage district (refer to section entitled "Fees"). Any remaining deposit will be returned to Proprietors of good standing upon satisfactory completion of all submittal requirements.

2. Section 433 Agreement

A Submittal Checklist for Section 425 and 433 Agreements is included in ***Appendix 3***.

a. Use

Section 433 of the Michigan Drain Code addresses enlargement of existing drainage districts and creation of new districts where none previously existed. A formal agreement is required between the Proprietor and the Drain Commissioner or drainage board on behalf of the affected drainage district. Owners of lands not owned by the Proprietor, who will be included in the drainage district, must also sign the agreement.

b. Submittals

(1) Agreement

(a) General

The Proprietor and all parties having legal interest in the plat or development, as well as adjoining landowners whose properties will be included in the enlarged or new drainage district, shall enter into a formal agreement dedicating drainage facilities therein for public use. The agreement form will be completed in coordination with the Drain Commissioner and stipulate conditions of transfer and responsibilities of parties. An acceptable Section 433 Agreement form is included in ***Appendix 3***.

(b) Signing and Recording

The 433 Agreement shall be signed by an authorized representative of the Proprietor and Drain Commissioner and be submitted for recording at the County Register of Deeds prior to final plat approval and the sale of any lots in a plat or units in a site condominium. If property is sold on a land contract, both land contract vendor and vendee must sign the agreement. If more than one individual, corporation, partnership, or limited liability company has interest in the property, duly authorized representatives of each shall sign the 433 Agreement. Proprietor shall obtain on the 433 Agreement the signatures of all landowners or unit owners to whom lots are sold, if any.

(2) Legal Descriptions

(a) Route and Course

The Proprietor's engineer shall provide centerline descriptions for each drain or branch to be dedicated.

(b) Drainage District

The Proprietor's engineer shall provide metes and bounds description of the contributing drainage area (drainage district) benefiting from such. A 24" by 36" drainage district map showing the drainage district boundary line, lot and parcel lines with numbering, and all other pertinent information shall be required. The Drain Commissioner may also require that adjoining drainage district boundaries changed by the dedication be described in their entirety for amending documents pertaining to those drains.

(c) Assessment Roll

A breakdown of individual areas in acres shall be provided by municipality for each parcel, and for railroad, state and county road, and municipal street rights-of-way. The Proprietor's engineer shall complete an assessment roll for the new district, submitted on paper and in electronic Microsoft Excel format, for future drain maintenance in the development. The roll shall include benefit factors for each lot in the development that is not common-owned property (e.g. parks or open space). Benefit factors shall be based on use of roads, lot size, topography, etc. The sum of the benefit factors for each parcel shall equal 1.00, and percentages for each parcel shall be carried to two (2) decimal places.

(3) Certification

The Proprietor's engineer shall include a sealed and dated statement attesting that lands to be added to a drainage district naturally drain into the area served by the existing drain or that the existing drain is the only reasonably available outlet and attesting to the adequacy of existing receiving drains. A Certification of Adequate Outlet form (Exhibit B to 433 Agreement) is included in ***Appendix 3***.

c. Costs

(1) Maintenance Fee

The Michigan Drain Code requires that any person dedicating a drain for public use shall provide funding for initial maintenance operations. Contribution is calculated by taking the lesser amount of $2,500 or 5% of the cost of constructing the drain and its appurtenances. These funds shall be submitted to the Drain Commissioner prior to construction drawing approval. The funds are deposited in the account set up for the subject drain and are not refundable. The $2,500 fee is based on a storm water system consisting solely of gravity components. Systems with non-gravity components are subject to fees above and beyond $2,500, pursuant to Section 196 of the Michigan Drain Code.

(2) Recording Deposit

An additional recording deposit shall be submitted for administrative expenses of establishing a district, including legal review of documents, any recording fees incurred by the district, final inspection costs, and publication of the drainage district (refer to section entitled "Fees"). Any remaining deposit will be returned to Proprietors of good standing upon satisfactory completion of all submittal requirements.

E. Construction

1. Insurance Coverage

The Proprietor shall maintain adequate insurance coverage for Proprietor's own employees, contractors and subcontractors, and their employees during construction. Prior to issuance of a grading (SESC) permit, the Proprietor shall submit satisfactory evidence of public liability and property damage insurance coverage as set forth by the State of Michigan in compliance with the Drain Commissioner's Insurance Certificate Requirements (refer to ***Appendix 4***).

2. Indemnity

The Proprietor shall hold the Drain Commissioner and any agents of the Drain Commissioner harmless for acts of omission, negligence, or error by the contractor(s) and subcontractor(s), the Proprietor's engineer, or the Proprietor. Costs incurred by the Drain Commissioner to defend against criminal or trespass actions, resulting from activities of any of the parties named above, as well as judgments awarded by any court of law, shall be paid by the Proprietor.

3. Documentation

Governmental accounting standards (GASB Statement 34) require the county to report the value of their drain infrastructure. Prior to issuance of a grading (SESC) permit, the Proprietor shall submit documentation relative to the contract covering the work to be performed including the cost of construction with an itemized breakdown.

4. Preconstruction Meeting

The Drain Commissioner may request a preconstruction meeting be held with all involved parties.

5. Inspections

a. By Proprietor

The Proprietor shall retain a qualified inspector, supervised by a registered professional engineer, to perform construction inspection of storm drains and appurtenances that will be the responsibility of the Drain Commissioner to operate and maintain to assure construction according to Drain Commissioner approved plans. Inspection activities shall be documented by written daily reports acceptable to the Drain Commissioner. Daily inspection reports shall be bound and submitted to the Drain Commissioner for review prior to final acceptance.

b. By Drain Commissioner

The Drain Commissioner may employ an inspector on behalf of the drainage district should it appear that the installation fails to meet minimum requirements. Spot inspections by the Engineer are to verify the proper construction of the drainage system. Inspection by the Drain Commissioner or the Engineer shall not relieve the Proprietor's engineer or the municipal engineer of their obligations.

c. By Others

Other agencies may periodically inspect progress for regulatory purposes. The presence of such inspector does not release the Proprietor or Proprietor's engineer from obligations defined elsewhere in these rules.

d. Final Inspection and Determination of Practicability

The Drain Commissioner will complete a final inspection jointly with the County Road Commission for the purpose of final acceptance of construction and determination of practicability of the county drain.

6. Repair Bond

Upon completion of construction, the Proprietor will post a repair bond or letter of credit in the amount of $5,000 or 10% of the construction cost, whichever is less, to guarantee repairs of any defects which may show up after substantial completion of the project as a result of poor workmanship or defective materials. This deposit will be held for one (1) year after the date of final acceptance of the storm water facilities. This deposit will be returned to the Proprietor, provided all storm water facilities are clean, unobstructed and in good working order. An acceptable Repair Bond form is included in ***Appendix 3***.

7. Post-Construction Certification

A post-construction letter of certification from the professional engineer responsible for the design that certifies construction of the system in accordance with the approved construction drawings shall be submitted to the Drain Commissioner. An acceptable Certification form is included in ***Appendix 3***.

8. Construction Record Drawings

Construction record drawings shall be submitted by the Proprietor to the Drain Commissioner in accordance with the submission requirements (refer to Part 1 section entitled "Submission of Construction Record Drawings"), along with the Post-Construction Certification and the final plat if construction is completed prior to final plat approval.

PART 2:
STORM WATER MANAGEMENT REQUIRMENTS

I. PURPOSE

It is the purpose of these site development rules to establish minimum storm water management requirements to meet the following objectives:

- Ensure that storm water drainage systems and BMPs are adequate to address storm water management needs within a proposed development and protect the drainage, property, and water rights of landowners outside of the proposed development.
- Reduce artificially induced flood damage.
- Minimize the degradation of existing watercourses.
- Prevent an increase in non-point source pollution.
- Maintain site hydrology to avoid detrimental changes in the balance between storm water runoff, groundwater recharge and evapo-transpiration.

Further documentation of the impacts of development on land and water resources and the importance of storm water management can be found in Chapter 2 of the *Low Impact Development Manual for Michigan* (SEMCOG, 2008).

http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_chapter2.pdf

II. GENERAL REQUIREMENTS

The following general storm water management requirements apply to all new and redevelopments in Kalamazoo County.

A. The design process shall begin by identifying sensitive areas located on the site, and laying out the site to protect the sensitive areas.

B. Best Management Practices (BMPs) that reduce the amount of storm water runoff are encouraged.

C. Onsite retention of storm water is required first and foremost, unless site constraints preclude this approach.

D. Storm water shall be managed using four standards referred to as stream protection, flood control, water quality and pre-treatment to protect both water resources and real property.

E. Stream protection shall be provided for surface water discharges to natural water courses (directly or through pipes or ditches) by retaining onsite the difference in storm water runoff volume between pre-development and post-development conditions for the 2-year, 24 hour storm (2.37 inches of rain). Stream protection for redevelopments shall be provided through retention of the difference in the 2-year storm water runoff volume between existing and post-development conditions. If site constraints preclude meeting the retention standard, extended detention of the 1-year, 24-hour storm (1.95 inches of rain) will be allowed.

F. Flood control shall be provided for all sites through retention or detention of the 25-year storm. The maximum allowable detention release rate is 0.15 cfs / acre. Onsite flood control may be waived for direct discharges to large lakes and rivers if the developer demonstrates no negative impacts, or if provided in a regional facility with adequate upstream infrastructure.

G. Overland flow routes and the extent of high water levels for the 100-year storm shall be identified for all sites.

H. Water quality treatment shall be provided for all sites. A minimum treatment volume equal to 0.5-inch of runoff from the directly contributing impervious area is required. A minimum volume of 750 cubic feet per acre is required for directly connected disturbed pervious areas (i.e. lawns).

I. Pre-treatment is required for infiltration, filtration and detention BMPs for ease of maintenance and to protect BMP integrity and preserve longevity.

J. Storm water discharges from activities with a high risk for an accidental spill of pollutants (storm water hot spot) shall provide spill containment.

K. Storm water discharges to cold water streams shall employ management strategies to reduce storm water runoff temperature and promote groundwater recharge.

L. The design maximum release rate, volume or concentration of storm water discharged from a site shall not exceed the capacity of existing infrastructure or cause impairment to the offsite receiving area. An adequate outlet must be provided.

M. The use of many decentralized Low Impact Development (LID) BMPs is not mandated, but is encouraged on private sites.

III. DESIGN PROCESS

The storm water site design process is summarized in the steps below. This process is intended to minimize negative impacts from development sites that could be avoided through proper planning.

A. Identify Sensitive Areas

Identify existing sensitive areas on the site plan that may require special consideration or pose a challenge for storm water management. For the purpose of these rules, sensitive areas include:

- Floodplains (and flood prone areas)
- Riparian areas
- Wetlands
- Rivers, streams and natural drainage ways
- Lakes and ponds
- Soils and topography (steep, erodible)
- Groundwater supplies (springs, wellhead protection areas)

Non-structural BMPs such as “Minimize Soil Compaction and Total Disturbed Area,” Protect Natural Flow Pathways,” Protect Sensitive Areas (including Riparian Buffers),” “Native Revegetation” and “Storm Water Disconnection” may be selected for use to reduce the amount of storm water controls necessary for the site.

B. Determine Standards

Adequate storm water runoff controls are required to reduce channel erosion, maintain groundwater recharge, prevent overbank flooding and meet pollutant removal goals. Storm water is managed onsite through all of the following standards:

- Stream Protection
- Flood Control
- Water Quality
- Pre-treatment

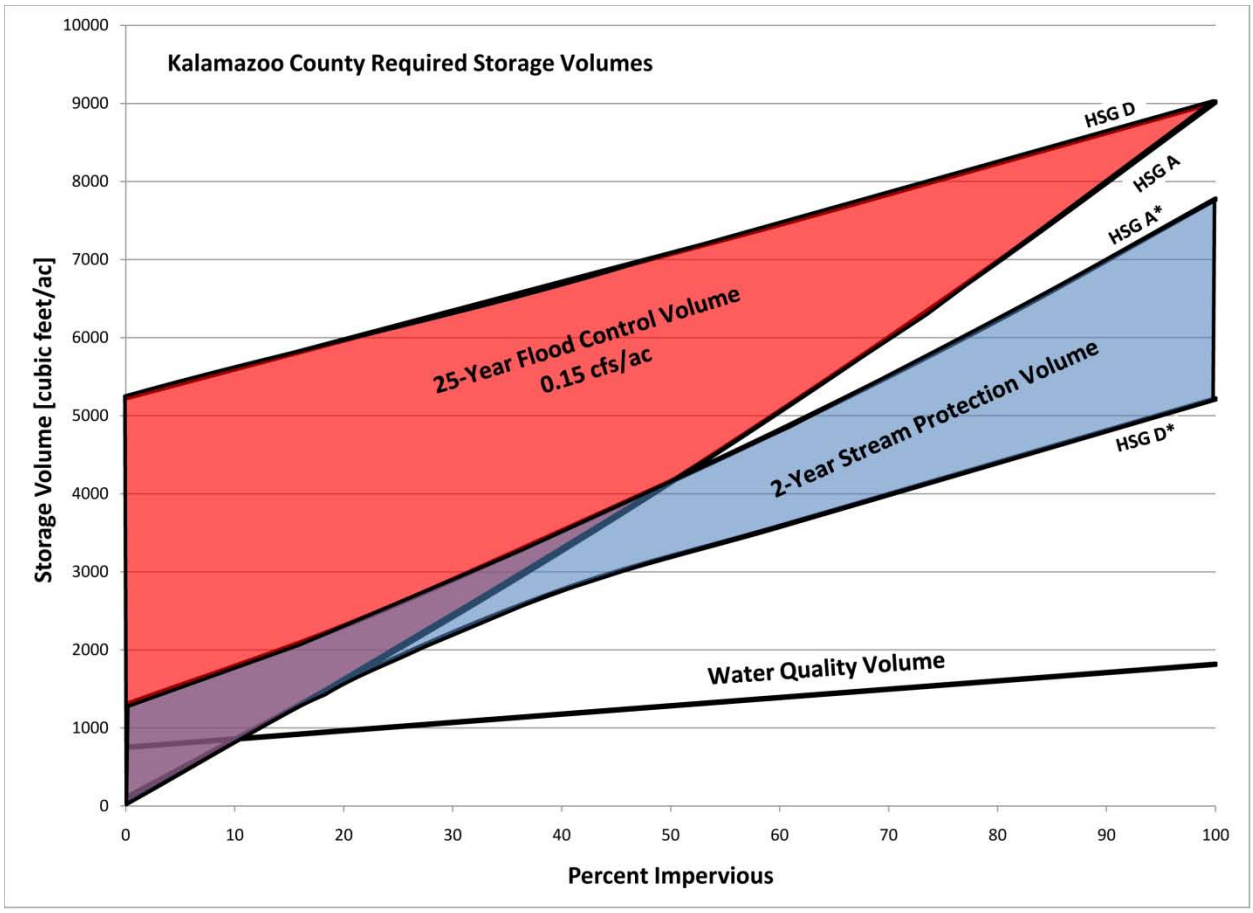
A summary of the minimum required storm water standards is provided in ***Table 1*** and shown graphically in ***Figure 1***.

Determine the storm water standards applicable to the site. A Storm Water Worksheet for individual sites is included as ***Worksheet 1*** located at the end of this section. A separate worksheet may be needed for each discharge location from the site.

Table 1 –Minimum Required Storm Water Standards

Standard	Applies	Sizing Criteria
Stream Protection	New and redevelopments that discharge to streams and rivers (directly, or through a storm sewer or ditch)	Retain the difference in 2-year pre-development and post-development runoff volumes onsite. **OR** Extended detention of the 1-year, 24-hour rainfall event for a period of 24 hours.
Flood Control	All new and redevelopments. May be waived for direct discharges to large lakes and rivers if no negative impacts, or if provided in a regional facility with adequate upstream infrastructure.	Retention or detention of the 25-year rainfall event with a maximum release rate of 0.15 cfs/acre. If retention of the total stream protection volume is provided, the maximum release rate may be increased to the pre-development 25-year peak rate. Identify overland flow routes and the extent of high water levels for the 100-year rainfall event to ensure no adverse impacts offsite or internal to the site.
Water Quality "first flush"	All new and redevelopments	Treat the first 0.5 inch of runoff from the directly connected impervious area. Provide minimum volume of 750 cubic feet per acre for directly connected disturbed pervious areas (i.e. lawns).
Pre-treatment	Detention basins Retention basins Infiltration practices Bioretention/rain garden Constructed filters Water quality swales	Sediment forebay: 30% of the water quality volume. **OR** Vegetated filter strips and vegetated swales meeting minimum length, slope and vegetated cover requirements. **OR** Water quality device

Figure 1 – Comparison of Required Storage Volumes



1. Stream Protection

Stream protection is required for discharges to natural watercourses either directly or via a storm sewer or ditch that does not receive any flow or volume mitigation prior to entering the stream (i.e. through a pond or wetland).

Retention of the increase in volume for a 2-year, 24-hour storm (2.37 inches) between pre-development and post-development conditions is required for new development.

The 2-year storm was selected since 95% or more of the annual average runoff volume will be controlled, including the bankfull event (typically between a 1- to 2-year rainfall). It is these smaller, more frequent events that have the greatest impact on the stability of headwater streams, which are most susceptible to erosion.

Retention can be provided through infiltration, evapotranspiration or reuse.

Pre-development condition is defined as a maximum runoff condition associated with “meadow” for all but existing woods. Using pre-developed in lieu of existing conditions is necessary to aid in the stability of headwater streams that are presently experiencing degradation.

For redevelopments, existing conditions may be used in lieu of pre-development conditions.

Existing condition means the runoff volume and rate for the last land use prior to the planned redevelopment after routing through all existing storm water controls.

Where retention is not possible due to site constraints, extended detention of the stream protection volume may be approved. Detention of the total 1-year, 24-hour storm (1.95 inches) runoff volume for a period of 24 hours is required to mitigate the impact of an increased volume of flow at the bankfull discharge. The idea is that storm water runoff will be stored and released in such a gradual manner (significantly less than the bankfull discharge rate) that critical erosive velocities during the bankfull and near-bankfull events will seldom be exceeded in downstream channels. The smaller storm is selected to avoid releasing extended volumes of runoff from the 2-year storm at or near the bankfull discharge rate, since there is less erosive work done by a slightly higher peak that occurs over a much shorter duration.

Site constraints that limit the use of infiltration may include poorly draining soils (< 0.24 inches per hour), high groundwater or the potential of mounded groundwater to impair other uses, well-head protection areas, Brownfield sites and areas of soil or groundwater contamination.

The Developer must demonstrate that onsite retention is maximized to the greatest extent practicable.

2. Flood Control

Flood control is required for all sites, except for direct discharges to lakes or rivers with demonstration of no negative impacts, or if provided in a regional facility with upstream infrastructure sized to handle undetained site runoff.

Retention or detention of the 25-year storm with a maximum allowable release rate of 0.15 cfs/acre is required.

This approach is overly conservative with the allowable release rate to prevent an increase in peak flow rates further downstream. Although less stringent rate controls may help protect the area immediately downstream from a development site, the increased volume of runoff and the prolonged duration of runoff from multiple development sites can actually increase peak flow rates and duration of flood flows in downstream reaches. The release rate of 0.15 cfs/acre is selected to be generally protective of floodplains in downstream watercourses, and is based on results found in previous hydrologic studies on West Michigan streams.

When retention of the total stream protection volume is provided, the maximum allowable release rate may be increased to the pre-development 25-year peak rate. This approach is effective in maintaining peak flow rates and floodplain levels in downstream watercourses, since it better mimics the pre-development hydrology of a site and eliminates the large volume increases that are associated with increased flooding.

Overland flow routes and the extent of high water levels for the 100-year storm shall be identified for all sites. Provisions shall be made to ensure no adverse impacts offsite or internal to the site.

3. Water Quality

Water quality volume is required to treat the “first flush” of storm water runoff that typically carries with it the highest concentration of pollutants.

Capturing and treating the first 0.5 inch of runoff from directly connected impervious areas has been found to generally meet pollutant load targets of:

> 80% decrease in total suspended solids (TSS); or
> discharge concentrations of TSS less than 80 mg/L

A majority of these pollutants build up and wash off from the surface of roadways, driveways, and parking areas.

Directly connected disturbed pervious surfaces (primarily lawns) can also contribute pollutant load (i.e. nutrients due to overuse of fertilizer; nutrients and bacteria due to overuse by wild/domestic animals). For these reasons, a minimum water quality volume of 750 cubic feet per acre of directly connected disturbed pervious area is used. This value is a conservative estimate of the amount of runoff produced in loam and clay soils (HSG C & D), and assumes compaction of more pervious soils, using the Small Storm Hydrology Method for 1-inch of rain (approximately equal to the 90-percent non-exceedance storm).

Water quality volume can be provided through one of the following methods:

- Permanent pool
- Extended detention
- Infiltration
- Filtration

The volume of a permanent pool incorporated into a storm water BMP can be counted as water quality volume. This is the volume below the ordinary static water level (also known as dead storage).

Extended detention is defined as holding the storm water runoff volume and releasing it gradually over a longer period of time than provided by conventional detention basins. The minimum extended detention time is 24 hours, and is defined as the time between the centroids of the inflow and outflow hydrographs. The storage volume provided by extended detention can be counted as water quality volume.

The volume of storm water runoff infiltrated into the ground through a storm water BMP can be counted as water quality volume.

The volume of storm water runoff routed through a BMP that provides filtration (i.e. an underdrained BMP) can be counted as water quality volume.

A vegetated filter strip or vegetated swale may also be used to provide filtering of storm water runoff.

4. Pre-Treatment

Pre-treatment provides for the removal of fine sediment, trash and debris, and is required to preserve the longevity and function of storm water BMPs, particularly infiltration and filtration practices.

A minimum pre-treatment volume equivalent to 30% of the water quality volume is required for sediment forebays using gravity. This approximates results given by the Hazen Equation for sediment basin sizing using a 50% settling efficiency for a 50-micron particle (silt) and a 1-year peak inflow.

Other methods of pre-treatment including the use of water quality devices and vegetated filter strips or vegetated swales are allowed.

C. Identify Special Cases

Identify any special cases for the site that may modify the storm water standards presented in ***Table 1***. The special cases most frequently encountered include:

- Storm Water Hot Spots / Wellhead Protection Areas
- Cold-water Streams
- Storm Water Policy Statements
- MS4s

1. Storm Water Hot Spots / Wellhead Protection Areas

Land use activities considered to be storm water hot spots are included in ***Table 2.*** These activities involve the production, transfer, and/or storage of hazardous materials in quantities that pose a high risk to surface and groundwater quality (those exceeding 55-gallons aggregate for liquids and 440 pounds aggregate for dry weights).

Kalamazoo County also has defined wellhead protection areas. A Wellhead Protection Map is included in ***Figure 2***. Developments in these areas must comply with local Wellhead Protection Ordinances.

a. Additional Criteria

Spill containment is only required for the transfer and storage areas of developments meeting the definition of storm water hot spots to provide for capture and containment of a slug discharge of pollutants from an accidental spill.

The spill containment volume is equivalent to the pre-treatment volume with a minimum of 400 gallons required. The minimum volume provides a reasonable capture size (a standard liquid propane truck has a hauling capacity of 1,000 gallons) that can be accommodated with a 6-foot diameter water quality device. Spill containment facilities must have an impermeable barrier between the treated material and the groundwater and have provisions for the capture of oil, grease and sediments.

b. Required Strategies

1) Infiltration of runoff from parking lots and road surfaces is discouraged in favor of a surface water discharge.

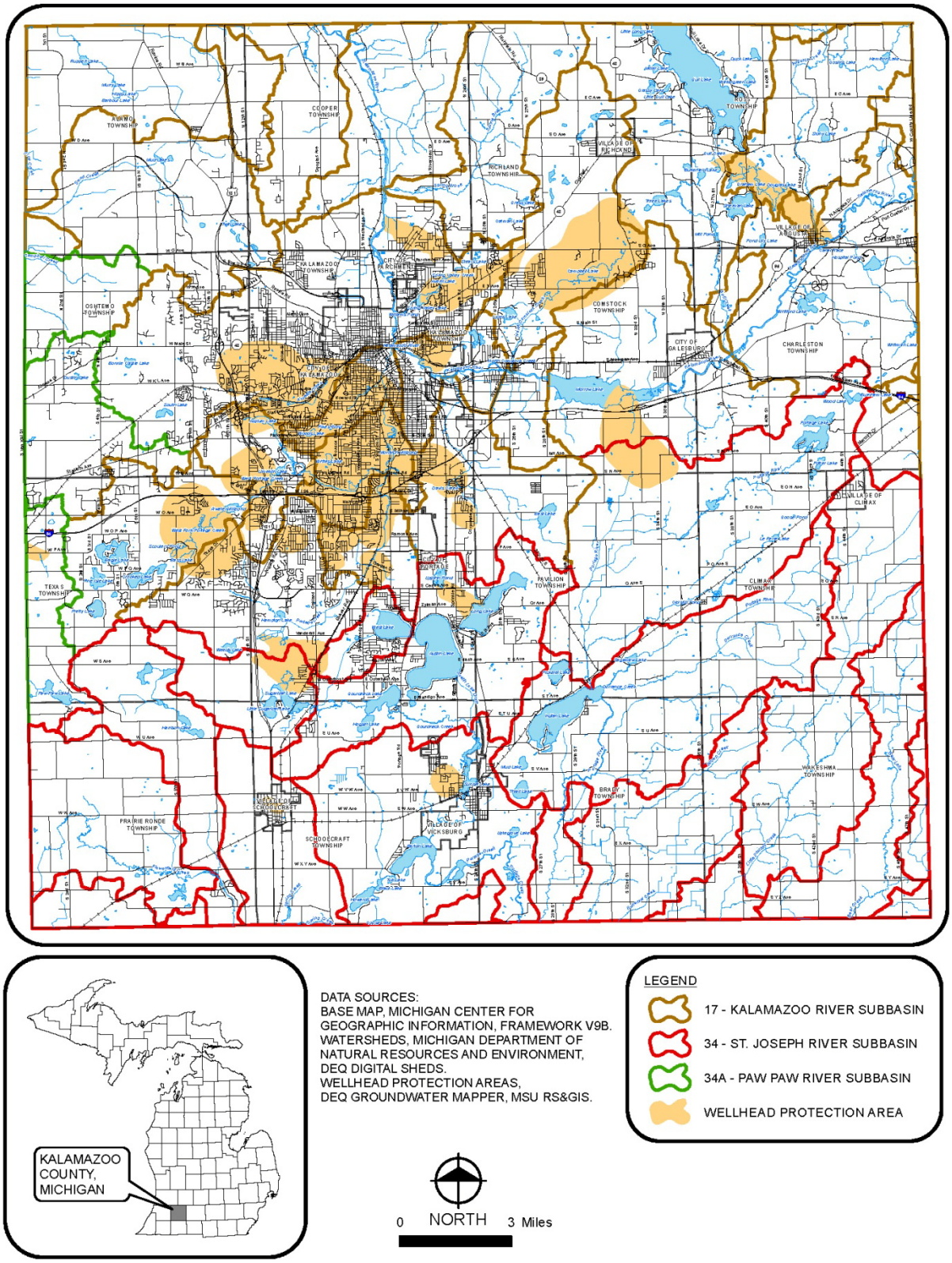
2) Porous pavements that infiltrate into the groundwater are not permitted because they do not allow for any pre-treatment or spill containment.

3) Perforated pipes for infiltration are not permitted because of the difficulty in isolating an accidental spill.

Table 2 – Storm Water Hot Spots

2007 North American Industry Classification System (NAICS)	
31 - 33	Manufacturing
44 - 45	Retail Trade (441 Motor Vehicle and Parts Dealers, 444 Building Material and Garden Equipment and Supplies Dealers, 447 Gasoline Stations, 454 Non-store Retailers (i.e. fuel dealers))
48 - 49	Transportation and Warehousing
71	Arts, Entertainment, and Recreation (79393 Marinas)
81	Other Services (8111 Automotive Repair and Maintenance, 8113 Commercial and Industrial Machinery and Equipment Repair and Maintenance, 8123 Dry Cleaning and Laundry Services, 8129 Other Personal Services (i.e. photofinishing laboratory))
	Salvage Yards and Recycling Facilities
	Other land uses and activities where there is a high probability for an accidental spill of petroleum products, chemicals or other polluting materials due to quantity of use, storage or waste products generated as determined by the Drain Commissioner (i.e. floor drains)
Many of these sites will also be regulated under the US EPA NPDES Industrial Storm Water Program. A detailed list of NAICS industries can be found at: http://www.census.gov/cgi-bin/sssd/naics/naicsrch?chart=2007	

Figure 2 – County Wellhead Protection Area Map



2. Cold-water Streams

The MDNR designates cold-water trout streams. These perennial streams require an adequate and stable base flow to maintain their cold water designation and support the fishery. Designated trout streams in Kalamazoo County are indicated on the County Watershed Map in ***Figure 3***.

a. Required Strategies

Development practices that increase surface water temperature or eliminate groundwater recharge should be avoided. The following strategies apply to developments located within a watershed of a designated trout stream that also propose a surface water discharge (direct, or indirect through upstream headwaters):

(1) Protect riparian buffers.
(2) Storm water disconnection.
(3) Incorporate heat-reducing BMPs such as green roofs and re-forestation.
(4) Implement structural BMPs that control volume through infiltration.
(5) If detention ponds are used, detention times must be limited to a maximum of 12 hours.
(6) Wet ponds should draw water from near the pond bottom to maintain a cooler discharge water temperature.

3. Storm Water Policy Statements

Developments may be located within a drainage district for which a storm water master plan or study was completed. Storm water policy statements for these drainage districts are available from the Drain Commissioner.

4. MS4s

Municipal Separate Storm Sewer Systems (MS4s) located in urban areas may have regulated storm water discharges under the US EPA NPDES MS4 program, including Total Maximum Daily Load (TMDL) allocations. Areas located within a regulated MS4 are indicated on the County Watershed Map in ***Figure 3***. Proposed developments located within a Municipal MS4 boundary must meet the requirements of the community's storm water ordinance and/or Storm Water Pollution Prevention Initiative (SWPPI). Developments located outside of a Municipal MS4 boundary, but inside the County MS4 boundary only need to comply with the SWPPI if they discharge to a county drain or county road drainage system. The water quality and stream protection standards in this manual meet the post-construction requirements of the County MS4 SWPPI.

D. Confirm an Adequate Outlet

The design criteria specified in this manual is generally protective of the receiving waterbody. However, the Developer must always demonstrate that an adequate outlet exists downstream of the development to receive the design rate, volume and concentration of the post-development site runoff without adverse impact to downstream properties or infrastructure (refer to Part 1 section entitled "Storm Water Discharge Requirements").

E. Select Best Management Practices

Select appropriate storm water BMPs from the Storm Water BMP Summary Matrix included in ***Table 3.*** The BMP or combination of BMPs selected must meet minimum volume and peak rate requirements and be designed in accordance with the design criteria provided in Part 3 of this manual.

Figure 3 – County Watershed Map

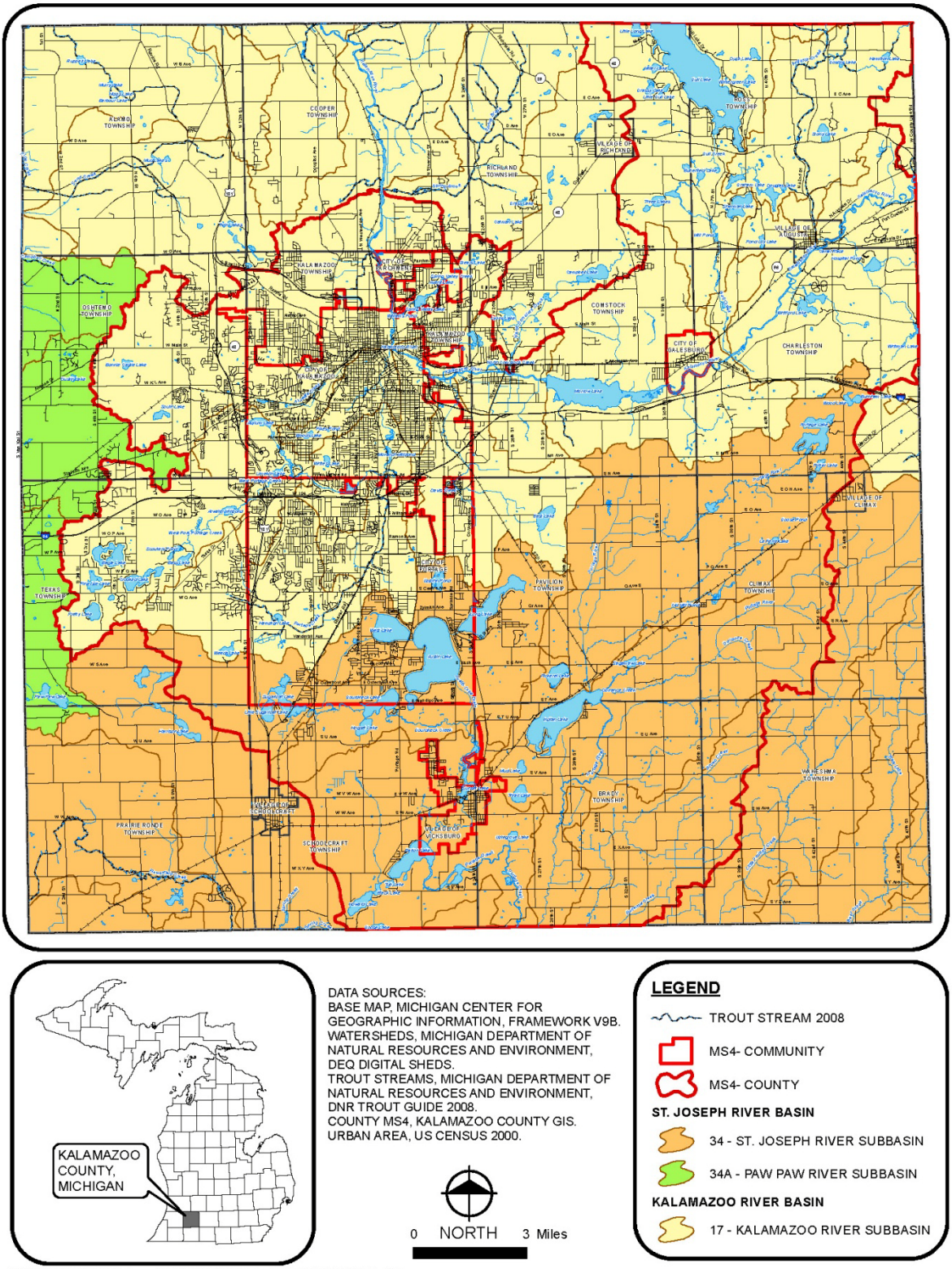


Table 3 – Storm Water BMP Matrix

Storm Water BMP	Treatment				Operation and Maintenance	
	Pre-Treatment Required	Provides Water Quality	Provides Pre-Treatment	Provides Spill Contain-ment	Maintenance Plan Required	Easement Required
Non-Structural BMPs						
Minimize Disturbed Area						
Protect Natural Flow Paths			X		Y	Y
Protect Sensitive Areas						
Native Revegetation			X		Y	
Storm Water Disconnection						
Structural BMPs – Conveyance and Storage						
Storm Sewer				X	Y	Y
Culvert or Bridge					Y	Y
Open Channel					Y	Y
Detention Basins	Y	X*			Y	Y
Retention Basins	Y	X			Y	Y
Structural BMPs –LID and Small Site						
Infiltration Practices	Y	X			Y	Y
Bioretention / Rain Garden	Y	X			Y	Y
Constructed Filter	Y	X		X	Y	Y
Planter Box		X			Y	Y
Pervious Pavement		X			Y	
Capture Reuse		X		X	Y	
Vegetated Roof			X		Y	
Structural BMPs – Pre-treatment						
Water Quality Device			X	X	Y	Y
Sediment Forebay		X	X		Y	Y
Spill Containment Cell		X	X	X	Y	Y
Water Quality Swale	Y	X	X	X	Y	Y
Vegetated Swale		X	X		Y	Y
Vegetated Filter Strip		X	X		Y	Y
Level Spreader			X		Y	Y
NOTES: Y = Yes; X = BMP may be used to meet treatment criteria; X* = does not include DRY detention basins						

Worksheet 1
STORM WATER WORKSHEET

Project: _____ **Date:** _____

New Development ____ **Redevelopment** ____ **MS4** ____ **By:** _____

Watershed: _____ **Drainage District:** _____

Site Discharge Location: _____

Storm Water Management Strategy: _____
_____

Adequate Outlet Description: _____
_____

Standard	Criteria
Stream Protection	___ **Retention of the entire 2-year volume increase.** *check, unless one of the following is allowed:* ___ Extended detention of 1-year runoff volume due to site constraints. ___ Not required.
Flood Control	___ **Retention or detention of the 25-year runoff volume with a maximum release rate of 0.15 cfs/acre.** *check, unless one of the following is allowed:* ___ 25-year storage volume with 25-year pre-development maximum release rate (when entire 2-year volume increase is retained onsite). ___ Not required to be provided onsite.
Water Quality	___ **Treat "first flush."** *check, unless the following is allowed:* ___ Provided in an offsite regional facility.
Pre-Treatment	___ **Required.** *check, if using any of the following:* detention and retention basins, infiltration and filtering practices including bioretention/rain gardens and water quality swales. ___ Not required.
Storm Water Hot Spot:	___ **Yes. Spill Containment** for _____ *describe activity (i.e. gas station)* ___ No.
Cold-water Stream:	___ **Yes. Add'l strategies needed.** *list no.s used:* _____ ___ No.

PART 3:
STORM WATER DESIGN CRITERIA

I. SOILS INVESTIGATION

A. Qualifications

Soils investigation by a qualified geotechnical consultant is required for retention and detention basins, infiltration practices, bioretention / rain gardens, constructed filters, planter boxes and pervious pavement to determine the site soil infiltration characteristics and groundwater level. The geotechnical consultant shall be a professional engineer, soil scientist, or professional geologist.

B. Background Evaluation

An initial feasibility investigation shall be conducted to screen proposed BMP sites. The investigation involves review of the following resources:

- County Soil Survey prepared by the NRCS and USDA Hydrologic Soil Group (HSG) classifications (http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm).
- Existing soil borings, wells or geotechnical report on the site.
- Onsite septic percolation testing.
- Kalamazoo County Depth to Groundwater Map (http://www.kalcounty.com/drain/new_pdfs/DepthToWater_Portrait.pdf).
- Cyclical groundwater levels (http://groundwaterwatch.usgs.gov/countymaps/MI_077.html).

C. Test Pit / Soil Boring Requirements

A test pit (excavated hole) or soil boring shall be used for geotechnical investigation. Test pits may typically be selected for shallower investigations in locations where groundwater is sufficiently low. The minimum number of test pits or soil borings shall be determined from ***Table 4***.

Table 4 – Minimum Number of Soil Tests Required

Type of BMP	Test Pit / Soil Boring	Depth of Test Pit / Soil Boring	Field Permeability Test
Retention basins Infiltration beds Rain garden Pervious pavement	1 soil boring per 5,000 square feet of bottom area; 2 minimum	8 feet below proposed bottom	1 test per soil boring
Infiltration trench Bioswale	1 soil boring per 100 linear feet of BMP; 2 minimum	8 feet below proposed bottom	1 test per soil boring
Dry well Planter box	1 soil boring minimum	5 feet below proposed bottom	1 test per soil boring
Detention basins	1 soil boring per 10,000 square feet of bottom area; 1 minimum	5 feet below proposed bottom	Not Applicable

Excavate a test pit or soil boring in the location of the proposed BMP.

At each test pit or soil boring, the following conditions shall be noted and described, referenced from a top-of-ground elevation:

- Depth to groundwater. The groundwater elevation shall be recorded during initial digging or drilling, and again upon completion of drilling.
- Depth to bedrock or hardpan.
- Depth and thickness of each soil horizon, including the presence of mottling.
- USDA soil texture classification for all soil horizons.

Test pit reports and soil boring logs shall include the date(s) data was collected and the location referenced to a site plan.

D. Highest Known Groundwater Elevation

The highest known groundwater elevation shall be determined by adjusting the measured groundwater elevation using indicators such as soil mottling and regional water level data. It should also take into consideration local conditions that may be temporarily altering water levels at the time of measurement. Such conditions could include, but not be limited to: dewatering, irrigation well or large quantity withdrawals in the area, or areas of groundwater infiltration (such as a nearby infiltration basin).

E. Field Permeability Testing

Field permeability testing is not required, but may be performed to determine if a design infiltration rate higher than indicated in ***Table 5*** may be used. The Drain Commissioner reserves the right to request that field permeability testing be performed on questionable sites. Acceptable field tests include:

- Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers (ASTM D-3385)
- Percolation Tests

The methodologies and procedures outlined on pages 440-441 in Appendix E of the *Low Impact Development Manual for Michigan* (SEMCOG 2008) shall be followed for each test.

http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_appendixE.pdf

An additional factor of safety of two (2) shall be applied to the permeability test results by the following equation:

Permeability-test infiltration rate (inches/hour) / 2 = Design infiltration rate (inches/hour)

The minimum number of field permeability tests shall be determined from ***Table 4.***

Tests shall be conducted in the location of the proposed BMP at the proposed bottom elevation. The Drain Commissioner may allow an alternate testing depth if material is identical and groundwater is not an issue.

Tests shall not be conducted in the rain or within 24 hours of significant rainfall events (>0.5 inch), or when the temperature is below freezing.

Field permeability testing reports shall include the date(s) data was collected and the location referenced to a site plan.

F. Design Infiltration Rates

A conservative value for the infiltration rate is used in calculating the storage volume of infiltration BMPs due to the uncertanty that the soil will infiltrate at the design rate during the time the basin is filling. The maximum allowable soil infiltration rate used to size the storage volume of the BMP shall be 0.52 inches per hour, except that 1.04 inches per hour may be used where soil borings indicate sand or gravel free of any other soil seams.

Where field permeability testing is not performed, the design infiltration rates provided in ***Table 5*** may be used to calculate the minimum infiltration area of the BMP necessary to drain in the allotted drawdown time.

Table 5 – Design Infiltration Rates by USDA Soil Texture Class

Soil Texture Class	Effective Water Capacity[1] (inches per inch)	Design Infiltration Rate[2] (inches per hour)	Hydrologic Soil Group[1]
Gravel	0.40	3.60	A
Sand	0.35	3.60	A
Loamy Sand	0.31	1.63	A
Sandy Loam	0.25	0.50	A
(Medium) Loam	0.19	0.24	B
Silty Loam / (Silt)	0.17	0.13	B
Sandy Clay Loam	0.14	0.11	C
Clay Loam	0.14	0.03	D
Silty Clay Loam	0.11	0.04	D
Sandy Clay	0.09	0.04	D
Silty Clay	0.09	0.07	D
Clay	0.08	0.07	D

[1]Source: Appendix D.13, Table D.13.1, *Maryland Stormwater Design Manual*, Maryland Department of Environment, 2000. (Rawls, Brakensiek and Saxton, 1982.)
[2]Source: Table 2, *Site Evaluation for Stormwater Infiltration (1002),* Wisconsin Department of Natural Resources, Conservation Practice Standards, 2004. (Rawls, 1998.)

Infiltration is the process by which water on the ground surface enters the soil. *Infiltration rate* is a measure of the rate at which soil is able to absorb rainfall or irrigation in inches per hour. The rate decreases as the soil becomes saturated. The design infiltration rate assumes saturated conditions and closely approximates the *hydraulic conductivity* (typically given in feet per day) of the near-surface soil.

The *effective water capacity* of a soil is the fraction of the void spaces available for water storage, measured in inches per inch.

Table 5 provides design values of the effective water capacity (void ratio) and the infiltration rate of the specific soil textural groups. The soil textures presented in ***Table 5*** correspond to the soil textures of the USDA Soil Textural Triangle included as ***Figure 4***.

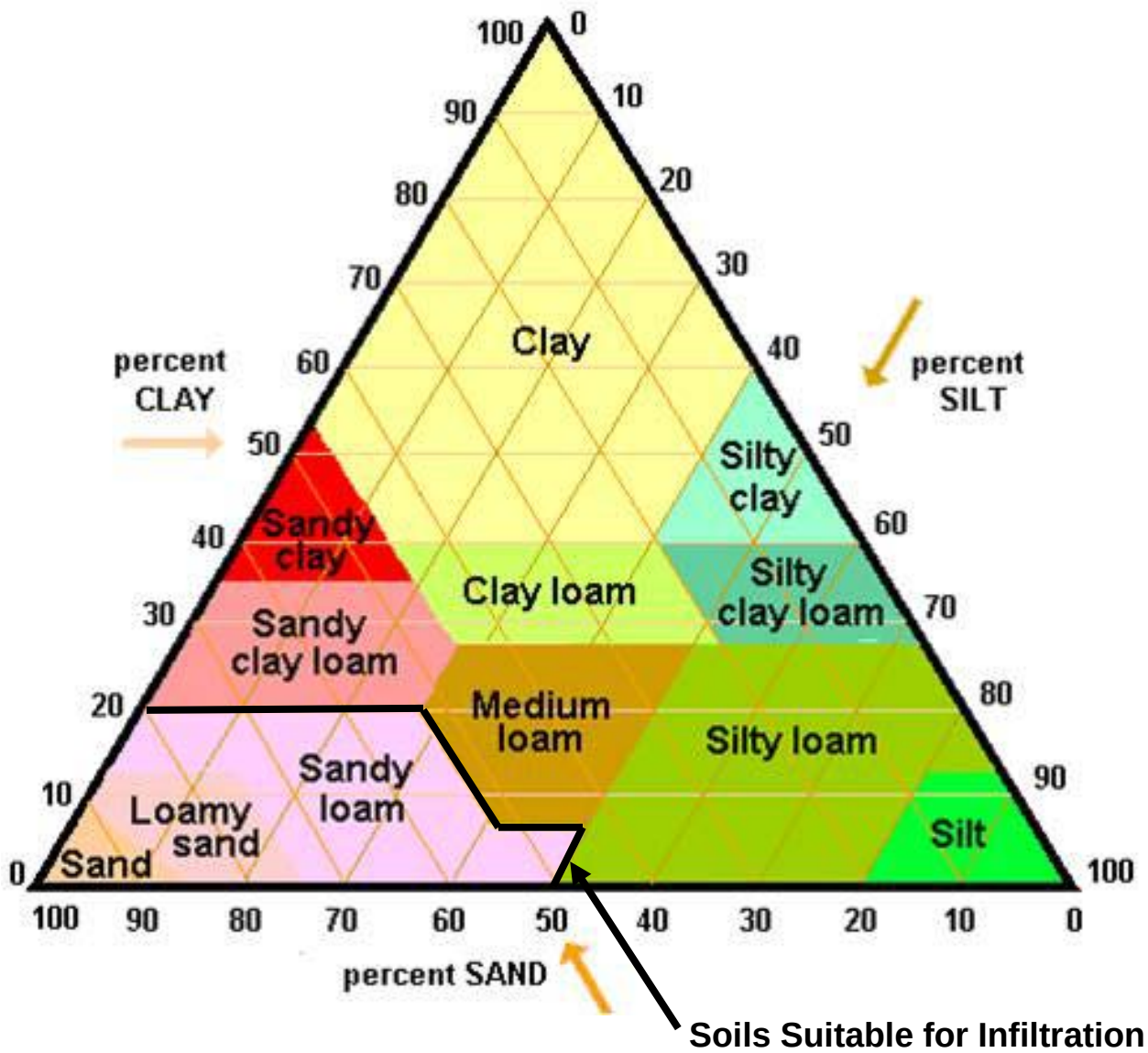
The least permeable soil horizon within four (4) feet below the proposed BMP bottom elevation shall be used to select the design infiltration rate.

G. Minimum Allowable Infiltration Rate

Soil textures with design infiltration rates less than 0.50 inches per hour are deemed not suitable for infiltration BMPs. Modifications to the BMP design through the use of underdrains or subsoil amendment, or selection of an alternative BMP shall be required.

For design infiltration rates between 0.24 and 0.50 inches per hour (medium loam), BMP design may include an underdrain placed at the top of the storage bed layer.

Figure 4 – USDA Soil Textural Triangle



II. CALCULATION METHODOLOGY

A. Calculating Runoff

1. Rainfall Loss Equations and Runoff Coefficients

a. **The Rational Method** may be used to calculate storm water runoff and generate peak discharges to size conveyance and storage systems. The peak runoff rate is given by the equation:

$$Q = C\,I\,A$$

where:
Q = peak runoff rate (cubic feet per second)
C = weighted runoff coefficient of the drainage area
I = average rainfall intensity for a storm with a duration equal to the time-of-concentration of the drainage area (inches per hour)
A = drainage area (acres)

Runoff coefficients for various land uses and surface types are included in ***Table 6***.

Table 6 – Rational Method Runoff Coefficients

Type of Development	Runoff Coefficients
Downtown Business Neighborhood Business	0.70 to 0.95 0.50 to 0.70
Single family Residentail Multi-units (detached) Multi-units (attached)	0.30 to 0.50 0.40 to 0.60 0.60 to 0.75
Residential (suburban)	0.25 to 0.40
Apartment	0.50 to 0.70
Light Industrial Heavy Industrial	0.50 to 0.80 0.60 to 0.90
Park, Cemeteries	0.10 to 0.25
Playgrounds	0.20 to 0.35
Railroad Yard	0.20 to 0.35
Unimproved	0.10 to 0.30
Character of Surface	
Asphalt and Concrete Pavement Brick Pavement	0.70 to 0.95 0.70 to 0.85
Roofs	0.75 to 0.95
Lawns, Sandy Soil Flat 2% Lawns, Sandy Soil Average 2% to 7% Lawns, Sandy Soil Steep 7%	0.05 to 0.10 0.10 to 0.15 0.15 to 0.20
Lawns, Heavy Soil Flat 2% Lawns, Heavy Soil Average 2% to 7% Lawns, Heavy Soil Steep 7%	0.13 to 0.17 0.18 to 0.22 0.25 to 0.35

Source: *Design and Construction of Sanitary and Storm Sewers*, American Society of Civil Engineers and the Water Pollution Control Federation, 1969.

b. **The Runoff Curve Number Method**, developed by the NRCS, may be used to calculate storm water runoff to generate peak discharges and runoff volumes. This method must be used when it is necessary to calculate runoff volumes for stream protection. The formulas are as follows:

$$Q_v = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

where:
Q_V = surface runoff volume (inches)
P = rainfall (inches)
S = potential maximum retention after runoff begins (inches)

and where:

$$S = \frac{1000}{CN} - 10$$

Surface runoff volumes are calculated separately for impervious and pervious areas.

Curve Number (CN) values shall be taken from Technical Release No. 55 (TR-55). Standard values are summarized in ***Table 7*** for convenience.

(1) Pre-development conditions shall consist of a "Meadow" cover type for all existing land covers other than woods. For existing woods use the "Woods" cover types for "good" hydrologic conditions.

(2) Open space in "fair" condition shall be used for post-development pervious areas that are <u>not</u> receiving non-structural BMP credits.

c. **The Michigan Modified Unit Hydrograph** formula shall be used with the Runoff Curve Number Method to generate peak storm water runoff rates:

$$Q = 238.6\ A\ Qv\ Tc^{-0.82}$$

where:
Q = peak runoff rate (cubic feet per second)
K = 238.6 constant reflecting shape of the unit hydrograph including unit conversion factors
A = drainage area (square miles)
Qv = surface runoff volume (inches)
Tc = time-of-concentration (hours)

Table 7 – Curve Numbers (CNs) from TR-55

Land Use Description		Curve Number[1]			
		Hydrologic Soil Group			
Cover Type	Condition[2]	A	B	C	D
Cultivated land	Poor	72	81	88	91
	Good	62	71	78	81
Pasture or range land	Poor	68	79	86	89
	Fair*	49	69	79	84
	Good	39	61	74	80
Meadow	Good	30	58	71	78
Orchard or tree farm (50% woods / 50% pasture)	Poor*	57	73	82	86
	Fair*	43	65	76	82
	Good*	32	58	72	79
Woods	Poor	45	66	77	83
	Fair*	36	60	73	79
	Good	30*	55	70	77
Open spaces (grass cover)	Poor*	68	79	86	89
	Fair	49	69	79	84
	Good	39	61	74	80
Paved parking lot, roof, driveway		98	98	98	98
Gravel		76	85	89	91
Dirt		72	82	87	89

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

[1]Antecedent moisture condition II and $I_a = 0.2S$

[2]Good Condition: cultivated land with conservation treatment; pasture, meadow or open space with 75% or more grass cover; woods with good cover of trees protected from grazing with litter and brush over soil

Fair Condition: pasture or open space with 50% to 75% grass cover; woods are grazed with some litter over soil

Poor Condition: cultivated land without conservation treatment; pasture or open space with less than 50% grass cover; woods with litter and brush destroyed by heavy grazing or burning

*From *Low Impact Development Manual for Michigan,* SEMCOG 2008

2. Time-of-Concentration

a. **Rational Method:** Overland flow time may be calculated using the nomograph shown as ***Figure 5***. A minimum of 15 minutes shall be used. Channel flow shall be calculated using Manning's equation.

b. **Runoff Curve Number Method:** Travel time shall be calculated using NRCS TR-55 methodology as outlined below.

The flow path is split into three sections – sheet flow, shallow concentrated flow, and open channel flow. In each flow regime the velocity and/or travel time are computed. The time-of-concentration is then the sum of the travel times.

(1) For sheet flow the travel time (in hours) is given as:

$$\frac{0.007(nL)^{0.8}}{P_2^{0.5} s^{0.4}}$$

where n is Manning's factor, L is the flow length (feet), P_2 is the 2-year precipitation depth, and s is the slope (feet/foot).

(2) Shallow concentrated flow velocities are calculated for paved and unpaved surfaces. The velocities are given as:

$$v = \begin{matrix} 16.1345 s^{.0.5} & Unpaved \\ 20.3282 s^{0.5} & Paved \end{matrix}$$

where s is the slope (feet/foot) and v is the velocity in feet per second. The flow length (feet) is then divided by the velocity (feet per second) to obtain travel time in hours.

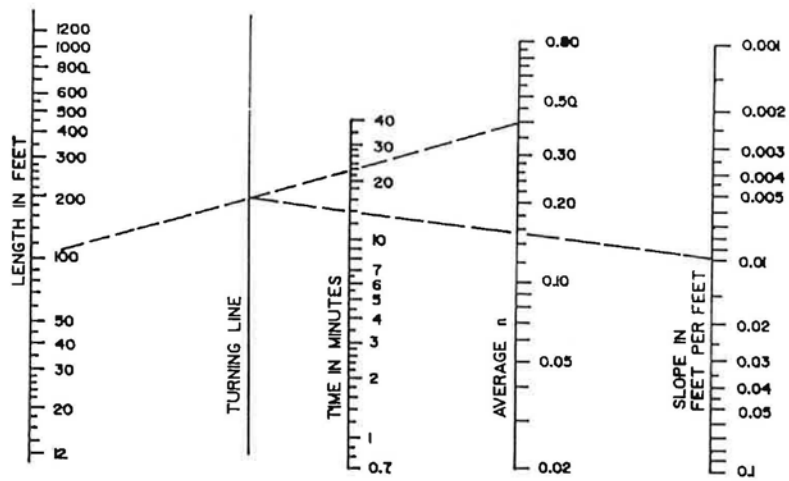
(3) Open channel flow uses Manning's equation to calculate the velocity based on slope, flow area, and wetted perimeter. The flow length (feet) is then divided by the velocity (feet per second) to obtain travel time in hours.

c. **BMP residence time** shall be calculated as the storage volume divided by the 10-year peak flow rate.

Figure 5 – Nomograph to Comupte Time of Concentration for Overland Flow

The following is a table used for determining n.

TYPE OF SURFACE	n VALUE
Smooth impervious Surface	0.02
Smooth bare packed soil	0.10
Poor grass, cultivated row crops or moderately rough bare surface	0.20
Pasture or average grass	0.40
Deciduous Timberland	0.60
Conifer Timberland, Deciduous Timberland with deep forest litter or dense grass	0.80



Example: N=0.40, L=100', S=0.01 feet/foot and tc=13.6 minutes

Chart is printed from the following equation.

$$tc = \left(\frac{2\,Ln}{3\sqrt{S}}\right)^{x} \qquad x = \frac{1}{2.14}$$

Taken from ENGINEER'S NOTEBOOK

"Time of concentration for overland flow" W.S. Kerby, J.M. Asce, Hydrologist, Servis, Van Doren & Hazard, Engineers, Topeka, Kansas.

The variables needed to compute time of concentration for a proposed development are its length, slope, and surface retardants. These variables can be computed from field survey notes.

The length L is the distance from the extremity of the development area in a direction parallel to the slope until a defined channel is reached. The units are in feet. Overland flow will become channel flow within 1,200 feet in almost all cases. Time of concentration is the sum of overland flow and channel flow.

The slope S is the difference in elevation between the extremity of the drainage area and the point in question divided by the horizontal distance. The units are in feet/foot.

The surface retardants coefficient, n, is the average surface retardants value of the overland flow.

3. Rainfall

a. The rainfall duration-frequency table provided in ***Table 8*** shall be used with the Rational Method to determine a rainfall intensity for a rainfall duration equal to the time-of-concentration.

b. The 24-hour rainfall amounts provided in ***Table 8*** shall be used with the Runoff Curve Number Method.

c. A Type II rainfall distribution shall be used when a unit hydrograph approach is used.

Table 8 – Rainfall Amounts

Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
24-hr	1.95	2.37	3.00	3.52	4.45	5.27	6.15
18-hr	1.83	2.23	2.82	3.31	4.18	4.95	5.78
12-hr	1.70	2.06	2.61	3.06	3.87	4.58	5.35
6-hr	1.46	1.78	2.25	2.64	3.34	3.95	4.61
3-hr	1.25	1.52	1.92	2.25	2.85	3.37	3.94
2-hr	1.13	1.37	1.74	2.04	2.58	3.06	3.57
1-hr	0.92	1.11	1.41	1.65	2.09	2.48	2.89
30-min	0.72	0.88	1.11	1.30	1.65	1.95	2.28
15-min	0.53	0.64	0.81	0.95	1.20	1.42	1.66
10-min	0.41	0.50	0.63	0.74	0.93	1.11	1.29
5-min	0.23	0.28	0.36	0.42	0.53	0.63	0.74

Source: Table 5 – Michigan, Section 8, *Rainfall Frequency Atlas of the Midwest, Bulletin 71*, Huff and Angel, 1992.

B. Calculating Storage Volumes and Release Rates

1. Stream Protection using Onsite Retention

a. Stream protection volume shall consist of retaining the 2-year runoff volume increase between pre-development and proposed development conditions. The minimum required stream protection volume is calculated by the formula:

$$V_{sp} = V_{dev} - V_{pre}$$

where:

$$V_{dev} = A\ (Qv_{perv} + Qv_{imp})\ /\ 12$$

$$V_{pre} = A\ (Qv_{perv} + Qv_{imp})\ /\ 12$$

and where:

V_{sp} = minimum required stream protection volume (cubic feet)
V_{dev} = runoff volume of the 2-year, 24 hour storm for proposed development conditions
V_{pre} = runoff volume of the 2-year, 24-hour storm under pre-development conditions
A = contributing disturbed site area (acres)
Qv = surface runoff volume (inches) by Runoff Curve Number Method, calculated separately for pervious and impervious surfaces
12 = factor to convert inches to feet

b. The stream protection volume must be retained onsite. This may be accomplished through infiltration, interception with storm water reuse, and/or interception with evapotranspiration (i.e. trees, wetlands).

c. If the required stream protection volume is not able to be met through retention, the remainder may be provided through extended detention. In this case, use the Extended Detention Curves in ***Figure 6***, calculate a weighted CN for the site, and reduce the total site area by the fraction of stream protection volume provided through retention. (For example, if 75% of the required stream protection volume is met by retention, then 25% of the site area would be used with the extended detention curves.)

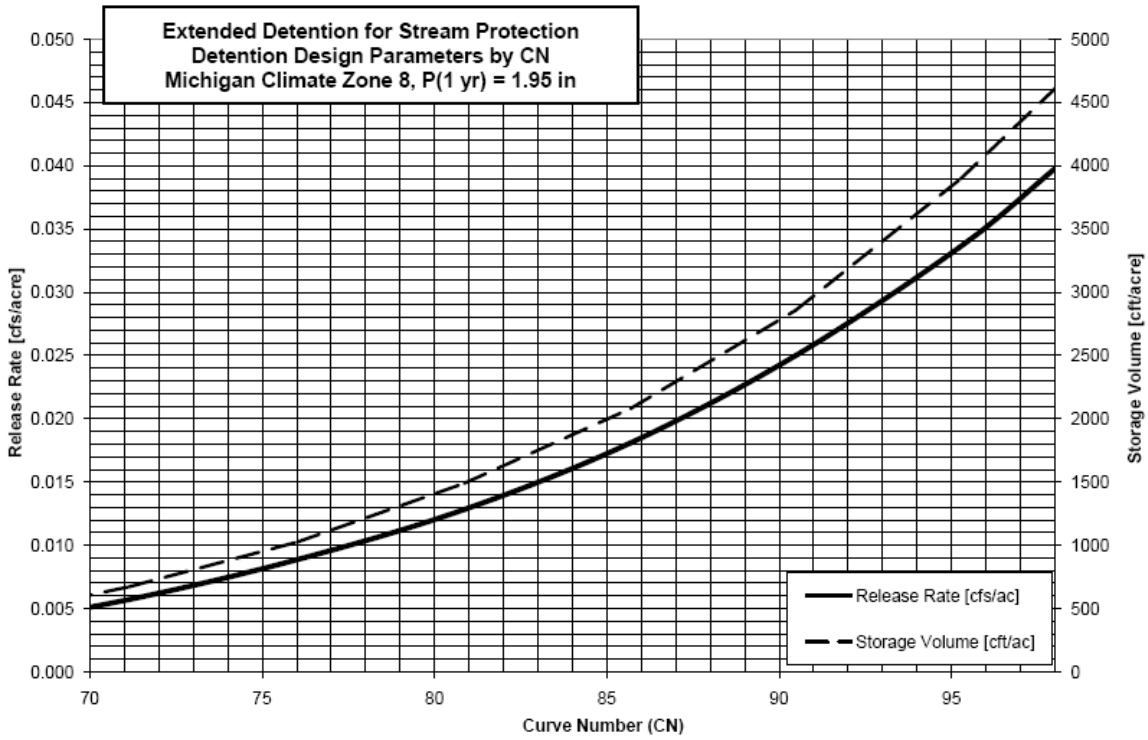
Green Calculator. The Green Calculator is a Microsoft Excel spreadsheet application that uses a unit hydrograph storm water runoff method with NRCS Curve Numbers (CN) and time-of-concentration formulas. It calculates required treatment volumes and detention release rates for a single treatment train on the site. A site with multiple (parallel) treatment trains requires one spreadsheet for each treatment train. The spreadsheet then allows the user to select non-structural and structural BMPs to meet required runoff rates and volumes. Output is graphed as hydrographs and summarized in tabular form for a range of rainfall frequencies (2, 10, and 25 year). A copy is provided with this manual.

The Green Calculator can be used to compute the required stream protection volume and the required extended detention volume and release rate.

2. Stream Protection using Extended Detention

a. Extended detention shall consist of detaining the total runoff from the 1-year, 24-hour rainfall event to achieve a 24-hour lag between the centroid of the outflow hydrograph and the inflow hydrograph, determined by reservoir routing. When extended detention is required, allowable release rates and storage volumes per acre can be selected from the curves provided in ***Figure 6.***

Figure 6 – Extended Detention Curves for Stream Protection



Source: *Lower Grand River Watershed, Stormwater Management for Stream Protection: Development of Michigan Statewide Rating Curves for Extended Detention Control of the Stream Protection Volume*, FTC&H, 2009.

b. Where the allowable release rate is so small that construction of a properly-sized orifice outlet is not feasible, an underdrained bioretention / raingarden, planter box, water quality swale or constructed filter BMP, sized for the required storage volume in ***Figure 6,*** may be used to meet stream protection requirements.

3. Flood Control using Detention Basins

a. The standard flood control criteria shall consist of detention of the 25-year, 24-hour rainfall event with a maximum allowable release rate of 0.15 cfs/acre.

b. If 2-year onsite retention is used to meet total stream protection requirements, a maximum release rate no greater than the pre-development 25-year peak runoff rate may be allowed.

c. If the Rational Method is used, the required storage volume shall be calculated by the "Modified Chicago" Method in a spreadsheet application. A factor of safety of 1.25 shall be applied because this method tends to underestimate the storage volume when compared to pond routing, particularly for short times-of-concentrations (15 to 30 minutes). A Microsoft Excel spreadsheet application (Rational Method spreadsheet) is provided with this manual.

> The Green Calculator can be used to compute the required detention volume using the Runoff Curve Number Method with a Michigan Unit Hydrograph and the Modified Puls Method for reservoir routing (see MDOT Drainage Manual, Section 8.4.8) given a user-specified release rate.
>
> When using the Green Calculator, the area of a detention basin (if required at the end of a treatment train) should be counted as a protected area or not included in the total site area since it is not part of the contributing area requiring stream protection or water quality treatment. This allows the user to match existing and developed site areas without having to provide additional "treatment" for a detention area.

d. When the Developer wants to receive credit for the reduction in runoff volume provided through site BMPs without using the Green Calculator, the Rational Method spreadsheet may be used with the Runoff Curve Number Method by "backing into" a weighted runoff coefficient.

(1) Determine the 25-year runoff volume of developed site (Qv) by the CN Method.

(2) Convert this volume to cubic feet by multiplying by the area and a unit conversion factor of 3,630.

(3) Subtract the volume of runoff retained by storm water BMPs.

(4) Convert the resulting net runoff volume (Qvn) to inches by dividing by the area and a unit conversion factor of 3,630.

(5) Calculate a weighted Rational Coefficient by the equation:

$$C = Qvn / P$$

where:
C = weighted runoff coefficient
Qvn = net surface runoff volume (inches)
P = 25-year, 24-hour rainfall amount (4.45 inches)

(6) Use this weighted runoff coefficient in a Rational Method spreadsheet application to determine the required detention storage volume.

Note: A factor of safety does not need to be included if more than 25% of the runoff volume is being retained and the time-of-concentration is 0.5 hour or greater.

4. Flood Control using Retention Basins

a. The maximum allowable soil infiltration rate used to size the storage volume of the BMP shall be 0.52 inches per hour, except that 1.04 inches per hour may be used where soil borings indicate sand or gravel free of any other soil seams.

b. If the Rational Method is used, retention basins shall be sized to store and infiltration a minimum of 3,630 cubic feet per acre, or the total runoff from a rainfall determined to be equivalent to the storage volume for the 25-year, 24-hour rainfall event with the maximum allowable design outflow (0.52 or 1.04 inches per hour) by the formula:

$$V_s = CAP(3630)$$

where:
V_s = storage volume (cubic feet)
C = weighted runoff coefficient
A = area (acres)
P = 3.65 rainfall amount (inches) for 0.52 in/hr, or
P = 3.05 rainfall amount (inches) for 1.04 in/hr
3630 = factor to convert acre-inches to cubic feet

The detention function of the Green Calculator can be used to calculate the 25-year storage volume required when retention basins are used to provide flood control.

The release rate shall be calculated as the maximum allowable infiltration rate times an assumed basin bottom area, given by the following equation:

$$Q_{out} = (i_{max} \times V / d) / (3600)(12)$$

where:
Q_{out} = average outflow from basin bottom (cubic feet per second)
i_{max} = maximum allowable infiltration rate (inches per hour)
V/d = total 25-year, 24-hour inflow volume divided by a maximum depth of 3 feet for i_{max} = 0.52 and 6 feet for i_{max} = 1.04 (equivalent to an assumed basin bottom area required to drain in 72 hours using maximum allowable infiltration rate)
3600 = factor to convert hours to seconds
12 = factor to convert inches to feet

CAUTION: The Green Calculator assumes that the resulting outflow volume is routed offsite when it is really infiltrated. When the detention function is used in this way, the user must be aware that this volume will be wrongly reflected in the discharge hydrographs.

5. Water Quality

a. Treatment of runoff by settling (permanent pool or extended detention), infiltration, or filtration is required from directly connected impervious areas for the first 0.5-inch of runoff. Water quality volume is calculated by the formula:

$$V_{wq} = 1815\ (DCIA)$$

where:
V_{wq} = minimum required water quality volume (cubic feet)
DCIA = directly connected impervious area (acres)
1815 = product of 0.5 inch and 3630 factor to convert acre-inches to cubic feet

b. For directly connected disturbed pervious areas (i.e. lawns) a minimum water quality volume of 750 cubic feet per acre shall be provided.

c. If a vegetated filter strip or vegetated swale is used, the filtering area must meet minimum standards for slope, length, and vegetative cover specified for the BMP.

6. Pre-treatment

a. Pre-treatment is required for detention and retention basins, infiltration practices, constructed filters and bio-retention / rain gardens.

b. Pre-treatment can be provided by any of the following methods:

(1) Sediment forebay:

$$V_{pt} = 0.30\ (V_{wq})$$

where:
V_{pt} = minimum required pre-treatment volume (cubic feet)
V_{wq} = water quality volume (cubic feet)

(2) Vegetated filter strips: Provide a 5-foot minimum sheet-flow length at a maximum slope of 2%.

(3) Vegetated swales: Provide a 15-foot minimum sheet-flow length at a maximum slope of 2%.

(4) Water quality device: Configured to trap floatables and sediment. Follow manufacturer's guidelines.

c. Pre-treatment volume may be included in the total water quality volume.

III. NON-STRUCTURAL BEST MANAGEMENT PRACTICES

Non-structural Best Management Practices (BMPs) consist of protection measures that reduce the volume of storm water runoff from the site. This differs from the goal of many structural BMPs which is to help mitigate the impact of storm water runoff.

The Drain Commissioner has adopted standards for the following non-structural BMPs:

- Minimize Soil Compaction and Total Disturbed Area
- Protect Natural Flow Pathways (including Riparian Buffers)
- Protect Sensitive Areas
- Native Revegetation
- Storm Water Disconnection

Further information and examples are provided in the BMP Fact Sheets in Chapter 6 of the *Low Impact Development Manual for Michigan* (SEMCOG 2008):

http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_chapter6.pdf

All of the following criteria must be met to receive credit for each non-structural BMP selected for use.

Minimize Soil Compaction and Total Disturbed Area

A. Summary

Pretreatment Required:	No
Maintenance Plan:	No
Easement Required:	No
Calculation Credits:	
Volume Reduction	Assign a CN reflecting open space in “good” condition, or woods in “fair” condition, instead of open space in “fair” condition as required for disturbed pervious areas. For small sites, individual trees can receive a credit of 800 square feet per tree, counted as woods in “fair” condition. Woods in “good” condition may be used if trees are protected by a local tree ordinance.
Rate Reduction	By virtue of lower CN
Water Quality	Exempt from water quality criteria

B. Criteria

This BMP applies to those portions of buildable lots located outside of lot building zones, construction traffic areas and staging areas that can be maintained as “minimal disturbance areas” during construction (i.e. wooded back portions of residential lots, green space required by ordinance).

Minimal disturbance area – Construction disturbance is limited to clearing and some grading, but no cutting, filling, stockpiling of material or construction traffic. Area is vegetated after disturbance (if any).

1. Identify “minimal disturbance areas” on site plan and construction drawings.
2. Minimal disturbance areas must be protected by having the limits delineated/flagged/fenced in the field. Notes to this effect must be included on construction drawings.
3. Minimal disturbance areas must not be subject to excessive equipment movement. Vehicle traffic and storage of equipment and/or materials is not permitted.
4. Pruning or other required maintenance of vegetation is permitted. Additional planting with site-appropriate plants, including turf grass is permitted.
5. Areas receiving credit must be located on the development project.

Protect Natural Flow Pathways

A. Summary

Pretreatment Required:	No. This BMP can provide pre-treatment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	Due to longer time-of-concentration for natural flow pathway
Water Quality	Exempt from water quality criteria

B. Criteria

1. Identify all existing natural flow pathways on site plan.

2. Identify natural flow pathways to be protected on site plan and construction drawings.

3. Natural flow pathways to be protected must have the limits delineated/flagged/ fenced in the field. Notes to this effect must be included on construction drawings.

4. Identify flow pathways designed as part of the storm water management system including strategies such as:

   a. Increased length
   b. Increased roughness
   c. Decreased slope

5. Ensure adequacy of flow pathway for post-development flows.

Protect Sensitive Areas (including Riparian Buffers)

A. Summary

Pretreatment Required:	No
Maintenance Plan:	No
Easement Required:	No
Calculation Credits:	Remove protected sensitive areas from storm water management calculations. (The area must still be included in storm water runoff calculations if it is necessary to determine the total downstream discharge from the site for sizing conveyance systems.)
Volume Reduction	Exempt from stream protection criteria
Rate Reduction	Exempt from flood control criteria
Water Quality	Exempt from water quality criteria

B. Criteria

This BMP includes protected areas on the development property located on separate out lots or set-asides that restrict land uses to those that do not increase runoff.

1. Identify all sensitive areas on site plan.
2. Identify all sensitive areas to be protected on the site plan and construction drawings.
3. Sensitive areas to be protected must have the limits delineated/flagged/ fenced in the field during construction and visible permanent boundary markers set to minimize encroachment (as appropriate). Notes and details to this effect must be included on construction drawings.
4. Identify municipal/township ordinance requirements, if any, and establish sensitive area standards for development site. In the absence of a local ordinance, Drain Commissioner standards for riparian buffers shall consist of:
   a. Variable width depending on topography, minimum 25-foot width (Zone 1)
   b. Naturally vegetated
5. Minimal clearing is allowed for lot access and fire protection.
6. For activities proposed within floodplains the proprietor shall demonstrate that any activity proposed within a 100-year floodplain will not diminish the flood storage capacity. Compensatory storage will be required at a minimum ratio of 1:1 for all lost floodplain storage, unless hydrologic analysis of the watershed indicates no harmful interference at a lower ratio.
   a. The compensating cut must be available during a flood event.
   b. Water must be able to move freely from stream to storage.
   c. Excavation must be adjacent to the floodplain.
   d. Compensating storage shall NOT be provided through channel widening.

Native Revegetation

A. Summary

Pretreatment Required:	No. This BMP can provide pre-treatment
Maintenance Plan:	Yes
Easement Required:	No
Calculation Credits:	Assign a CN reflecting a meadow instead of open space in “fair” condition as required for other disturbed pervious areas. For small sites, individual trees can receive a credit of 200 square feet per tree, counted as woods in “good” condition.
Volume Reduction	None
Rate Reduction	By virtue of lower CN
Water Quality	Exempt from water quality treatment criteria

B. Criteria

1. Identify native revegetation areas on site plan and construction drawings.

2. Native revegetation areas must be protected by having the limits delineated/flagged/fenced in the field. Notes to this effect must be included on construction drawings.

3. City standards shall consist of:

   a. Variable width depending on topography, minimum 25-foot width (Zone 1)

   b. Native revegetation selected from the *Low Impact Development Manual for Michigan* (SEMCOG 2008), Appendix C

   http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_appendixC.pdf

4. Areas receiving credit must be located on the development project.

Storm Water Disconnection

A. Summary

Pretreatment Required:	No
Maintenance Plan:	No
Easement Required:	No
Calculation Credits:	
Volume Reduction	Weight impervious runoff coefficient with pervious area runoff coefficient
Rate Reduction	Multiply time-of-concentration by a 1.25 factor to account for paved areas flowing onto pervious areas
Water Quality	Exempt from water quality criteria

B. Criteria

1. Storm water from rooftops and other impervious areas is considered disconnected if it is routed to a stabilized vegetated area including onsite swales and bioretention areas, or an onsite depression storage area that meets the following criteria:

    a. Disconnection must ensure no basement seepage.

    b. Roof downspouts and curb cuts must be at least 10 feet away from the nearest connected impervious surface to discourage “re-connections.”

    c. Disconnection in less permeable soils (HSGs C and D) may require the use of dry wells, french drains, or other temporary storage device to compensate for poor infiltration capability if ponding of water for extended period of time becomes problematic.

    d. For disconnects to stabilized vegetated areas:

        (1) Size of disconnect area shall be twice the size of the contributing impervious area.

        (2) Length of disconnect area must be at least the length of the flow path of the contributing impervious area (maximum 75 feet).

        (3) Slope of disconnect area must be no greater than 5%.

        (4) Disconnect area may be a “minimal disturbance” area.

2. Identify disconnect areas on site plan and construction drawings.

IV. STRUCTURAL BEST MANAGEMENT PRACTICES

Structural Best Management Practices (BMPs) are constructed measures that convey, store and treat storm water in a site-specific location and help mitigate the impact of storm water runoff.

The Drain Commissioner has adopted standards for the following structural BMPs:

Conveyance and Storage

- Storm Sewer
- Culvert or Bridge
- Open Channel
- Detention Basins
- Retention Basins

LID and Small Site

- Infiltration Practices
- Bioretention / Rain Garden
- Constructed Filter
- Planter Box
- Pervious Pavement
- Capture Reuse
- Vegetated Roof

Pre-treatment

- Water Quality Device
- Sediment Forebay
- Spill Containment Cell
- Water Quality Swale
- Vegetated Swale
- Vegetated Filter Strip
- Level Spreader

BMPs shall be designed in accordance these standards.

Further information and examples for LID and pre-treatment BMPs are provided in the BMP Fact Sheets in Chapter 7 the *Low Impact Development Manual for Michigan* (SEMCOG 2008):

http://www.semcog.org/uploadedfiles/Programs_and_Projects/Water/Stormwater/LID/LID_Manual_chapter7.pdf

Storm Sewer

A. Summary

Description:	Provides storm water conveyance in an enclosed system
Types:	Pipe (solid wall, perforated)
Pretreatment Required:	No. This BMP can provide spill containment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Solid wall pipe: None Perforated pipe (with slope): None Perforated pipe or leaching basin: Count storage volume below outlet pipe invert.
Rate Reduction	None
Water Quality	None

B. Design Requirements

1. Sizing and Configuration

   a. The storm sewer system shall be designed to convey runoff from a 10-year frequency rainfall event.

   b. Storm sewer design velocities, capacities, and friction losses shall be based on Manning's equation:

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

   where:
   Q = discharge (cubic feet per second)
   A = wetted area (square feet)
   R = hydraulic radius (feet)
   S = slope (feet per foot)
   n = Manning's Coefficient

   c. Manning's coefficients for closed conduit are included in ***Table 9***

   d. Acceptable slopes for circular pipe ("n" = 0.013) are included in ***Table 10.*** Minimum and maximum grade for other Manning's n values must be calculated based on allowable minimum and maximum velocities (V).

   e. As a general rule, surcharging the pipe will be allowed to 1 foot below the top of casting. However, minor losses must be considered in hydraulic grade line calculations.

   f. Storm sewer pipe shall have a minimum diameter of 12 inches.

   g. The minimum depth of cover shall be 24 inches from grade to the top of pipe.

2. End Treatment

   a. Outlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 10 feet per second.

Storm Sewer (continued)

Table 9 - Manning's Roughness Coefficients

Conduit	Coefficients
Closed Conduits	
Asbestos-Cement Pipe	0.011 to 0.015
Brick	0.013 to 0.017
Cast Iron Pipe (Cement-lined and seal-coated)	0.011 to 0.015
Concrete (Monolithic)	
Smooth forms	0.012 to 0.014
Rough forms	0.015 to 0.017
Concrete Pipe	0.011 to 0.015
Corrugated-Metal Pipe (1/2-inch corrg.)	0.022 to 0.026
Paved invert	0.018 to 0.022
Spun asphalt-lined	0.011 to 0.015
Plastic Pipe (Smooth)	0.011 to 0.015
Vitrified Clay Pipes	0.011 to 0.015
Liner channels	0.013 to 0.017
Open Channels	
Lined Channels	
Asphalt	0.013 to 0.017
Brick	0.012 to 0.018
Concrete	0.011 to 0.020
Rubble or riprap	0.020 to 0.035
Vegetal	0.030 to 0.040
Excavated or Dredged	
Earth, straight and uniform	0.020 to 0.030
Earth, winding, fairly uniform	0.025 to 0.040
Rock	0.030 to 0.045
Unmaintained	0.050 to 0.140
Natural Channels (streams, top width at flood state <100 feet)	
Fairly regular section	0.030 to 0.070
Irregular section with pools	0.040 to 0.100

Source: *Design and Construction of Sanitary and Storm Sewers*, American Society of Civil Engineers and the Water Pollution Control Federation, 1969.

Table 10 - Minimum and Maximum Slopes for Storm Sewers

Pipe Size	Minimum % of Grade (V = 2.5 feet/second)	Maximum % of Grade (V = 10 feet/second)
12"	0.32	4.88
15"	0.24	3.62
18"	0.20	2.84
21"	0.16	2.30
24"	0.14	1.94
27"	0.12	1.66
30"	0.10	1.44
36"	0.08	1.12
42"	0.06	0.92
48"	0.06	0.76
54"	0.04	0.60
60"	0.04	0.54
66"	0.04	0.48

(Manning's "n" = 0.013)

3. Manholes and Catch Basins

   a. Manhole spacing shall not exceed 400 feet for sewers less than 42 inches in diameter and 600 feet for larger sewers.

   b. Manholes shall be placed at all changes in pipe direction, pipe size, all inlet connection locations, and at the end of the storm sewer.

   c. Pipe inverts at junctions shall be designed to minimize junction losses (match 0.8 points of pipe diameters).

   d. Minimum inside diameter of all manholes, catch basins, and inlet structures shall be 48 inches.

   e. Inlet structures shall be placed at low points of streets and yards, and be spaced a maximum of 400 feet apart. Spacing and/or number of inlet structures required to accommodate the design flows in streets, private drives, and parking areas shall be provided based on inlet capacity with no ponding occurring during a 10-year storm.

   f. No more than 300 feet of pavement surface drainage will be allowed. No more than 200 feet of surface drainage will be allowed for grades exceeding 4%.

   g. No more than 150 feet of street drainage will be allowed to flow around a corner.

   h. No flow will be allowed across a street intersection.

   i. For pipes crossing or entering a county road right-of-way, a minimum 48-inch diameter manhole may be required on the enclosed county drain just outside of the county road right-of-way.

4. Materials

   a. Storm sewer pipe shall be reinforced concrete or smooth interior wall polyethylene in accordance with MDOT Standard Specifications.

   b. Pipe joints shall be designed to prevent excessive infiltration or exfiltration.

   c. Manholes and catch basins shall be in accordance with MDOT Standard Specifications.

   d. Connections to manholes shall be made with a resilient connector for pipe diameters 24 inches or less.

Culvert or Bridge

A. Summary

Description:	Provides storm water conveyance through a crossing structure
Types:	Pipe Culvert; Box Culvert; Bridge
Pretreatment Required:	No
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	None

B. Design Requirements

1. Sizing and Configuration

   a. Bridges shall be designed to provide a 2-foot-minimum freeboard to the underside (low chord) of the bridge for a 100-year flood.

   b. Footings shall extend at least 4 feet below the bottom of the channel.

   c. Culverts serving a drainage area of less than 2 square miles shall be designed for the 10-year peak discharge in the developed watershed with a maximum outlet velocity of 8 feet per second. A maximum of 1 foot of inlet submergence may be permitted, if this does not backup water out of the easement.

   d. The effect of the 100-year storm shall be reviewed to ensure no adverse increase in water elevation off of the development property or flooding of structures within the development.

   e. Sizing of culverts and bridges shall be performed using the Bernouli Equation and include consideration of inlet and outlet control, entrance and exit losses, and tailwater condition. Published culvert nomographs and other computer software may be used.

   f. Minimum diameter of a drive culvert shall be 12 inches.

   g. Minimum diameter of a road crossing culvert shall be 18 inches or equivalent pipe arch.

2. End Treatment

   Headwalls, wingwalls, and all other end treatments shall be designed to ensure the stability of the surrounding soil. MDOT, County Road Commission, or manufacturer's designs may be used.

3. Materials

   Culverts may be reinforced concrete pipe, corrugated steel pipe, or pipe arch in accordance with MDOT Standard Specifications.

Open Channel

A. Summary

Description:	Storm water conveyance in an excavated channel
Types:	Ditch
Pretreatment Required:	No
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	None

B. Design Requirements

1. Sizing and Configuration

   a. The open channel shall be designed to convey the 10-year peak discharge with 1-foot of freeboard to top of bank.

   b. Open channel design velocities, capacities, and friction losses shall be based on Manning's equation:

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

   where:
   Q = discharge (cubic feet per second)
   A = wetted area (square feet)
   R = hydraulic radius (feet)
   S = slope (feet per foot)
   n = Manning's Coefficient

   c. Manning's Coefficients shall be determined from ***Table 9***. A minimum Manning's Coefficient of 0.035 shall be used for open channels, unless special treatment is given to the bottom and sides (riprap, paving, mown sod, etc.).

   d. Minimum bottom width shall be 2 feet.

   e. Minimum longitudinal slope shall be 0.10%.

   f. Side slopes shall be no steeper than 2:1 (horizontal to vertical).

   g. Open channel flow velocities shall be neither siltative nor erosive. The minimum velocity for open channels shall be 1.5 feet per second. The maximum velocity shall be 4 feet per second. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 10 feet per second.

2. Connections and Crossings

   a. Outlets into the open channel shall enter at an angle of 90 degrees or less with the direction of flow.

   b. A minimum clearance of 4 feet is required between open channel inverts and underground utilities unless special provisions are approved.

Detention Basins

A. Summary

Description:	Provides storm water storage with a surface outlet
Types:	Dry Basin; Underground Vault; Wet Pond; Constructed Wetland; Extended Detention
Pretreatment Required:	Yes
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	Calculated release rate
Water Quality	Dry Basin: None Underground Vaults: None Wet Pond: Count volume of permanent pool Constructed Wetland: Count volume of permanent pool Extended Detention: Count volume detained 24 hours

B. Sizing Calculations

1. Determine contributing site drainage area.

2. Calculate allowable release rate.

3. Determine a Rational Method weighted runoff coefficient, or select CNs for the developed site as outlined in "Calculating Runoff" (page 39).

4. Use the Rational Method spreadsheet, or the Green Calculator to calculate the required storage volumes for flood control as outlined in "Flood Control Using Detention Basins" (page 47).

5. Where stream protection and water quality treatment are provided through detention, these volumes may be included in the flood control volume.

6. If stream protection is to be provided as extended detention, calculate the required storage volume and release rate from ***Figure 5*** using a weighted CN for the developed site as outlined in "Stream Protection using Extended Detention" (page 46). Extended detention can be included as the first stage of a two-stage detention basin.

7. If extended detention is used, water quality standards are also met. Otherwise, water quality standards can met through a permanent pool, or underdrain (i.e. gravel filter) in the bottom of a dry detention basin. Determine water quality volume using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

8. Size forebay(s) for pre-treatment using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

Detention Basins (continued)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

      (1) A minimum of 2 feet is required between the bottom of dry detention basins and the highest known groundwater elevation.

      (2) Wet ponds and constructed wetlands shall have a reliable supply of baseflow or groundwater to support a permanent pool.

      (3) Wet ponds and constructed wetlands proposed in HSG A and HSG B soils above the groundwater table shall have a clay or synthetic liner to minimize infiltration.

   b. Setbacks shall be as follows:

      (1) Adjacent property line: 10 feet
      (2) Building foundation: 30 feet
      (3) Private well: 50 feet
      (4) Public well: 200 feet from Type I or Type IIa wells, 75 feet from Type IIb or Type III wells (Safe Drinking Water Act, Act 399, PA 1976)
      (5) Septic system drainfield: 100 feet

2. Sizing and Configuration

   a. General

      (1) Where water quality and stream protection are provided through detention, these volumes may be included in the flood control volume.

      (2) Distances of flow paths between inlets and outlets shall be maximized. A minimum basin length-to-width ratio of 3 to 1 is required.

      (3) If site constraints preclude placing pipes at opposite ends of the basin or meeting the length-to-width ratio, baffles may be used to lengthen the flow path.

      (4) Where steeper side slopes than those specified are unavoidable, safety railing, fencing or other access barriers may be approved.

   b. Dry Basin

      (1) The design high water depth should generally not exceed 10 feet above the bottom of the basin.

      (2) Side slopes shall not be steeper than 3:1 (H:V). Where basins are to be maintained as a mown lawn, side slopes shall be no steeper than 4:1 (H:V) to facilitate mowing.

      (3) The bottom of dry detention basins shall be graded to provide positive flow to the pipe outlet. A minimum flow line bottom slope of 1% should be provided. Cross slopes should be 2% minimum. If continuous flow is anticipated, a low-flow channel shall be provided, with necessary crossings, and sloped to eliminate standing water. If site grades prohibit achieving these minimum slopes, the Drain Commissioner may approve the use of an underdrain with flatter slopes.

Detention Basins (continued)

c. Wet Pond

(1) At a minimum, the volume of the permanent pool for wet ponds shall be 2.5 times the water quality volume to account for reduced settling efficiency due to turbulence caused by wind.

(2) Wet ponds shall generally be wedge-shaped with inflow at the narrow end to prevent short-circuiting and stagnation. However, other shapes meeting the design intent may be approved.

(3) Permanent pools shall have a minimum depth of 3 feet across the deepest part of the basin to discourage aquatic plant infill and provide open water.

(4) The design high water depth should generally not exceed 10 feet above the permanent pool elevation.

(5) Side slopes shall not be steeper than 3:1 (H:V). Where basins are to be maintained as a mown lawn to the water's edge, side slopes shall be no steeper than 4:1 (H:V) to facilitate mowing.

(6) Permanent pools deeper than 4 feet shall have two safety ledges each between 6 and 8 feet wide. One shall start at the normal water surface and extend up to the pond side slopes at a maximum slope of 15%. The other shall extend from the water surface into the pond to a depth of 12 inches at a slope of 15%.

(7) Warning signs prohibiting swimming and skating shall be posted for wet ponds.

d. Constructed Wetland

(1) The emergent vegetation zone shall comprise 60 to 65% of the total surface area. Half shall be high marsh with a normal water depth of 6-inches or less, and half shall be low marsh with a normal water depth between 6 and 18 inches.

(2) The open water zone shall comprise 35 to 40% of the total surface area with a normal water depth of between 18 inches and 6 feet.

(3) At a minimum, the volume of the permanent pool for the open water zone shall be 2.5 times the water quality volume to account for reduced settling efficiency due to turbulence caused by wind.

(4) The 10-year water surface elevation shall not exceed the normal water surface elevation by more than 3 feet.

(5) Side slopes shall not be steeper than 3:1 (H:V).

(6) Open water deeper than 4 feet shall have two safety ledges each between 4 and 6 feet wide. One shall be situated 12 to 18 inches above the normal water surface and the other 24 to 30 inches below the water surface.

(7) A micro pool shall be located at the outlet of the storm water wetland to protect the low flow pipe from clogging and prevent sediment resuspension. The micro pool shall be 3 to 6 foot deep and have a minimum surface area equivalent to the forebay.

Detention Basins (continued)

3. Inlet Design

   a. Inlet pipes shall not be fully submerged at normal pool elevations.

   b. Inlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 10 feet per second.

   c. Pre-treatment is required for each inlet, unless the inlet supplies less than 10% of the total design flow to the detention basin.

   d. Pretreatment can be provided in a sediment forebay or spill containment cell located within the detention basin. For small sites, a water quality device located prior to the basin may be allowed. Pre-treatment for overland sheet flow entering the basin can be provided through a vegetated filter strip.

   e. When spill containment is required and a spill containment cell is used, all pipes contributing runoff from the high risk area must enter this cell for pre-treatment.

4. Outlet Design

   a. The outlet may be designed using the orifice equation, rearranged to solve for area.

$$A = \frac{Q}{c\sqrt{2gH}}$$

   where:
   A = required area (square feet)
   Q = required outflow (cubic feet per second)
   c = orifice coefficient (approximately 0.6)
   2g = two times the gravitation constant (g = 32.2 feet per second)
   H = height of design high water level above center of orifice outlet (feet)

   b. Other types of outlet devices shall have full design calculations provided for review.

   c. The outlet shall be designed to prevent clogging.

   d. Pipes or orifice plates shall have a minimum diameter of 4 inches.

   e. Orifices used to maintain a permanent pool shall be designed to withdraw water a minimum of 2 feet below the normal water surface.

   f. Riser pipes with holes or slits less than 4 inches in diameter shall have a stone and gravel filter placed around the outside of the pipe.

   g. Hoods and trash racks shall be placed on riser pipes. Grate openings shall be a maximum of 3 inches on center.

h. Riser pipes shall have a minimum diameter of 24 inches. Riser pipes greater than 4 feet in height shall be 48 inches in diameter.

i. Riser pipes shall be constructed of reinforced concrete or corrugated metal and be set in a concrete base. Plastic is not acceptable as a riser material.

j. Outlet control structures shall be placed near or within the embankment to facilitate maintenance access.

k. Outlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 10 feet per second.

l. A drain for completely dewatering the detention basin shall be installed for maintenance purposes.

m. Pipes placed through embankments shall have anti-seep collars.

5. Emergency Overflow

a. All detention facilities must have a provision for overflow at the high water level. A spillway shall be designed for the 10-year inflow with a maximum flow depth of 1 foot. The spillway shall be sized using the weir equation.

$$Q = 2.6LH^{\frac{3}{2}}$$

where:
Q = discharge (cubic feet per second)
2.6 = coefficient of discharge
L = length of spillway crest (feet)
H = total head measured above spillway crest (feet)

b. The top of berm elevation shall be a minimum of 18 inches above the crest of the spillway to allow for at least 6-inches of freeboard between the overflow spillway water elevation and the top of berm.

c. Overflow spillways shall be protected with concrete, riprap or a permanent erosion control blanket to prevent erosion of the structure.

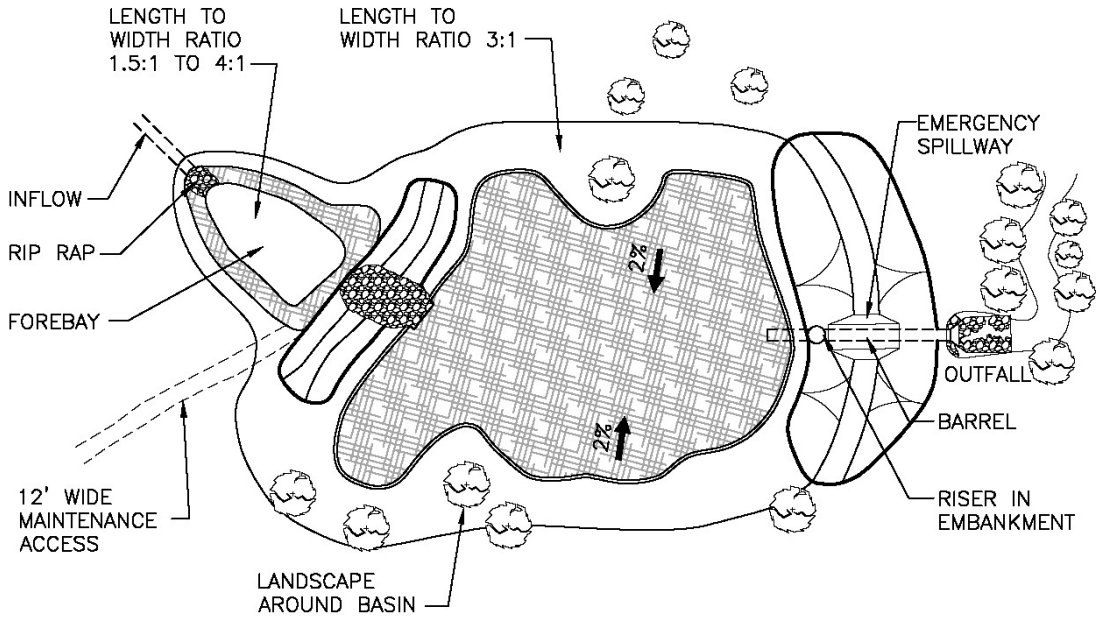
6. Access

a. Berm top width shall be a minimum of 16 feet.

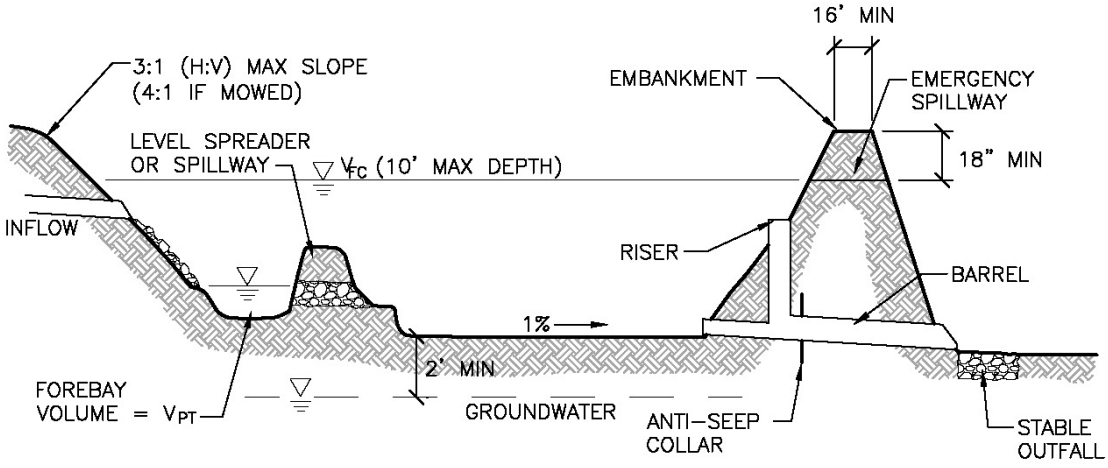
b. A minimum 12-foot wide maintenance access route from a public or private right-of-way shall be provided to the basin. The access way shall have a slope of no greater than 5:1 (H:V) and shall be stabilized to withstand the passage of heavy equipment. Direct access to the forebay, control structures and the outlet shall be provided.

D. Design Schematics

DRY DETENTION BASIN



PLAN VIEW

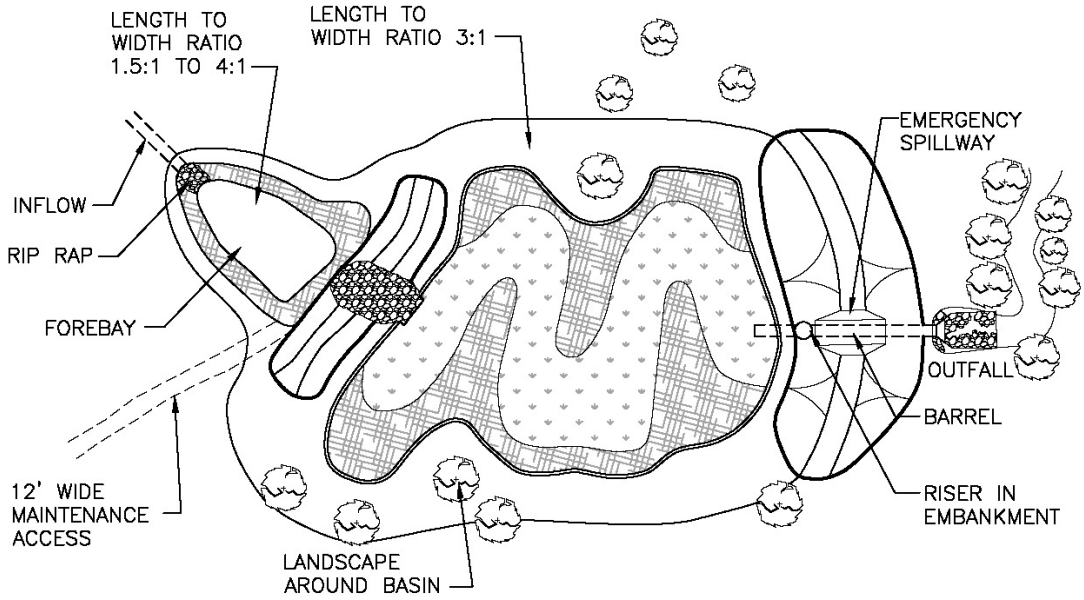


PROFILE

DRY DETENTION BASIN MUST BE COMBINED WITH OTHER BMP'S TO MEET WATER QUALITY VOLUME CRITERIA.

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

EXTENDED DRY DETENTION BASIN



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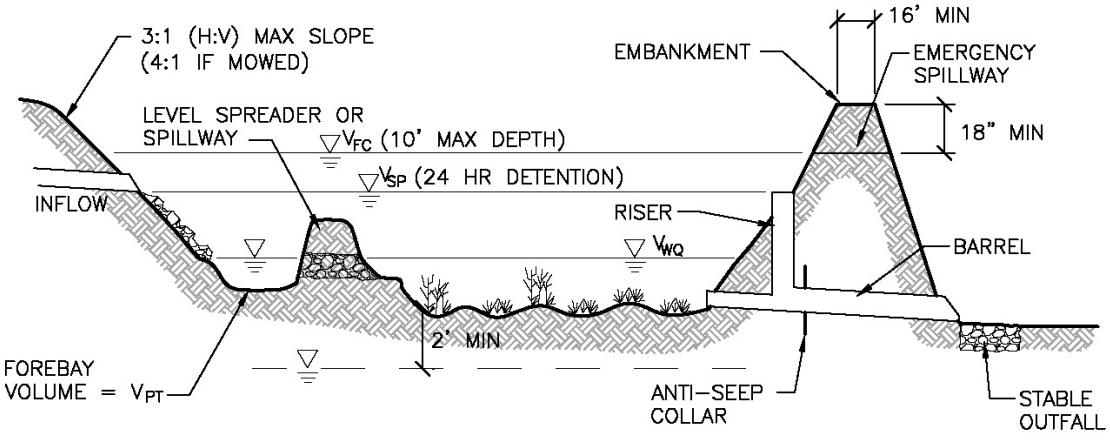
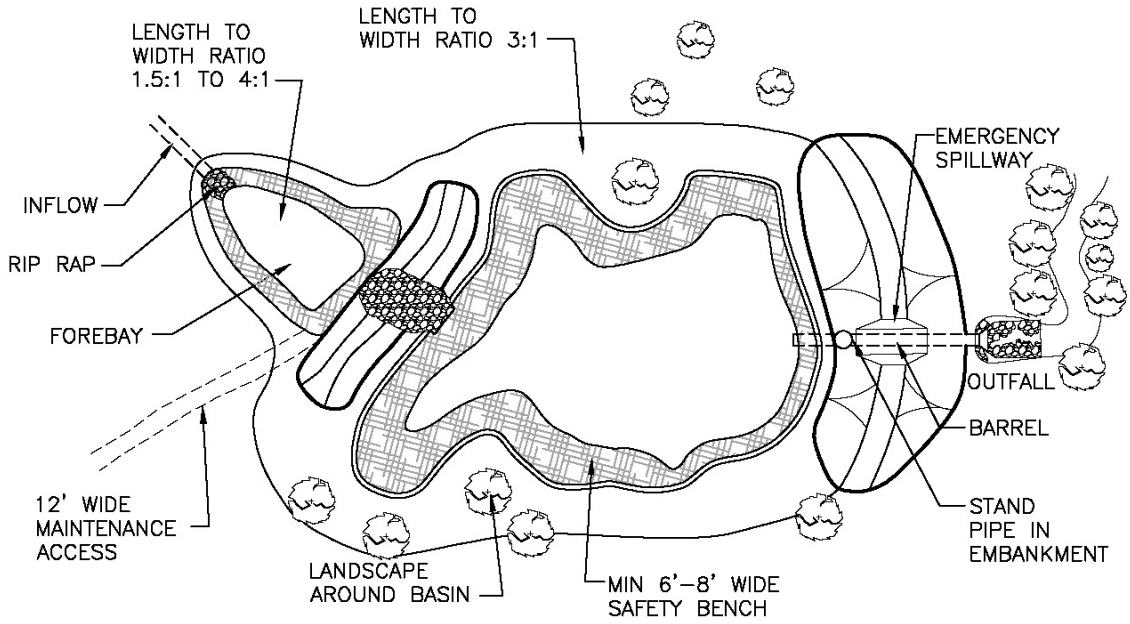


PROFILE

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

WET DETENTION BASIN (WET POND)



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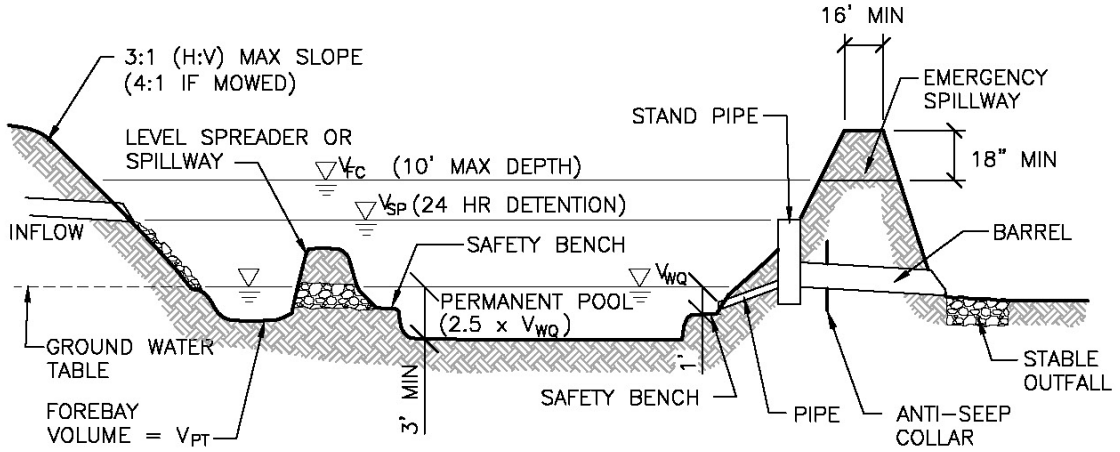
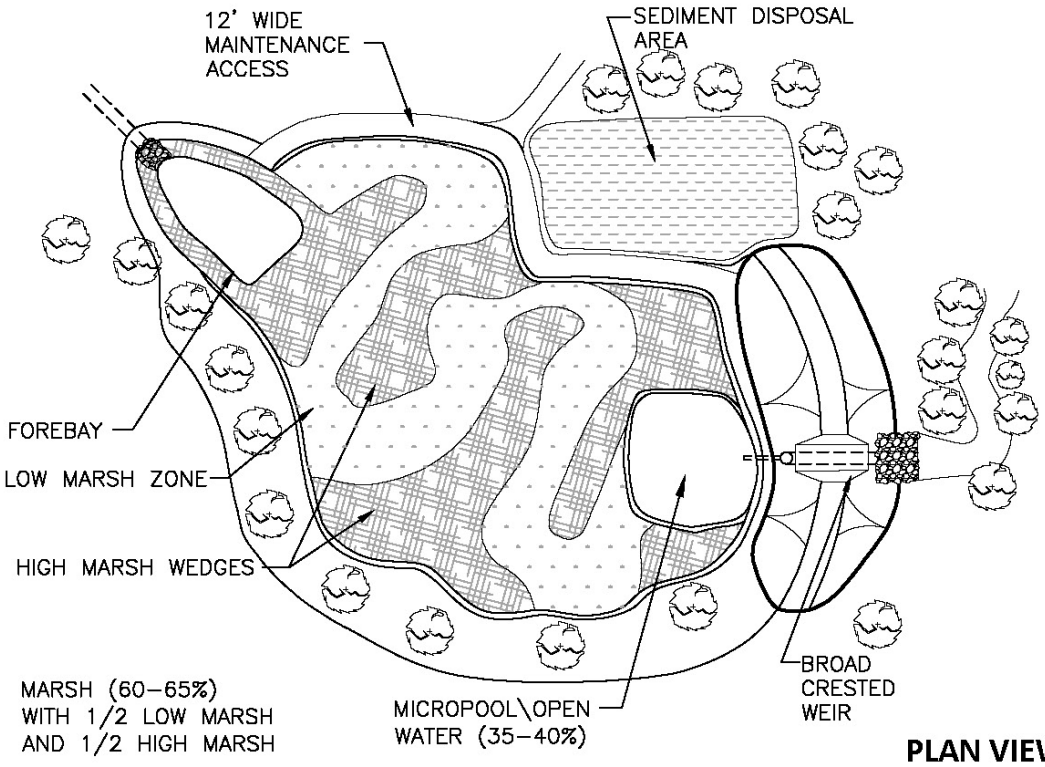


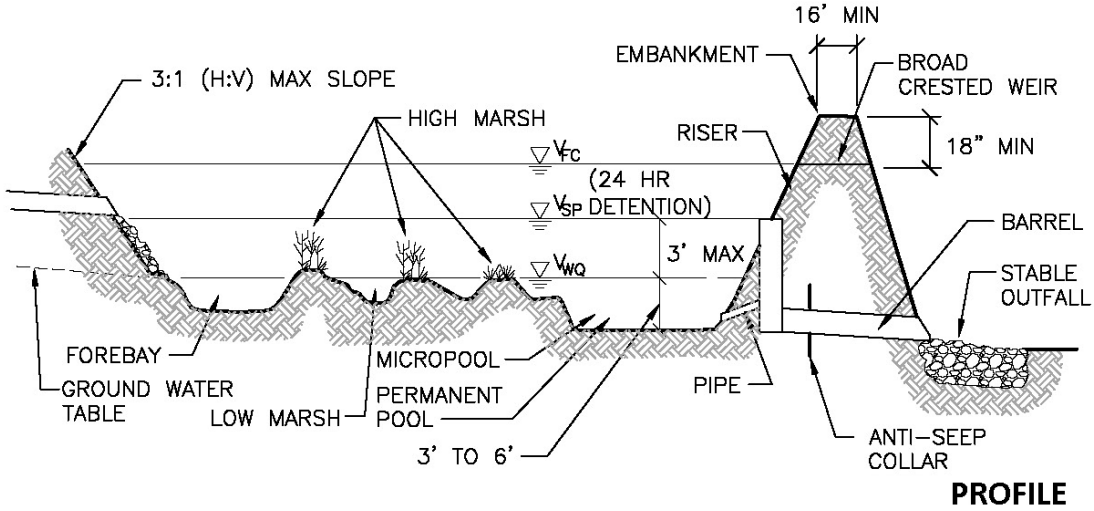
PROFILE

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

CONSTRUCTED WETLAND



PLAN VIEW



PROFILE

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

Retention Basins

A. Summary

Description:	Provides storm water storage without a surface outlet
Types:	Dry Basin; Wet Pond
Pretreatment Required:	Yes
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Count volume stored and infiltrated
Rate Reduction	Designed for flood control: 100%
Water Quality	Count volume stored and infiltrated

B. Sizing Calculations

1. Determine contributing site drainage area.

2. Use the Rational Method spreadsheet, or the Green Calculator to calculate the required storage volumes for flood control as outlined in "Flood Control Using Retention Basins" (page 48).

3. Calculate the minimum infiltration area required to drain the required storage volume in the specified drawdown time using the design infiltration rate of the underlying soil.

$$A = [V_s / (i \times t_d)] \times 12$$

where:
A = minimum infiltration area (square feet)
V_s = storage volume (cubic feet)
i = design infiltration rate of soil (inches per hour) from ***Table 5***
t_d = maximum allowable drawdown time (hours)
12 = factor to convert inches to feet

4. Drawdown time shall be no more than 72 hours.

5. The infiltration area shall be defined as the bottom of the basin.

6. Stream protection and water quality volumes may be included in the flood control volume.

7. Size forebay(s) for pre-treatment using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

Retention Basins (continued)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

      (1) A minimum of 4 feet is required between the bottom of dry retention basins and the highest known groundwater elevation.

   b. Setbacks shall be as follows:

      (1) Adjacent property line: 10 feet
      (2) Building foundation: 30 feet
      (3) Private well: 50 feet
      (4) Public well: 200 feet from Type I or Type IIa wells, 75 feet from Type IIb or Type III wells (Safe Drinking Water Act, Act 399, PA 1976)
      (5) Septic system drainfield: 100 feet

2. Sizing and Configuration

   a. General

      (1) Where water quality and stream protection are provided through retention, these volumes may be included in the flood control volume.

      (2) Where steeper side slopes than those specified are unavoidable, safety railing, fencing or other access barriers may be approved.

   b. Dry Basin

      (1) The design high water depth should generally not exceed 10 feet above the bottom of the basin.

      (2) Side slopes shall not be steeper than 3:1 (H:V). Where basins are to be maintained as a mown lawn, side slopes shall be no steeper than 4:1 (H:V) to facilitate mowing.

      (3) The bottom of dry retention basins shall be flat to encourage uniform ponding and infiltration.

      (4) The bottom of dry retention basins shall be scarified to a depth of 4 to 6 inches after final grading has been established.

      (5) Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.

   c. Wet Pond (no surface water outlet)

      (1) The design high water depth should generally not exceed 10 feet above the permanent pool elevation.

      (2) Where excavation and reshaping of the retention area is necessary, side slopes shall not be steeper than 3:1 (H:V). Where basins are to be maintained as a mown lawn to the water's edge, side slopes shall be no steeper than 4:1 (H:V) to facilitate mowing.

      (3) Where excavation and reshaping of the retention area is necessary, permanent pools deeper than 4 feet shall have two safety ledges each between 6 and 8 feet wide. One shall start at the normal water surface and extend up to the pond side slopes at a maximum slope of 15%. The other shall extend from the water surface into the pond to a depth of 12 inches at a slope of 15%.

      (4) Warning signs prohibiting swimming and skating shall be posted for wet ponds.

Retention Basins (continued)

3. Inlet Design

   a. Inlet pipes shall not be fully submerged at normal pool elevations.

   b. Inlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 10 feet per second.

   c. Pre-treatment is required for each inlet and can be provided in a sediment forebay or spill containment cell located within the retention basin. For small sites, a water quality device may be allowed prior to the basin. Pre-treatment for overland sheet flow entering the basin can be provided through a vegetated filter strip.

   d. When spill containment is required and a spill containment cell is used, all pipes contributing runoff from the high risk area must enter this cell for pre-treatment.

4. Emergency Overflow

   a. All retention basins must have a provision for overflow at the high water level. A spillway shall be designed for the 10-year inflow with a maximum flow depth of 1 foot. The spillway shall be sized using the weir equation.

$$Q = 2.6LH^{\frac{3}{2}}$$

   where:
   Q = discharge (cubic feet per second)
   2.6 = coefficient of discharge
   L = length of spillway crest (feet)
   H = total head measured above spillway crest (feet)

   b. The top of berm elevation shall be a minimum of 18 inches above the design high water level to allow for at least 6-inches of freeboard between the overflow spillway water elevation and the top of berm.

   c. Overflow spillways shall be protected with concrete, riprap or a permanent erosion control blanket to prevent erosion of the structure.

   d. Infiltration basins without an acceptable surface water overflow route shall be designed for 1.5 times the required flood control volume.

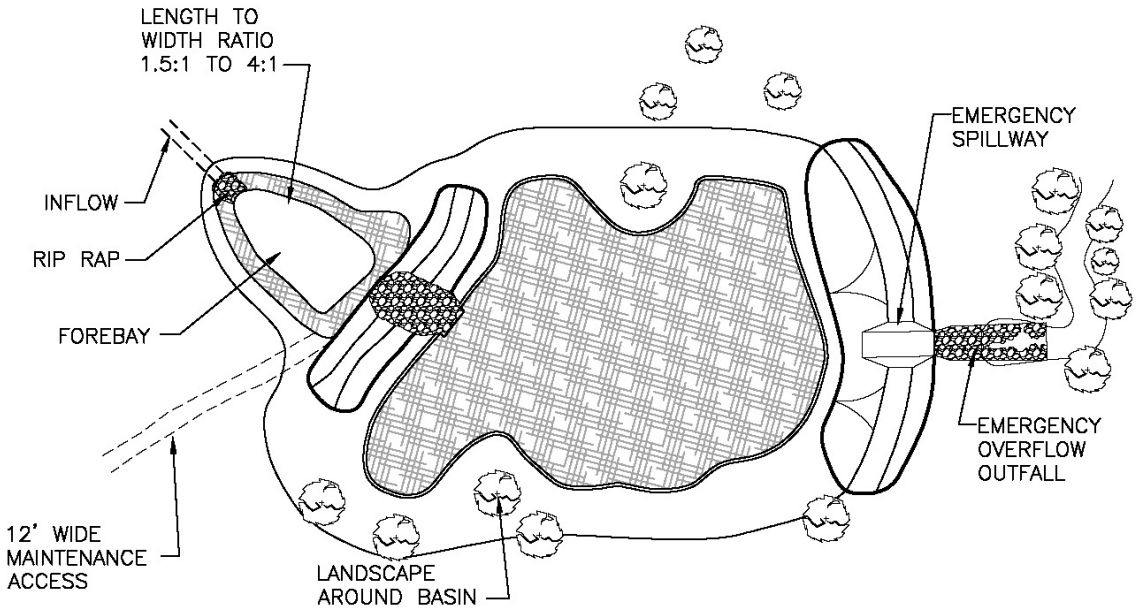
5. Access

   a. Berm top width shall be a minimum of 16 feet.

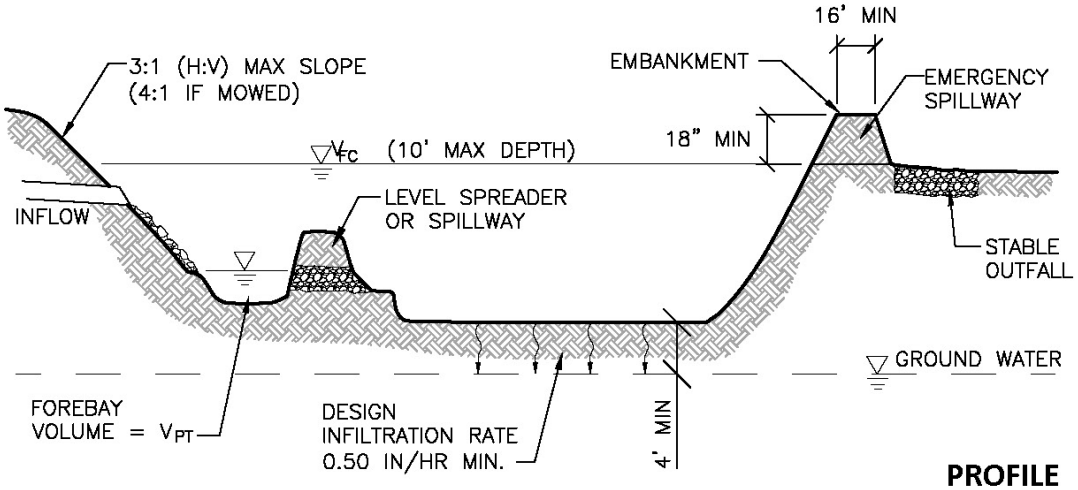
   b. A minimum 12-foot wide maintenance access route from a public or private right-of-way shall be provided to the basin. The access way shall have a slope of no greater than 5:1 (H:V) and shall be stabilized to withstand the passage of heavy equipment. Direct access to the forebay, control structures and the outlet shall be provided.

D. Design Schematics

DRY RETENTION BASIN



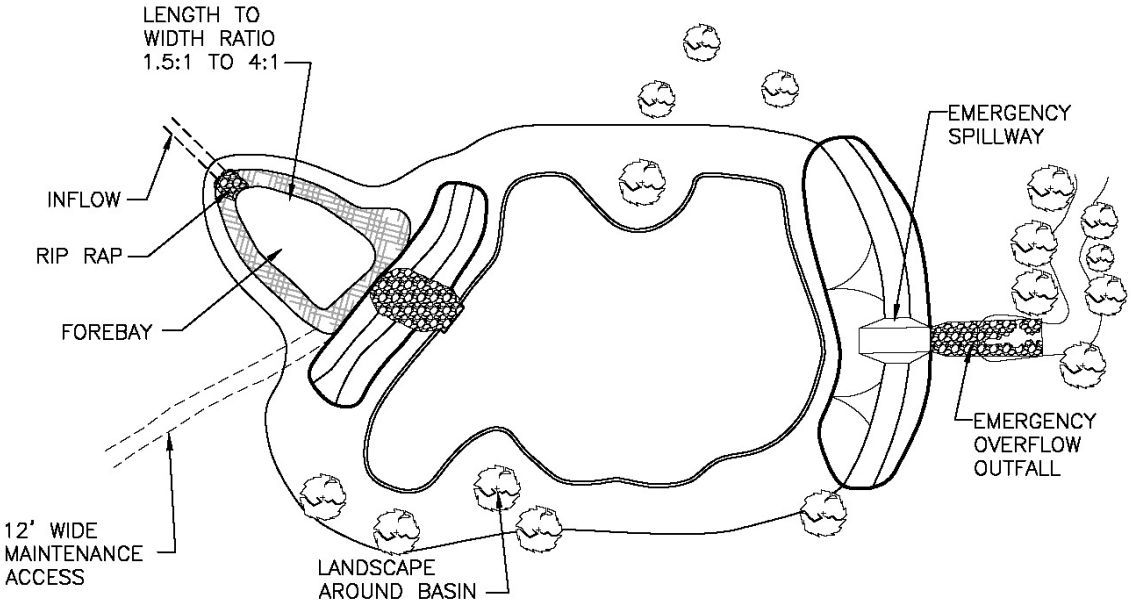
PLAN VIEW



PROFILE

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

WET RETENTION BASIN



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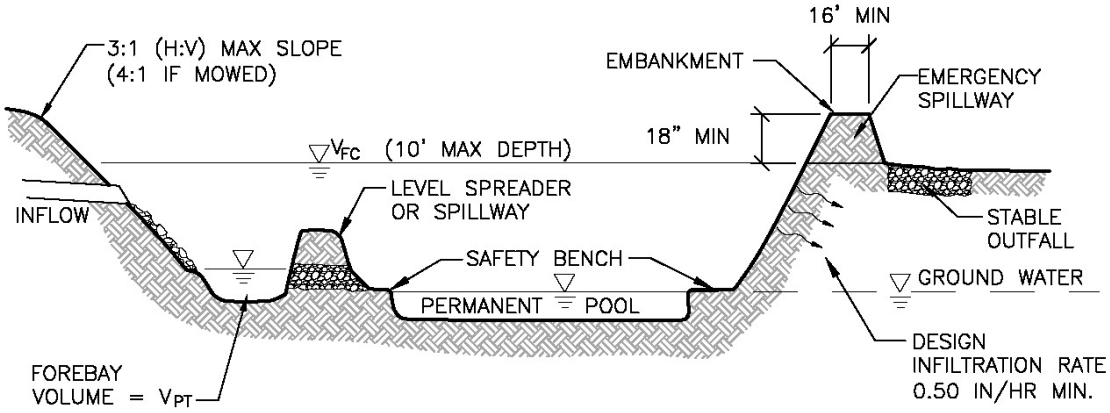


PROFILE

FINAL OUTLET CONFIGURATION MUST BE DESIGNED TO PREVENT CLOGGING

Infiltration Practices

A. Summary

Description:	Storm water treatment and storage without a surface outlet
Types:	Dry Well; Leaching Basin; Infiltration Trench; Infiltration Bed; Infiltration Berm
Pretreatment Required:	Yes
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Count volume stored and infiltrated
Rate Reduction	Designed for flood control: 100% Designed for stream protection and/or water quality: Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count volume stored and infiltrated

B. Sizing Calculations

1. If the infiltration practice is to be sized for stream protection or water quality, use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volumes.

   a. Subtract the volume infiltrated by the BMP during the infiltration period to determine the required storage volume of the BMP. The infiltration volume is calculated as:

      Maximum Allowable Infiltration Rate (inches per hour) x 6 hours x Infiltration Area (square feet) x 1/12 unit conversion

   b. The maximum allowable soil infiltration rate used to size the storage volume of the BMP shall be 0.52 inches per hour, except that 1.04 inches per hour may be used where soil borings indicate clean sand or gravel free of any other soil seams.

   c. The infiltration period is the time when the bed is receiving runoff and is capable of infiltrating at the design rate, which is conservatively estimated as 6 hours.

2. If the infiltration practice is to be sized for flood control, use one of the methods outlined in "Flood Control Using Retention Basins" (page 48) to calculate the required storage volume.

3. Stream protection and water quality volumes may be included in the flood control volume.

4. Calculate the minimum infiltration area required to drain the required storage volume in the specified drawdown time using the design infiltration rate of the underlying soil.

$$A = [V_s / (i \times t_d)] \times 12$$

where:
A = minimum infiltration area (square feet)
V_s = storage volume (cubic feet)
i = design infiltration rate of soil (inches per hour) from ***Table 5***
t_d = maximum allowable drawdown time (hours)
12 = factor to convert inches to feet

5. Total drawdown time shall be no more than 72 hours. Depth of surface ponding shall be no more than 2 feet and drain within 24 hours.

6. Infiltration area shall be defined as:

   a. Dry Well/Leaching Basin: Bottom and sides (lateral)
   b. Infiltration Trench: Bottom of trench (length x width)
   c. Infiltration Bed: Bottom area of the bed
   d. Infiltration Berm: Ponding area (length of berm x average width of ponding behind berm)

7. Calculate the storage volume of the BMP.

   e. Dry wells, infiltration trenches, infiltration beds:

      Subsurface Storage Volume (cubic feet) = Length (feet) x Width (feet) x Depth (feet) x Void Ratio of Material

      Where perforated pipe is used in the trench or infiltration bed design, the formula is modified:

      Subsurface Storage Volume (cubic feet) = Volume of Pipe (cubic feet) + [Length (feet) x Width (feet) x Depth (feet) – Volume of Pipe (cubic feet)] x Void Ratio of Material

   f. Leaching basins:

      Storage Volume (cubic feet) = $2 \Pi r^2$ *(square feet) x Depth (feet)*

      where:
      r = radius of leaching basin (feet)
      Π = *pi* (approximately 3.14)

      Volume of storage in stone envelope around leaching basin may also be counted.

   g. Infiltration berm:

      Surface Storage Volume (cubic feet) = Average Ponding Area (square feet) x Design High Water Depth (feet)

Infiltration Practices (continued)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

      (1) A minimum of 4 feet is required between the bottom of infiltration practices and the highest known groundwater elevation.

      (2) Void ratio for the imported material shall be based on the USDA soil textural class and effective water capacity in ***Table 5***. A maximum design value of 0.40 shall be used for the void ratio of stone.

   b. Setbacks shall be as follows:

      (1) Adjacent property line: 10 feet
      (2) Building foundation: 10 feet
      (3) Private well: 50 feet
      (4) Public well: 200 feet from Type I or Type IIa wells, 75 feet from Type IIb or Type III wells (Safe Drinking Water Act, Act 399, PA 1976)
      (5) Septic system drainfield: 50 feet

   c. Infiltration practices shall be located outside of the drip line of adjacent trees.

2. Sizing and Configuration

   a. General

      (1) Where water quality and stream protection are provided through infiltration, these volumes may be included in the flood control volume.

      (2) A combination of surface and subsurface storage may be used to provide the required storage volume.

   b. Dry wells, infiltration trenches and infiltration beds

      (1) Infiltration trench width shall generally be as follows: 3-foot minimum to 6-foot maximum.

      (2) Course aggregates shall be uniformly graded, washed and wrapped in a non-woven geotextile to provide separation between the aggregate and the surrounding soil and prevent fines from clogging the infiltration surface.

      (3) An observation well shall be provided for each dry well, at each end of an infiltration trench, and at each corner of an infiltration bed with intermediate center wells added so as not to exceed maximum distance of 50 feet between wells.

      (4) Perforated pipes laid flat may be used to distribute runoff over the bottom of infiltration trenches and infiltration beds.

Infiltration Practices (continued)

(5) Cleanouts shall be provided at pipe ends.

(6) Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.

c. Leaching Basins

(1) Leaching basins shall have a minimum diameter of 4 feet with a maximum spacing of 400 feet between basins.

(2) Leaching basins shall have an open bottom and perforations around the circumference of the structure at no greater than 12-inch intervals horizontally and vertically the entire depth of the sump.

(3) Bedding and backfill shall consist of clean stone with nonwoven geotextile fabric placed along the walls of the trench and wrapped around the stone and the basin.

d. Infiltration Berms

(1) Infiltration berms shall be constructed along (parallel to) contours at a constant level elevation.

(2) Maximum berm height shall be 2 feet to prevent excessive ponding behind berm.

(3) Berm top width shall be a minimum of 16 feet.

(4) Side slopes shall not be steeper than 4:1 (H:V) to facilitate mowing and ensure stable side slopes.

(5) Well compacted cohesive soil shall be used to construct the berm.

(6) The berm shall be well vegetated to prevent erosion if overtopped.

3. Inlet Design

a. Pre-treatment is required for each inlet and for overland flow entering the infiltration practice. Exceptions may be allowed for small paved drainage areas contributing directly to a leaching basin.

4. Emergency Overflow

a. All infiltration practices must have a provision for overflow at the high water level.

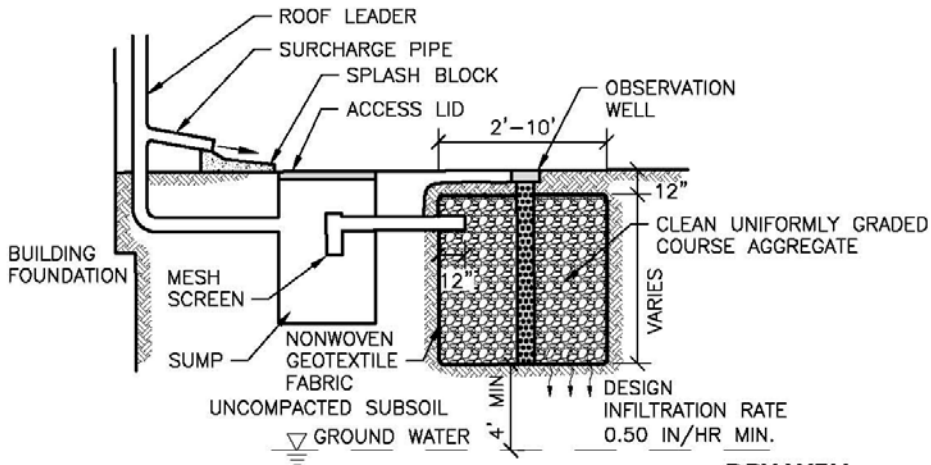
b. Infiltration practices without an acceptable surface water overflow route shall be designed for 1.5 times the required flood control volume.

5. Access

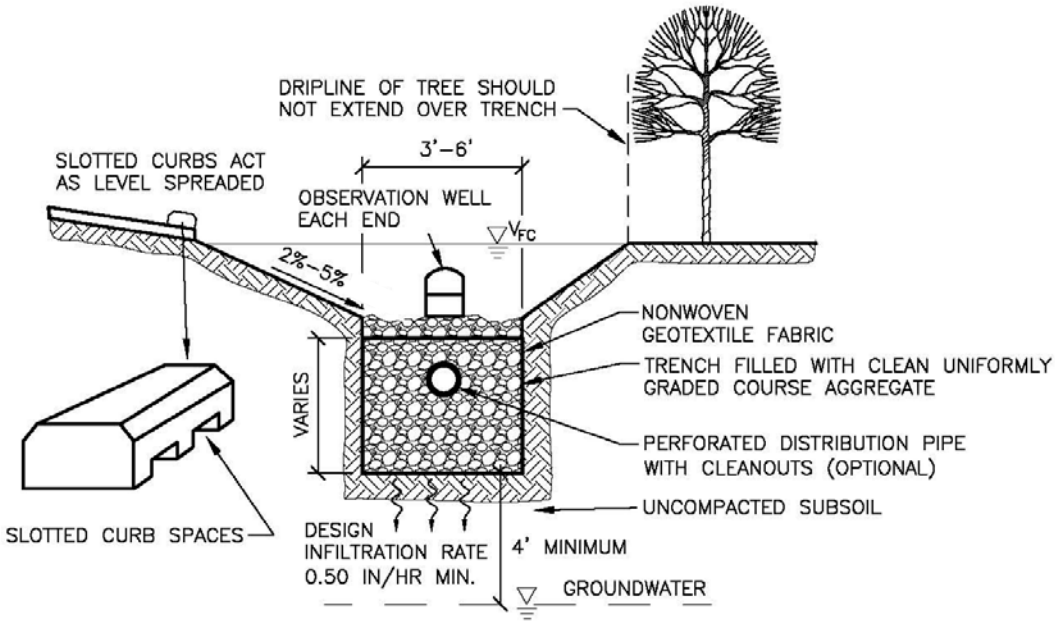
a. Inspection and maintenance access to the infiltration practice shall be provided.

D. Design Schematics

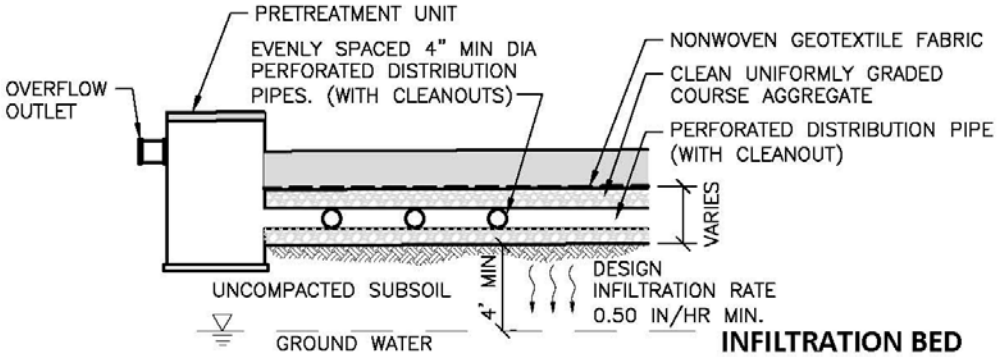
INFILTRATION PRACTICES



DRY WELL



INFILTRATION TRENCH



INFILTRATION BED

Bioretention / Rain Garden

A. Summary

Description:	Provides storm water treatment, storage and uptake with or without a surface outlet; Underdrained BMP may be allowed on small sites in lieu of extended detention
Types:	Bioretention: Natural-looking herbaceous Rain garden: Landscaped and manicured Infiltration; Underdrain at top of storage layer; Underdrain at bottom of storage layer; Lined
Pretreatment Required:	Yes
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Infiltration: Count volume stored and infiltrated Underdrained: Count volume stored and infiltrated between bottom of BMP and invert of underdrain
Rate Reduction	Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count total volume stored and infiltrated/filtered

B. Sizing Calculations

1. For underdrained BMP, follow criteria for "Constructed Filter."

2. Bioretention / rain gardens may be sized for stream protection or water quality treatment. Use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volumes.

   a. Subtract the volume infiltrated by the BMP during the infiltration period to determine the required storage volume of the BMP. The infiltration volume is calculated as:

      Maximum Allowable Infiltration Rate (inches per hour) x 6 hours x Infiltration Area (square feet) x 1/12 unit conversion

   b. The maximum allowable soil infiltration rate used to size the storage volume of the BMP shall be 0.52 inches per hour, except that 1.04 inches per hour may be used where soil borings indicate sand or gravel free of any other soil seams.

   c. The infiltration period is the time when the bed is receiving runoff and is capable of infiltrating at the design rate, which is conservatively estimated as 6 hours.

3. Bioretention / rain gardens may be able to provide flood control on small sites. Use one of the methods outlined in "Flood Control Using Retention Basins" (page 48) to calculate the required storage volume.

Bioretention / Rain Garden (continued)

4. Calculate the minimum infiltration area required to drain the required storage volume in the specified drawdown time using the design infiltration rate of the underlying soil.

$$A = [V_s / (i \times t_d)] \times 12$$

where:
A = minimum infiltration area (square feet)
V_s = storage volume (cubic feet)
i = design infiltration rate of soil (inches per hour) from ***Table 5***
t_d = maximum allowable drawdown time (hours)
12 = factor to convert inches to feet

5. Total drawdown time shall be no more than 72 hours. Depth of surface ponding shall be no more than 9 inches and drain within 24 hours.

6. Surface ponding depth may be increased up to 18 inches for bioretention areas.

7. The bottom area of the BMP shall be used as the infiltration area.

8. Calculate the storage volume of the BMP.

Average Bed Area (square feet) = [Area at Design High Water Depth (square feet) + Bottom Area (square feet)] / 2

Surface Storage Volume (cubic feet) = Average Bed Area (square feet) x Design High Water Depth (feet)

Subsurface Storage Volume (cubic feet) = Length (feet) x Width (feet) x Depth (feet) x Void Ratio of Material

Total Storage Volume (cubic feet) = Surface Storage Volume (cubic feet) + Subsurface Storage Volume (cubic feet)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in “Soils Investigation” (page 35).

      (1) A minimum of 4 feet is required between the bottom of bioretention / rain gardens capable of infiltration and the highest known groundwater elevation.

      (2) A minimum of 2 feet is required between the bottom of lined or underdrained bioretention / rain gardens and the highest known groundwater elevation.

Bioretention / Rain Garden (continued)

(3) An underdrain shall be provided for design infiltration rates of the underlying native soil less than 0.50 inches per hour, or if bioretention / rain garden will be lined.

(4) Void ratio for the amended soil material shall be based on the USDA soil textural class and effective water capacity in ***Table 5***. A maximum design value of 0.30 shall be used for the void ratio of the amended soil material. A maximum design value of 0.40 shall be used for the void ratio of stone.

b. Setbacks shall be as follows:

(1) Adjacent property line: 10 feet
(2) Building foundation: 10 feet
(3) Private well: 50 feet
(4) Public well: 200 feet from Type I or Type IIa wells, 75 feet from Type IIb or Type III wells (Safe Drinking Water Act, Act 399, PA 1976)
(5) Septic system drainfield: 50 feet

2. Sizing and Configuration

a. General

(1) The bottom shall be flat to encourage uniform ponding and infiltration.

(2) Minimum bottom width shall be 3 feet.

(3) Bioretention / rain gardens located in areas with steep slopes shall be terraced to minimize earth disturbance and maximize infiltration area.

(4) Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.

(5) Bioretention / rain gardens located in areas of existing soil contamination shall be lined to prevent infiltration.

(6) Underdrains shall have a 4-inch minimum pipe diameter.

(7) All underground pipes shall have clean-outs accessible from the surface.

(8) Pipe slopes shall have a minimum slope of 1%.

(9) Side slopes shall not be steeper than 3:1 (H:V), unless landscape retaining walls are used.

(10) An observation well shall be provided for each bioretention / rain garden.

b. Rain gardens

(1) A landscape plan shall be provided.

Bioretention / Rain Garden (continued)

3. Inlet Design

   a. Inlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second up to a maximum allowable design velocity of 10 feet per second.

   b. Pre-treatment is required for each inlet and for overland flow entering the bioretention / rain garden.

4. Emergency Overflow

   a. All bioretention / rain gardens must have a provision for overflow at the high water level.

5. Materials

   a. Amended soil material shall consist of 18 to 48 inches of the following materials, evenly mixed: Compost: 30-50%; Sand: 20-40%; Topsoil: 20-30% (maximum clay content of topsoil shall be 20%).

      (1) Alternative mix designs with ratios outside of the limits provided will be considered with justification.

      (2) The soil mix shall have a pH between 5.5 and 7.5.

   b. Stone shall consist of clean, uniformly graded course aggregate.

   c. A nonwoven geotextile fabric shall be placed between the amended soil and the stone, when a stone layer is used.

   d. When used, impermeable liner shall have a maximum permeability of 1×10^{-7} centimeters per second certified by the manufacturer.

   e. Plant selection shall consider exposure and tolerance to salt, sediment and pollutants, and the design depth of surface storage. Native species are encouraged.

      (1) Bioretention: Plugs and seed.

      (2) Rain gardens: Container stock.

   f. Mulch shall be applied after planting.

      (1) Bioretention: Straw mulch or mulch blanket shall be uniformly applied and tacked.

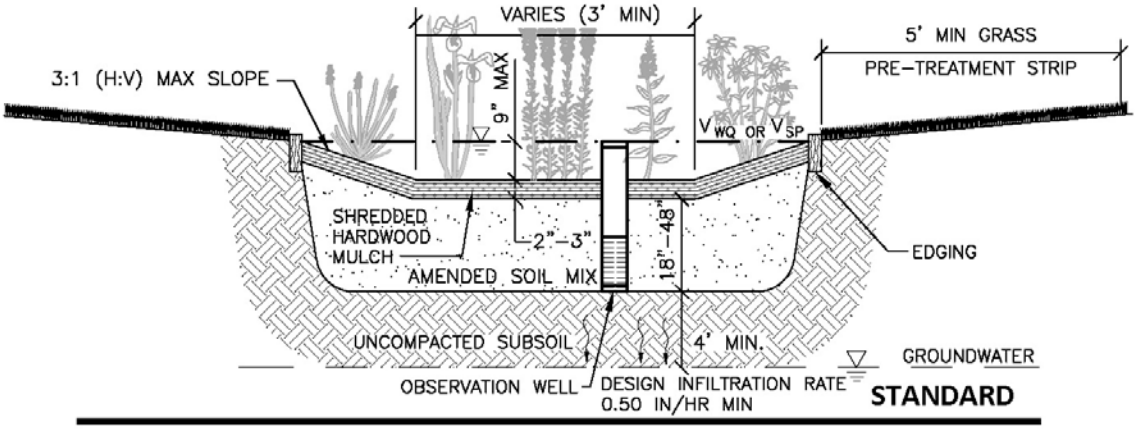
      (2) Rain gardens: Shredded hardwood mulch shall be uniformly applied to a depth of 2 to 3 inches.

6. Access

   a. Inspection and maintenance access to the bioretention / rain garden shall be provided.

D. Design Schematics

BIORETENTION/RAIN GARDEN



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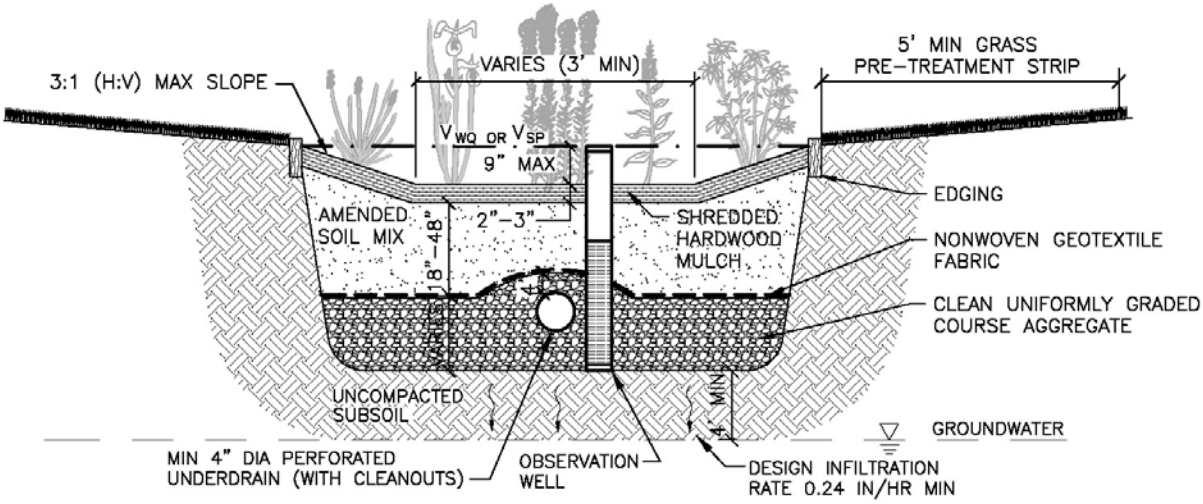
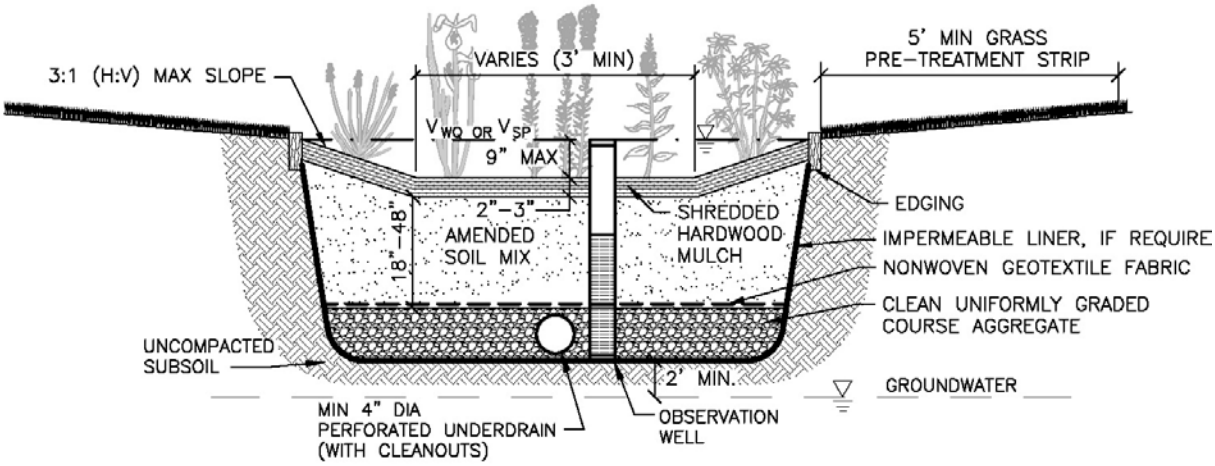


BIORETENTION/RAIN GARDEN WITH STONE STORAGE LAYER



BIORETENTION/RAIN GARDEN WITH BOTTOM DRAIN

Constructed Filter

A. Summary

Description:	Provides storm water treatment and storage with a surface outlet (underdrain); May be allowed on small sites in lieu of extended detention
Types:	Sand; Gravel; Sand/compost mix; Other media
Pretreatment Required:	Yes. This BMP can provide spill containment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count total volume stored and filtered

B. Sizing Calculations

1. Use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volumes for stream protection, water quality and/or pre-treatment.

2. Calculate filter surface area required to drain the design volume in the specified drawdown time using hydraulic conductivity of filter media.

$$A = V \times d_f / [K \times (h_f + d_f) \times t_d]$$

where:
A = minimum surface area of filter (square feet)
V = design runoff volume (cubic feet)
d_f = depth of filter media (1.5-foot minimum to 3-foot maximum)
K = hydraulic conductivity (feet per day)
h_f = average head; typically ½ of the maximum head on filter media (feet)
t_d = maximum allowable drawdown time (days)

3. Total drawdown time shall be no more than 72 hours.

4. Check whether soil conductivity or hydraulics of underdrain governs.

Constructed Filter (continued)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

      (1) A minimum of 2 feet is required between the bottom of the constructed filter and the highest known groundwater elevation.

      (2) Design values for hydraulic conductivity of the filter media shall be as specified in ***Table 11***, or documented by field tests in accordance with "Soils Investigation" (page 36), or by other sources for other filter media.

Table 11 – Minimum Hydraulic Conductivities for Filter Media

Filter Media	Hydraulic Conductivity (feet per day)
Gravel	20
Course Sand	7.2
Compost (loose)	8.7[1]
Rain Garden Mix (compost, sand, topsoil)	1.5[2]
Peat	1[3]

Source: From design infiltration rates in ***Table 7.***
[1]*Low Impact Development Manual for Michigan,* SEMCOG, 2008.
[2]Adapted from An *Investigation of Rain Garden Planting Mixtures and the Implications for Design,* D. Carpenter and L. Hallam, 2007
[3]*Dynamics of Fluids in Porous Media,* J. Bear,1972.

2. Sizing and Configuration

   a. Filter media shall have a minimum depth of 18-inches and a maximum depth of 36 inches.

   b. A gravel layer shall be located below the filter media.

   c. A 4-inch minimum diameter underdrain shall be provided in the gravel layer with lateral spacing no more than 10 feet.

   d. All underground pipes shall have clean-outs accessible from the surface.

   e. Pipe slopes shall have a minimum slope of 1%.

   f. Constructed filters located in areas of existing soil contamination shall be lined to prevent infiltration.

3. Inlet Design

   a. A level spreader, distribution pipes or other flow dispersion measure shall be used for energy dissipation and to uniformly distribute the flow.

   b. Pre-treatment is required for each inlet and for overland flow entering the constructed filter.

Constructed Filter (continued)

4. Emergency Overflow

   a. All constructed filters must be designed so that larger storms may safely overflow or bypass the filter. Flow splitters, multi-stage chambers or other devices may be used.

   b. Sufficient space must be provided between the top of the filtering bed and the overflow to allow the maximum design head to be stored for filtration.

5. Materials

   a. Pipe bedding shall consist of at least 3 inches of gravel under the pipe and 6 inches above the pipe.

   b. A nonwoven geotextile fabric shall be placed between the filter media layer(s) and the gravel layer.

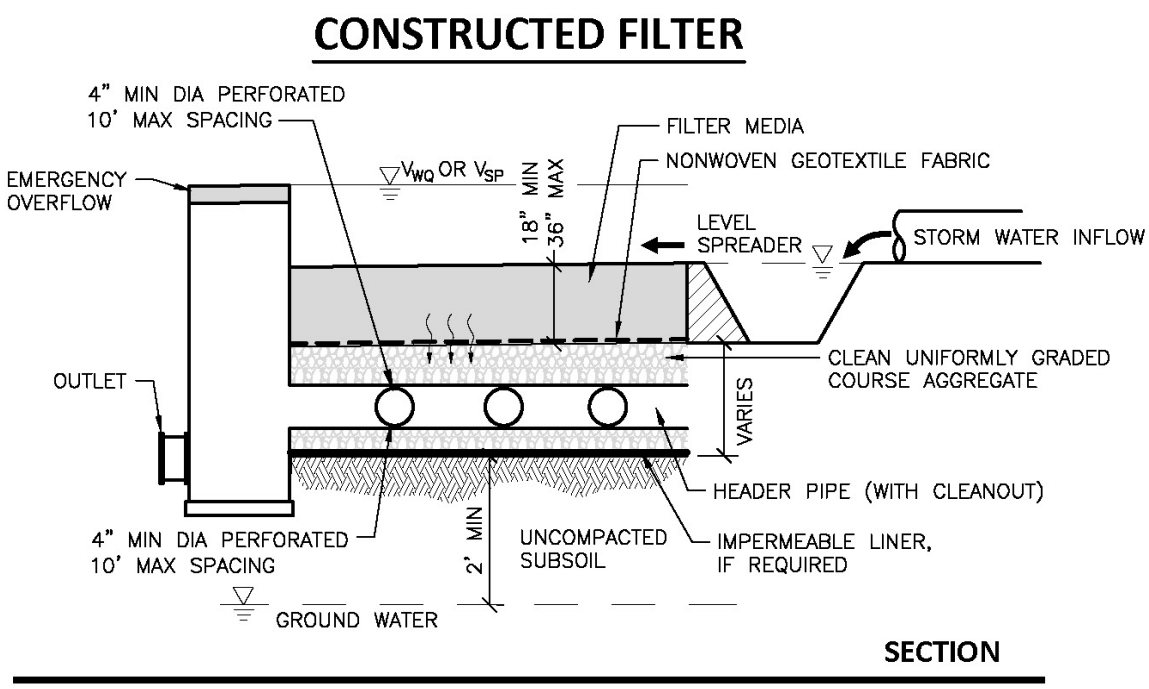
   c. When used, impermeable liner shall have a maximum permeability of 1 x 10^{-7} centimeters per second certified by the manufacturer.

6. Access

   a. Inspection and maintenance access to the constructed filter shall be provided.

   b. For underground vault heights greater than 4 feet, ladder access shall be provided.

D. Design Schematics



Planter Box

A. Summary

Description:	A type of rain garden applicable for small sites or highly urban areas; Underdrained BMP may be allowed on small sites in lieu of extended detention
Types:	Infiltration; Underdrain at top of storage layer; Underdrain at bottom of storage layer; Lined
Pretreatment Required:	No
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Infiltration: Count volume stored and infiltrated Underdrained: Count volume stored and infiltrated between bottom of BMP and invert of underdrain
Rate Reduction	Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count total volume stored and infiltrated/filtered

B. Sizing Calculations

1. For underdrained BMP, follow criteria for "Constructed Filter."

2. Planter boxes may be sized for stream protection or water quality treatment. Use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volumes.

   a. Subtract the volume infiltrated by the BMP during the infiltration period to determine the required storage volume of the BMP. The infiltration volume is calculated as:

      Maximum Allowable Infiltration Rate (inches per hour) x 6 hours x Infiltration Area (square feet) x 1/12 unit conversion

   b. The maximum allowable soil infiltration rate used to size the storage volume of the BMP shall be 0.52 inches per hour, except that 1.04 inches per hour may be used where soil borings indicate sand or gravel free of any other soil seams.

   c. The infiltration period is the time when the bed is receiving runoff and is capable of infiltrating at the design rate, which is conservatively estimated as 6 hours.

Planter Box (continued)

3. Calculate the minimum infiltration area required to drain the required storage volume in the specified drawdown time using the design infiltration rate of the underlying soil.

$$A = [V_s / (i \times t_d)] \times 12$$

where:
A = minimum infiltration area (square feet)
V_s = storage volume (cubic feet)
i = design infiltration rate of soil (inches per hour) from ***Table 5***
t_d = maximum allowable drawdown time (hours)
12 = factor to convert inches to feet

4. Total drawdown time shall be no more than 12 hours. Depth of surface ponding shall be no more than 1 foot and drain within 4 hours.

5. The bottom area of the BMP shall be used as the infiltration area.

6. Calculate the storage volume of the BMP.

Surface Storage Volume (cubic feet) = Bed Area (square feet) x Design High Water Depth (feet)

Subsurface Storage Volume (cubic feet) = Length (feet) x Width (feet) x Depth (feet) x Void Ratio of Material

Total Storage Volume (cubic feet) = Surface Storage Volume (cubic feet) + Subsurface Storage Volume (cubic feet)

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

      (1) A minimum of 4 feet is required between the bottom of the planter box and the highest known groundwater elevation.

      (2) An underdrain shall be provided for design infiltration rates less than 0.50 inches per hour, or if planter box will be lined.

      (3) Void ratio for the amended soil material shall be based on the USDA soil textural class and effective water capacity in ***Table 5***. A maximum design value of 0.30 shall be used for the void ratio of the amended soil material. A maximum design value of 0.40 shall be used for the void ratio of stone.

2. Sizing and Configuration

   a. A combination of surface and subsurface storage may be used to provide the required storage volume.

   b. Minimum width of planter boxes shall be 18 inches.

   c. Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.

Planter Box (continued)

d. Planter boxes located in areas of existing soil contamination shall be lined to prevent infiltration.

e. Underdrains shall have a 4-inch minimum pipe diameter.

f. All underground pipes shall have clean-outs accessible from the surface.

g. Pipe slopes shall have a minimum slope of 1%.

h. A planting plan shall be provided.

3. Inlet Design

   a. Inlet pipes shall require energy dissipation. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 feet per second, up to a maximum allowable design velocity of 10 feet per second.

4. Emergency Overflow

   a. All planter boxes must have a provision for overflow at the high water level.

5. Materials

   a. Suggested structural elements of planter boxes are stone, concrete, brick or pressure-treated wood.

   b. Amended soil material shall consist of 12 to 36 inches of the following materials, evenly mixed: Compost: 20-40%; Sand: 30-50%; Topsoil: 20-30% (with a clay content of 0-10%).

      (1) Alternative mix designs with ratios outside of the limits provided will be considered with justification.

      (2) The soil mix shall have a pH between 5.5 and 6.5.

   c. Stone bedding shall consist of clean, uniformly graded course aggregate.

   d. A nonwoven geotextile fabric shall be placed between the amended soil and the stone.

   e. Impermeable liner shall have a maximum permeability of 1×10^{-7} centimeters per second certified by the manufacturer.

   f. Plant selection shall consider exposure and tolerance to salt, sediment and pollutants, and the design depth of surface storage. Native species are encouraged.

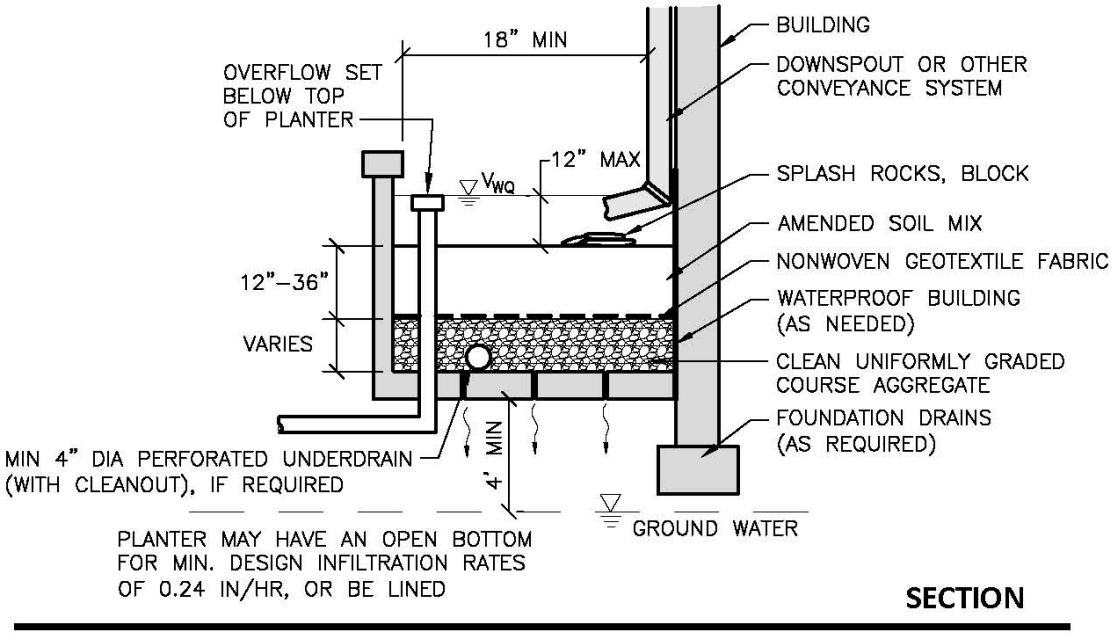
   g. Plants shall be container stock.

6. Access

   a. Inspection and maintenance access to the planter box shall be provided.

D. Design Schematics

PLANTER BOX



Pervious Pavement

A. Summary

Description:	Provides storm water treatment and storage with or without a surface outlet
Types:	Infiltration; Underdrain at top of storage layer; Underdrain at bottom of storage layer; Lined
Pretreatment Required:	No
Maintenance Plan:	Yes
Easement Required:	No
Calculation Credits:	
Volume Reduction	Infiltration: Count volume stored and infiltrated Underdrained: Count volume stored and infiltrated between bottom of BMP and invert of underdrain
Rate Reduction	Infiltration: 100% Underdrained: Calculated allowable release rate
Water Quality	Count total volume stored and infiltrated/filtered

B. Sizing Calculations

1. Use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volumes for stream protection (if necessary).

2. The required storage volume shall be equal to the volume from a 25-year, 24 hour rainfall event from the contributing surface area (porous pavement, roof).

3. The bottom area of the BMP shall be used as the infiltration area.

4. Maximum allowable drawdown time shall be 72 hours.

5. Calculate the subsurface storage volume of the BMP.

   Subsurface Storage Volume (cubic feet) = Length (feet) x Width (feet) x Depth (feet) x Void Ratio of Material

6. For underdrained BMP, follow criteria for "Constructed Filter."

C. Design Requirements

1. Siting

   a. Soil borings are required as outlined in "Soils Investigation" (page 35).

Pervious Pavement (continued)

(1) A minimum of 4 feet is required between the bottom of pervious pavement capable of infiltration and the highest known groundwater elevation.

(2) A minimum of 2 feet is required between the bottom of lined or pervious pavement and the highest known groundwater elevation.

(3) An underdrain shall be provided for design infiltration rates less than 0.50 inches per hour, or if stone bed will be lined.

(4) A maximum design value of 0.40 shall be used for the void ratio of stone.

b. Runoff from offsite areas shall not be directed onto pervious pavement surface.

2. Sizing and Configuration

   a. The stone bed shall be flat to encourage uniform ponding and infiltration.

   b. For pervious pavements located in areas with steep slopes, stone beds shall be terraced to maximize infiltration area.

   c. Pervious pavements located in areas of existing soil contamination shall be lined to prevent infiltration.

   d. Underdrains shall have a 4-inch minimum pipe diameter with lateral spacing no more than 10 feet

   e. All underground pipes shall have clean-outs accessible from the surface.

   f. Pipe slopes shall have a minimum slope of 1%.

3. Inlet Design

   a. Pervious pavements shall have a backup method for water to enter the storage bed. Backup drainage may consist of an unpaved 1- to 2-foot wide stone edge or inlets with sediment traps.

4. Emergency Overflow

   a. Stone beds must have a provision for overflow below the level of the pavement surface when an underdrain is not already provided.

5. Materials

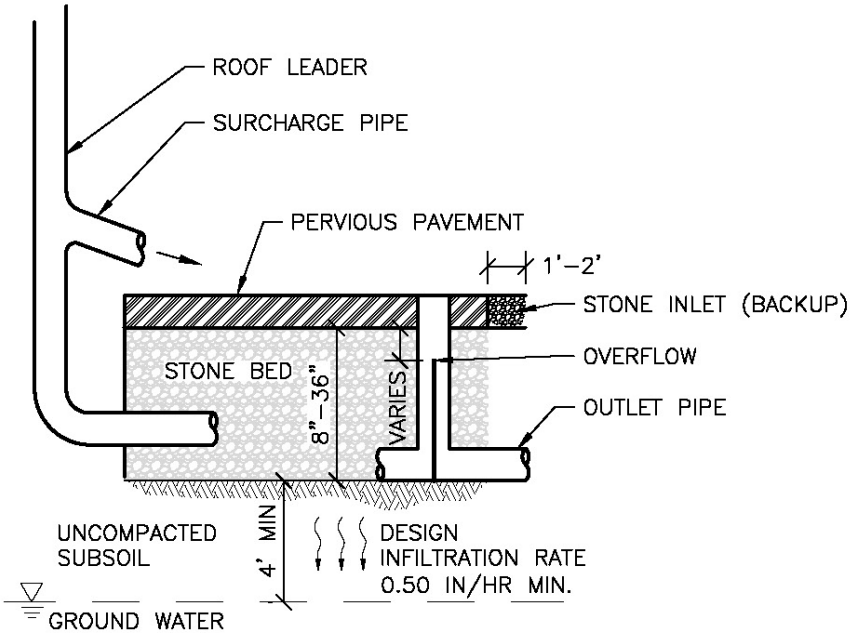
   a. Stone bed shall consist of 8 to 36 inches of clean, uniformly graded course aggregate.

   b. A nonwoven geotextile fabric shall be placed between the stone bed and the subsoil.

   c. Impermeable liner shall have a maximum permeability of 1×10^{-7} centimeters per second certified by the manufacturer.

D. Design Schematics

PERVIOUS PAVEMENT



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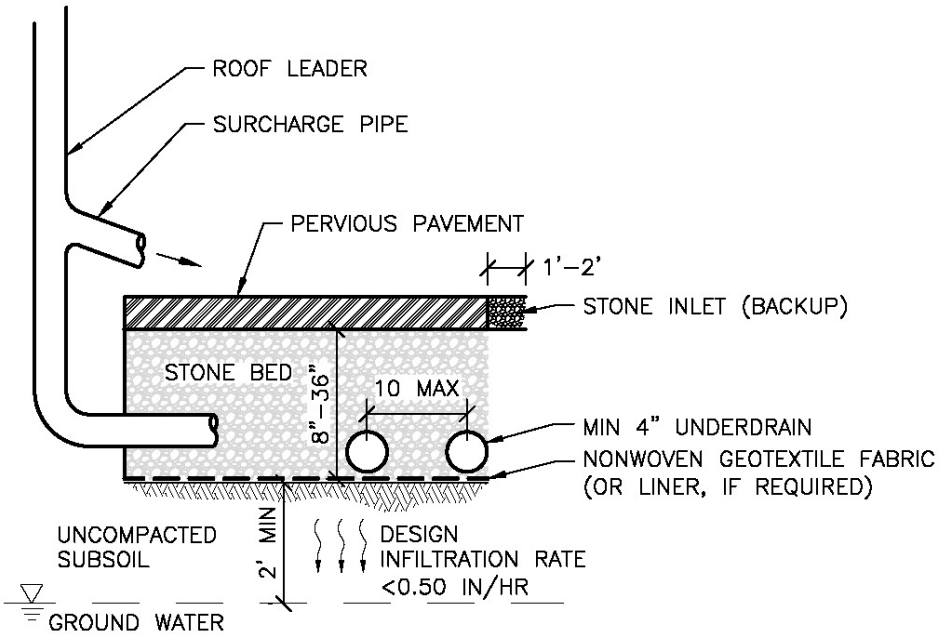


PERVIOUS PAVEMENT WITH BOTTOM DRAIN

Capture Reuse

A. Summary

Description:	Storm water capture, storage and removal from storm flow by reuse for irrigation or as greywater
Types:	Rain barrels; Cisterns (both above ground and underground); Tanks; Ponds
Pretreatment Required:	Yes. This BMP can provide spill containment
Maintenance Plan:	Yes
Easement Required:	No
Calculation Credits:	
Volume Reduction	Count storage volume provided
Rate Reduction	Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count total volume stored

B. Sizing Calculations

1. Determine water use (gallons per day) and add up for each month of the year.
2. Obtain average monthly precipitation (inches) and evapo-transpiration (ET) in inches. www.enviroweather.msu.edu
3. Multiply average monthly precipitation by contributing area and area-weighted Small Storm Hydrology Method runoff coefficient (assuming 90% of the storms produce 1 inch of rain or less) to obtain volume of recharge. The Small Storm Hydrology Method is given below:

$$V = PR_vA(3630)$$

where:
V = recharge volume (cubic feet)
P = rainfall (inches)
R_v = area-weighted volumetric runoff coefficient (individual runoff coefficients are given in ***Table 12***.)
A = contributing area (acres)
3630 = factor to convert acre-inches to cubic feet

Table 12 – Runoff Coefficients for Small Storm Hydrology Method

Rainfall Amount (inches)	Volumetric Runoff Coefficient, R_v					
	Directly Connected Impervious Area			Disturbed Pervious Area		
	Flat Roofs / Unpaved	Pitched Roofs	Paved	Sandy Soils (HSG A)	Silty Soils (HSG B)	Clayey Soils (HSG C&D)
1.0	0.815	0.965	0.980	0.035	0.120	0.205

Source: Adapted from Table 9.3, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (Adapted from *The Source Loading and Management Model (WinSLAMM): Introduction and Basic Uses,* R. Pitt, 2003.)

4. Multiply recharge volume by 7.48 gallons per cubic foot to convert to gallons.
5. Calculate ET for open water surfaces. Multiply average monthly ET (inches) by surface area of pond (square feet) and divide by 12 to calculate the volume of

water evaporated in cubic feet. Multiply by 7.48 gallons per cubic foot to convert to gallons.

6. Select trial size container or pond volume.
7. Calculate the water balance. A tabular method may be used similar to that illustrated below:

Volume of Water in Storage at End of Month = Storage Volume at Start of Month + Recharge from Monthly Precipitation - ET - Monthly Water Use

Month	Vstart	+Recharge	- ET	- Use	= Vend*	Lost
1						
2	=Vend1					
Total	--				--	

* Limited by total volume of the selected container or pond. If value is greater than container volume, surplus is lost to overflow. If value is negative, it means that amount must be supplemented.

8. Adjust size of container or pond to balance reuse efficiency and cost.

C. Design Requirements

1. Siting
   a. Storage units shall be positioned to receive rooftop runoff.
   b. Protect storage units from direct sunlight to minimize algae growth.
   c. Discharge points and storage units shall be clearly marked “Caution: Untreated Rainwater. Do Not Drink.”
2. Sizing and Configuration
   a. If storage units are used to supplement greywater needs, a parallel conveyance system must be installed to separate greywater from other potable water piping systems.
   b. Storage units shall be watertight with a smooth interior surface.
   c. Covers and lids shall have a tight fit to keep out surface water, insects, animals, dust and light.
   d. Observation risers shall be provided for buried storage units.
   e. Pumps and pressure tanks may be used to add pressure (most irrigation systems require at least 15 pounds per square inch).
3. Inlet Design
   a. Screens shall be used to filter debris from runoff flowing into the storage unit.
4. Emergency Overflow
   a. A positive outlet for overflow shall be provided a few inches from the top of the storage unit and sized to safely discharge the peak flow from the 10-year design storm when the storage unit is full.
   b. Above-ground storage units shall have a release mechanism to drain and empty the unit between storm events.

Vegetated Roof

A. Summary

Description:	Provides storm water treatment and storage with a surface overflow
Types:	Intensive (> 4 inches, wide variety of plants, public use); Extensive (≤ 4 inches, plants are herbs, mosses, succulents and grasses)
Pretreatment Required:	No. This BMP can provide pre-treatment
Maintenance Plan:	Yes
Easement Required:	No
Calculation Credits:	
Volume Reduction	Count storage volume (limited by design rainfall on roof)
Rate Reduction	Adjust CN to 65
Water Quality	Exempt from water quality criteria

B. Sizing Calculations

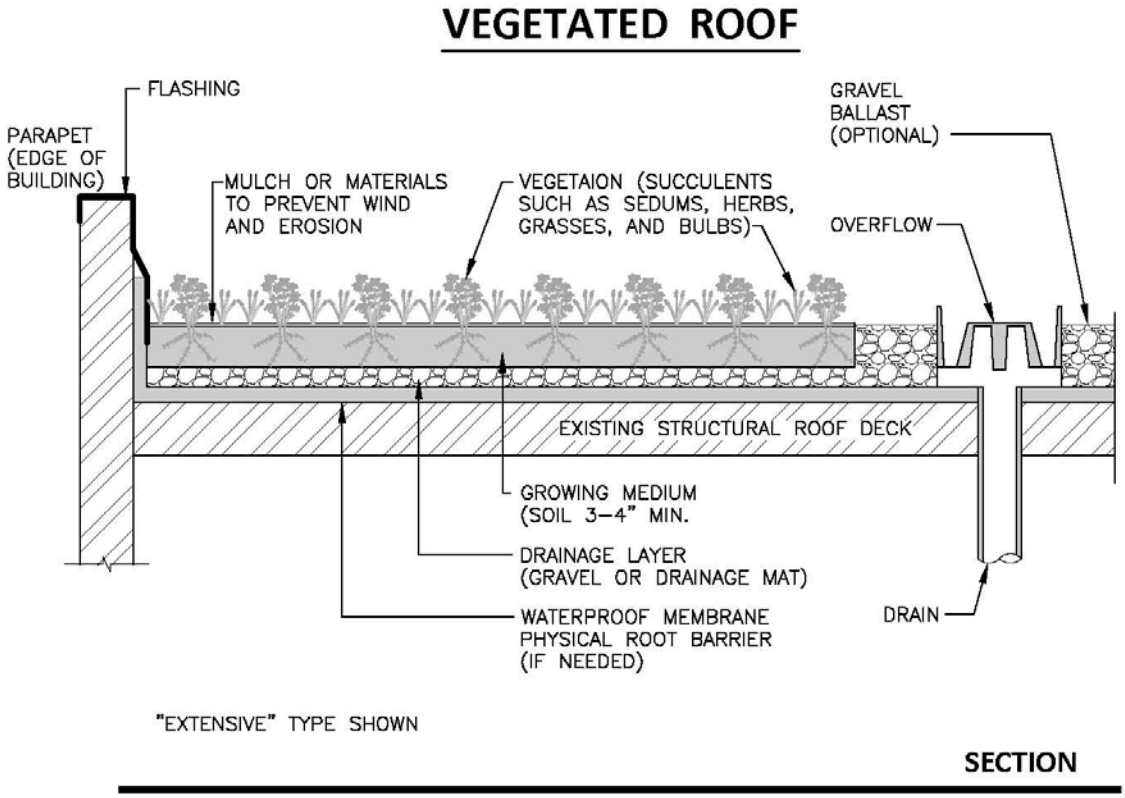
1. Use the methods outlined in "Calculating Storage Volumes and Release Rates" (page 45) to calculate the required volume for stream protection.
2. The required storage volume shall be equal to the design volume from the rain falling on the roof area.
3. Calculate the subsurface storage volume of the BMP.

   Subsurface Storage Volume (cubic feet) = Length (feet) x Width (feet) x Depth (feet) x Void Ratio of Material

C. Design Requirements

1. Sizing and Configuration
   a. Follow manufacturer's and structural engineer's guidelines.
2. Emergency Overflow
   a. A positive outlet for overflow shall be provided.

D. Design Schematics



Water Quality Device

A. Summary

Description:	Storm water pre-treatment unit
Types:	Filtration; Settling; Hydrodynamic Separator
Pretreatment Required:	No. This BMP can provide pre-treatment and spill containment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	Does not provide sufficient treatment, except on small sites where volume of unit equals required water quality volume

B. Sizing Calculations

1. Select water quality device unit/model based on manufacturer's recommendations.

C. Design Requirements

1. Sizing and Configuration

    a. The geometry of the water quality device shall promote the trapping of floatables, sediments and capture of a slug pollutant load from accidental spills of toxic materials.

    b. The water quality device shall be designed to prevent surcharging in pipes upstream of the device.

2. Emergency Overflow

    a. A bypass overflow shall be designed to convey the 10-year peak discharge at a minimum without release of trapped sediments and pollutants.

    b. The outlet from the overflow shall not be submerged under normal conditions.

Sediment Forebay

A. Summary

Description:	Storm water pre-treatment practice
Types:	Wet basin; Dry basin; Level spreader
Pretreatment Required:	No. This BMP can provide pre-treatment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	Count permanent pool volume if sized to meet water quality standards

B. Sizing Calculations

1. Size for pre-treatment using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

C. Design Requirements

1. Siting

   a. A sediment forebay is typically used with a detention or retention basin.

   b. Where more than one inlet pipe is required, the calculated forebay volume shall be pro-rated by flow contribution of each inlet.

2. Sizing and Configuration

   a. The minimum sediment forebay volume shall be equivalent to the pre-treatment volume.

   b. The sediment forebay shall be a separate sump, which can be formed by grading.

   c. The length-to-width ratio shall be a minimum of 1.5:1 and a maximum of 4:1.

   d. The overflow berm or spillway shall be designed to prevent erosion.

D. Design Schematics

See "Detention Basin" and "Retention Basin" BMPs.

Spill Containment Cell

A. Summary

Description:	Storm water pre-treatment practice
Types:	Lined wet basin
Pretreatment Required:	No. This BMP can provide pre-treatment and spill containment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	Count permanent pool volume if sized to meet water quality standards

B. Sizing Calculations

1. Size for pre-treatment using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

C. Design Requirements

1. Siting

    a. Where spill containment is required, all inlets shall enter the spill containment cell unless the inlet collects storm water exclusively from non-hot-spot areas (i.e. office parking, courtyard, roof).

2. Sizing and Configuration

    a. The minimum spill containment cell volume shall be equivalent to the pre-treatment volume.

    b. The minimum surface area shall be 25% of the required volume (with a maximum depth of 4 feet).

    c. The length-to-width ratio shall be a minimum of 3:1, and a maximum of 4:1 to allow for adequate hydraulic length yet minimize scour velocities.

    d. The minimum hydraulic length shall be equal to the length specified in the length-to-width ratio.

    e. The minimum diameter of the transfer pipe between the spill containment cell and the basin shall be 12 inches.

    f. The overflow structure from the spill containment cell shall be sized for the peak inflow from a 10-year rainfall event.

Spill Containment Cell (continued)

g. The top-of-berm elevation between the spill containment cell and the basin shall be a minimum of 1 foot below the outer berm elevation.

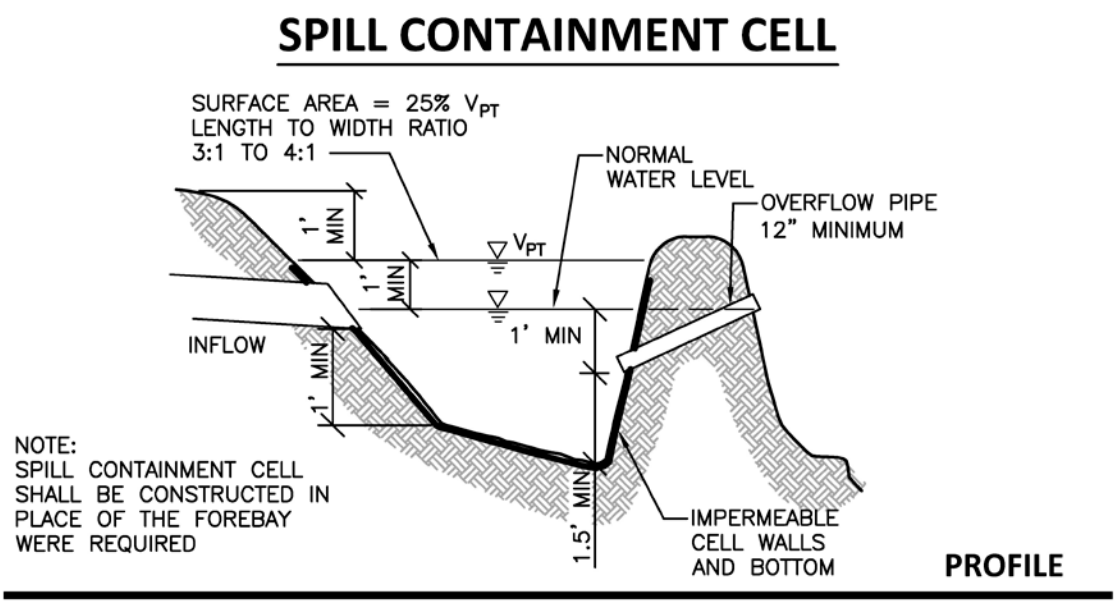
h. The spill containment cell shall have a minimum 1-foot-deep sump below the inlet pipe for sediment accumulation.

i. The outlet structure from the spill containment cell shall be designed to draw water from the central portion of the water column within the cell to trap floatables and contain sediments. The inlet side of the structure shall be located a minimum of 1 foot below the normal water level, and a minimum of 1.5 feet from the bottom of the spill containment cell. Minimum depth of the permanent pool is 2.5 feet.

3. Materials

a. The spill containment cell shall be lined with impermeable materials extending up to the design high water elevation. A minimum 18-inch-thick clay layer, or an impermeable liner protected with a minimum 12 inches of soil cover are acceptable alternatives. Maximum allowable permeability shall be 1 x 10^{-7} centimeters per second as determined by the geotechnical consultant for clay placement, or manufacturer's certificate for liner products.

D. Design Schematics



Water Quality Swale

A. Summary

Description:	Lined storm water filter designed to provide spill containment; May be allowed on small sites in lieu of extended detention
Types:	Dry swale
Pretreatment Required:	Yes. This BMP can also provide pre-treatment and spill containment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	Adjust time-of-concentration by dividing storage volume by 10-year peak flow rate; BMP routing using computer software
Water Quality	Count storage volume if sized to meet water quality standards

B. Sizing Calculations

1. Size for pre-treatment using equation given in "Calculating Storage Volumes and Release Rates" (page 49).

C. Design Requirements

1. Siting

    a. Water quality swales can be used where spill containment is required on small sites or in lieu of a spill containment cell.

    b. Where spill containment is required, all inlets shall enter the water quality swale unless the inlet collects storm water exclusively from non-hot-spot areas (i.e. office parking, courtyard, roof).

2. Sizing and Configuration

    a. The minimum water quality swale volume shall be equivalent to the pre-treatment volume.

    b. The swale shall be designed for a maximum water depth of 3 feet.

    c. The swale shall have a minimum bottom width of 2 feet and a maximum bottom width of 8 feet.

    d. Side slopes shall be 3:1 (H:V) or flatter.

    e. Minimum thickness of the sand filter shall be 24 inches with a minimum of 6 inches of stone bedding.

Water Quality Swale (continued)

3. Inlet Design

    a. Inlets shall enter a water quality device or forebay.

4. Outlet Design

    a. The outlet structure shall be constructed within a catchbasin and be designed to draw water from the central portion of the water column within the catchbasin to trap floatables and contain sediments in a minimum 2-foot sump.

    b. The rim elevation of the catchbasin shall be designed high enough to contain the required volume of water within the swale (pre-treatment volume, water quality volume, etc.)

    c. The swale and outlet shall be designed to pass the 10-year peak discharge.

5. Emergency Overflow

    a. A positive outlet for overflow shall be provided a few inches from the top of the storage unit and sized to safely discharge the peak flow from the 10-year design storm when the storage unit is full.

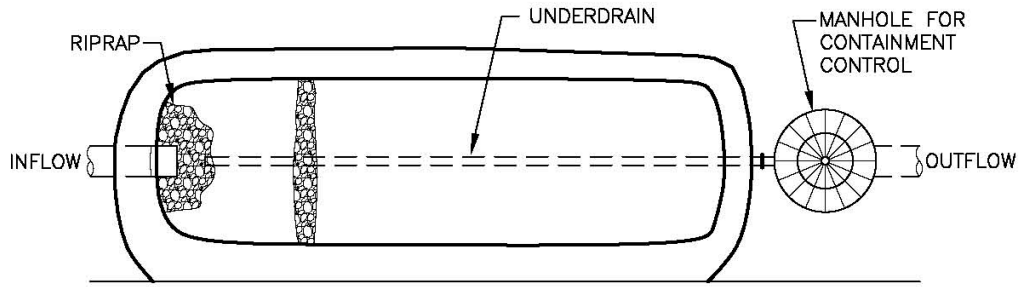
6. Materials

    a. A 4-inch perforated underdrain shall be placed along the center length of the swale and bedded in stone.

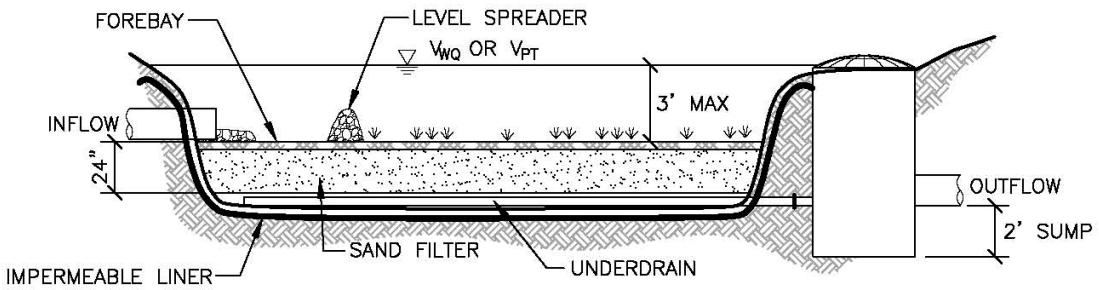
    b. The water quality swale shall be lined with impermeable materials extending up to the design high water elevation. A minimum 18-inch-thick clay layer, or an impermeable liner below the stone layer are acceptable alternatives. Maximum allowable permeability shall be 1×10^{-7} centimeters per second as determined by the geotechnical consultant for clay placement, or manufacturer's certificate for liner products.

D. Design Schematics

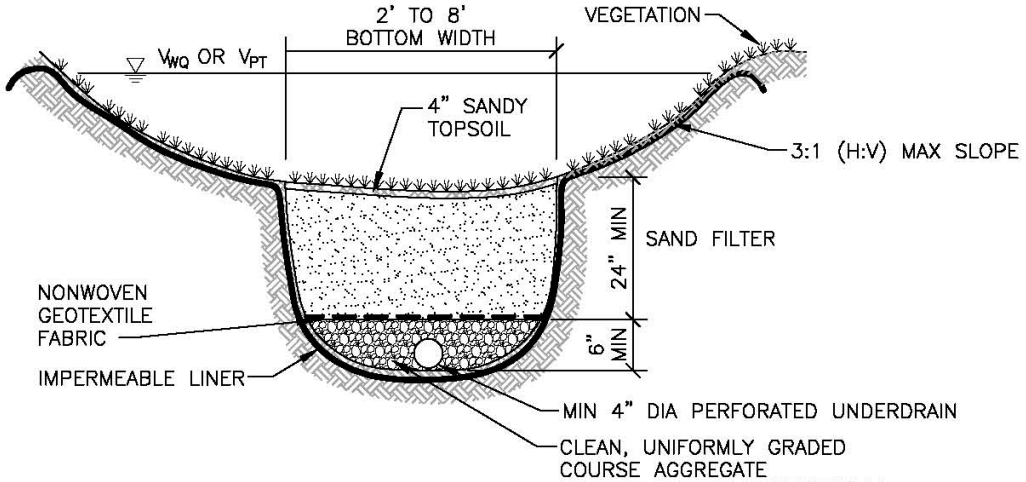
WATER QUALITY SWALE



PLAN VIEW



PROFILE



SECTION

Vegetated Swale

A. Summary

Description:	Storm water conveyance designed to slow, filter and infiltrate storm water
Types:	Dry swale; Wetland swale
Pretreatment Required:	No. This BMP provides pre-treatment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	Count storage volume behind check dams (if any)
Rate Reduction	Due to longer time-of-concentration for swale
Water Quality	Count storage volume behind check dams; Count as being met if vegetated swale meets filter strip length and slope requirements

B. Sizing Calculations

1. Channel

   a. The vegetated swale shall be sized to pass the 10-year peak flow.

   b. Calculate 10-year peak flow rate using the equations given in "Calculating Runoff" (page 39).

   c. Size swale using Manning's Equation:

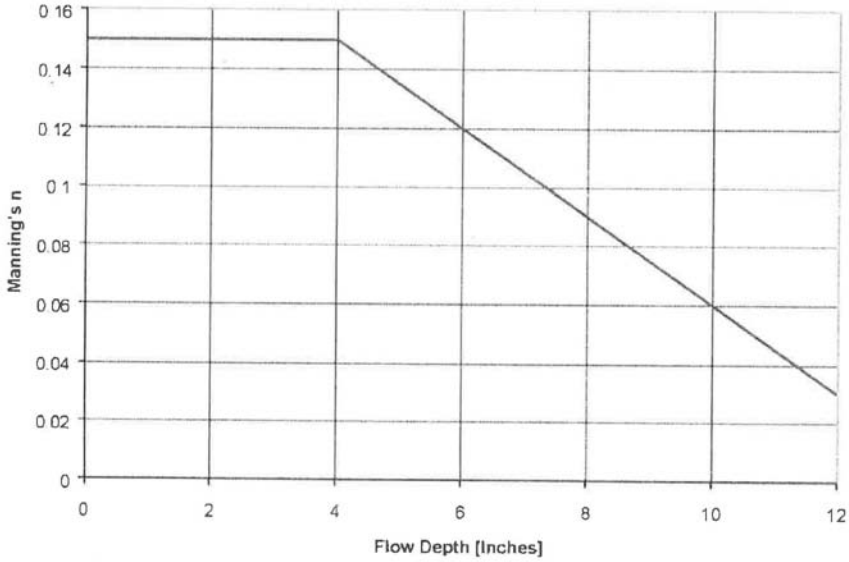
$$Q = \frac{1.49 A R^{\frac{2}{3}} S^{\frac{1}{2}}}{n}$$

where:
Q = discharge (cubic feet per second)
A = wetted area (square feet)
R = hydraulic radius (feet)
S = slope (feet per foot)
n = Manning's Coefficient

   d. Select the more conservative value of Manning's Roughness Coefficient from ***Table 9*** or ***Figure 7*** below.

Vegetated Swale (continued)

Figure 7 – Manning's Roughness Coefficients for Vegetated Swales



Source: Figure 7.62, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (Schueler and Claytor, 1996.)

e. Check that flow velocities are within acceptable limits. The minimum velocity for open channels shall be 1.5 feet per second. The maximum velocity shall be 4 feet per second.

2. Volume Behind Check Dam (if used)

   a. Calculate the wedge-shaped storage volume behind each check dam.

      Storage Volume (cubic feet) = 0.5 x Length of Swale Impoundment Area per Check Dam (feet) x Depth of Check Dam (feet) x [Top Width of Check Dam (feet) + Bottom Width of Check Dam (feet)] / 2

C. Design Requirements

1. Siting

   a. Vegetated swales can be used for drainage areas up to 5 acres. Drainage areas greater than this may require open channels.

2. Sizing and Configuration

   a. The swale shall have a minimum bottom width of 2 feet and a maximum bottom width of 8 feet.

   b. The maximum bottom width to depth ratio for a trapezoidal swale shall be 12:1.

   c. Side slopes shall be 3:1 (H:V) or flatter.

   d. Longitudinal slope shall be a minimum of 1% and a maximum of 6%. Flatter slopes may be allowed on permeable soils.

Vegetated Swale (continued)

4. Check Dam Design

   a. Check dams may be used along vegetated swales with longitudinal slopes greater than 3%, or to encourage ponding and infiltration on flatter slopes.

   b. Maximum ponding depth behind check dams shall be 18 inches.

   c. Check dams shall be keyed into the bottom and sides of the swale a minimum of 1-foot on all sides. The height of the key must exceed the 10-year water surface elevation by a minimum of 6 inches on both sides.

   d. The center of the check dam crest must be below the sides of the check dam by a minimum of 12 inches.

5. Materials

   Establishment of vegetation shall follow the guidelines outlined in ***Table 13.***

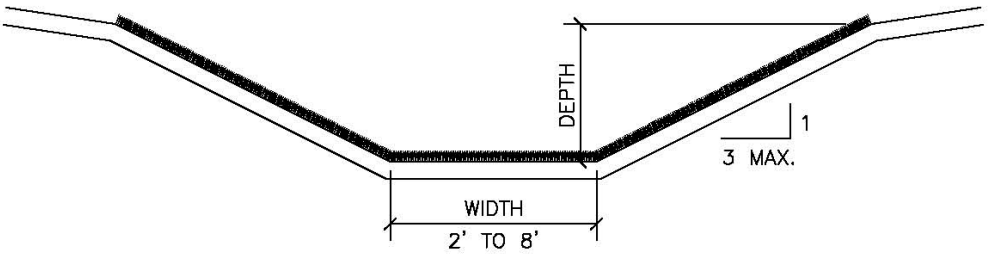
Table 13 – Permanent Stabilization Treatment for Vegetated Swales

Swale Bottom Treatment	Swale Grade
Seed and Mulch	0.3% to 0.5%
Standard Mulch Blanket	0.5% to 1.5%
High Velocity Mulch Blanket or Sod	1.5% to 3.0%
Turf Reinforcement Mat or Check Dams	3.0% to 6.0%
Specific Design Required	> 6.0%

Source: *Michigan Department of Transportation Drainage Manual,* 2006.

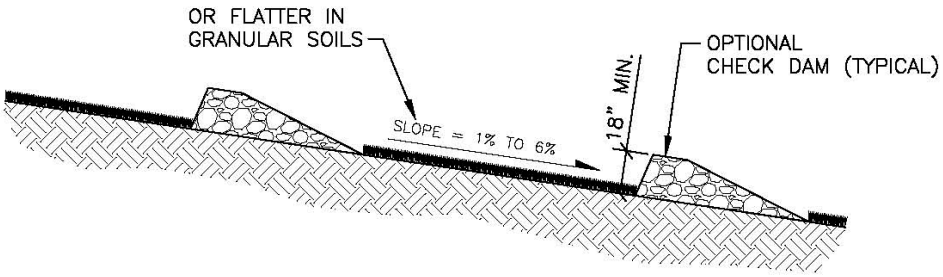
D. Design Schematics

VEGETATED SWALE

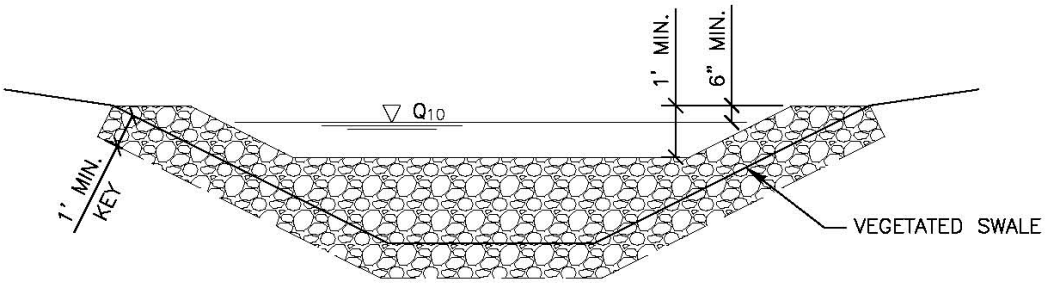


MAX. WIDTH TO DEPTH RATIO = 12:1

SECTION



PROFILE



CHECK DAM DETAIL

Vegetated Filter Strip

A. Summary

Description:	Overland flow path designed to slow and filter storm water
Types:	Turf grass; other dense herbaceous groundcover vegetation
Pretreatment Required:	No. This BMP provides pre-treatment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	Adjust time-of-concentration
Water Quality	Count as being met if filter strip meets area, length and slope requirements

B. Sizing Calculations

1. Calculate the area contributing storm water runoff.

2. Calculate the minimum required filter strip area by the equation:

$$A_{fs} = A / 6$$

where:
A_{fs} = area of filter strip (square feet)
A = contributing drainage area (square feet)

3. Calculate minimum required longitudinal length based on slope and type of vegetation using the graphs in ***Figures 8a*** through ***8d***.

C. Design Requirements

1. Siting

   a. Maximum upstream drainage area shall generally be 100 feet impervious or 200 feet pervious upgradient.

2. Sizing and Configuration

   a. The upstream edge of the filter strip shall be level and at an elevation at least 1 inch below the adjacent pavement.

   b. A level spreader may also be required to evenly distribute flow across filter strip.

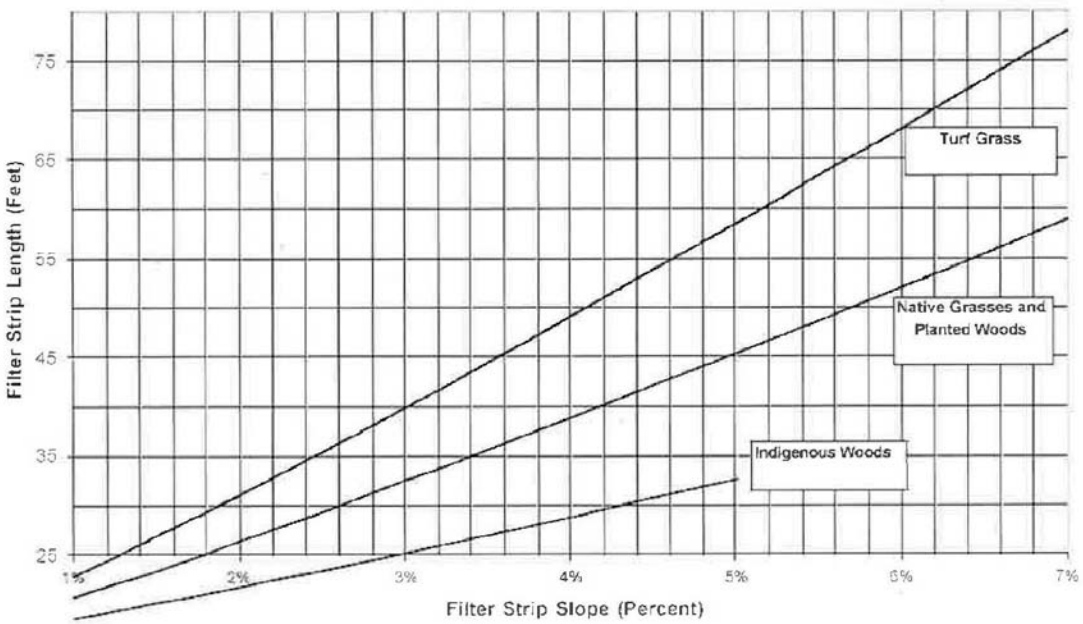
   c. Slopes shall range from a minimum of 1% to a maximum of 8%. Optimal slopes range from 2% to 5%.

   d. The maximum lateral slope shall be 1%.

   e. Berms and curbs may be installed along the sides of the filter strip parallel to the direction of flow to prohibit runoff from laterally bypassing the filter strip.

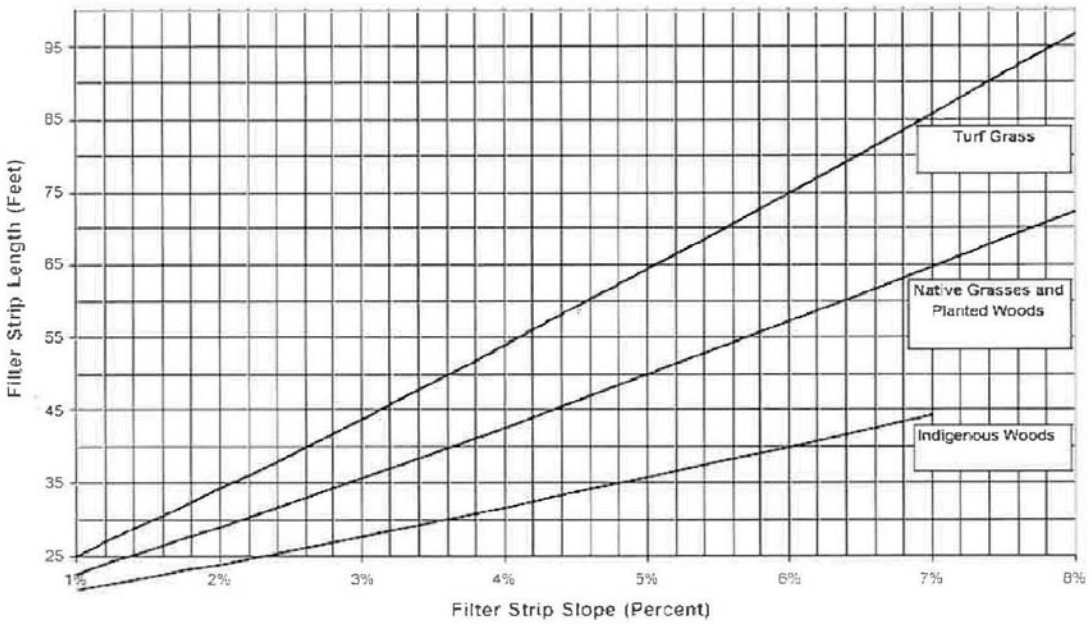
Vegetated Filter Strip (continued)

Figure 8a – Filter Strip Length (Sandy soils with HSG A)



Source: Figure 7.52, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (*New Jersey Stormwater Best Management Practices Manual*, 2004)

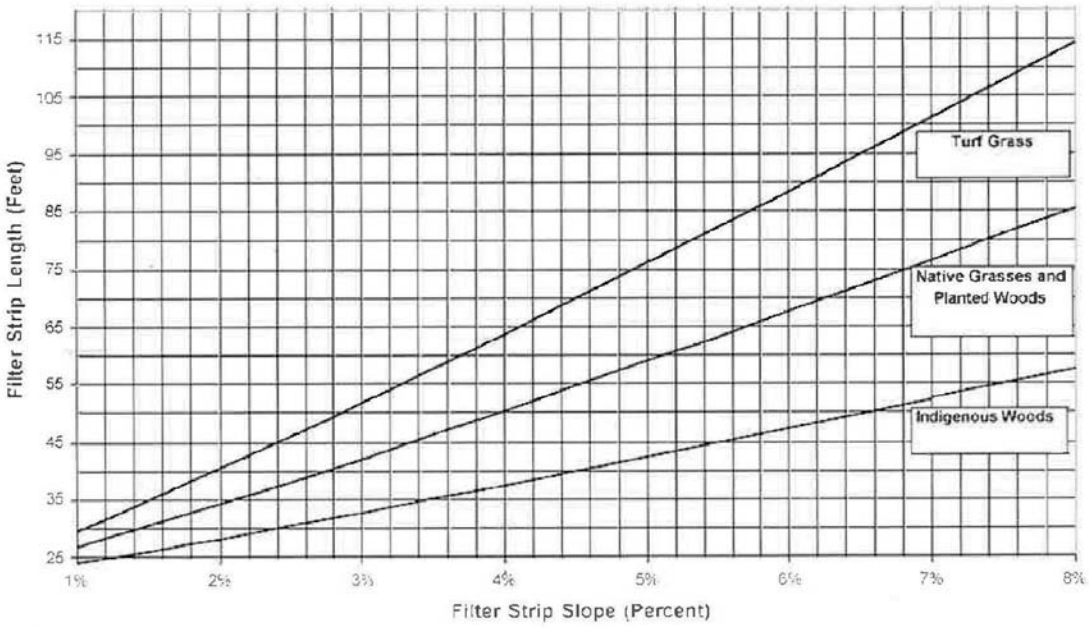
Figure 8b1 – Filter Strip Length (Sandy Loam soils with HSG B)



Source: Figure 7.53, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (*New Jersey Stormwater Best Management Practices Manual*, 2004)

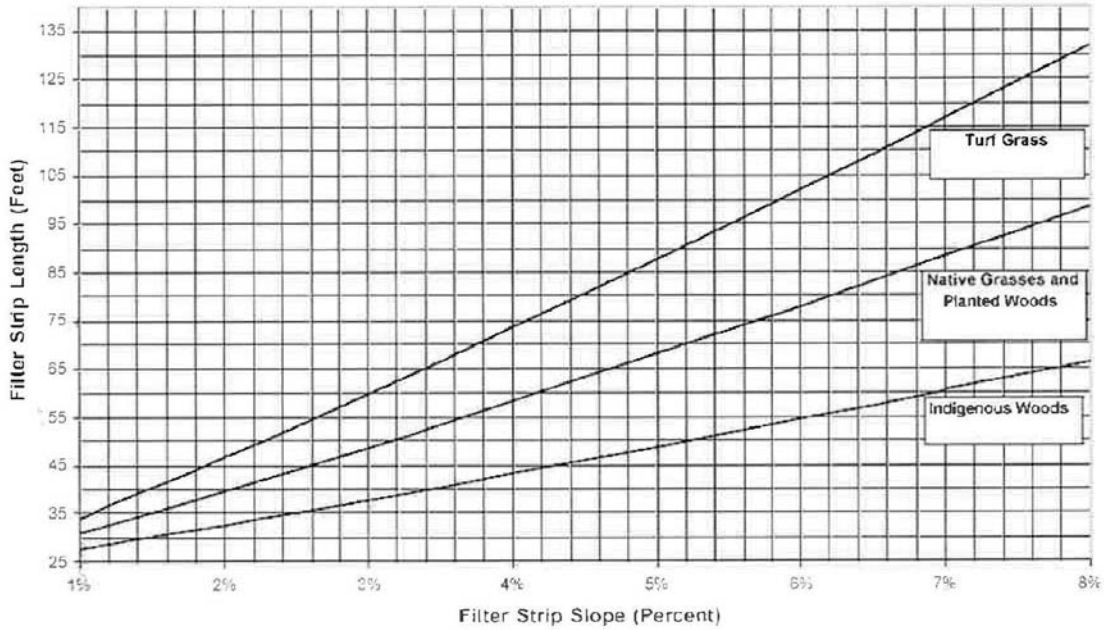
Vegetated Filter Strip (continued)

Figure 8b2 – Filter Strip Length (Loam, Silt-Loam soils with HSG B)



Source: Figure 7.54, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (*New Jersey Stormwater Best Management Practices Manual*, 2004)

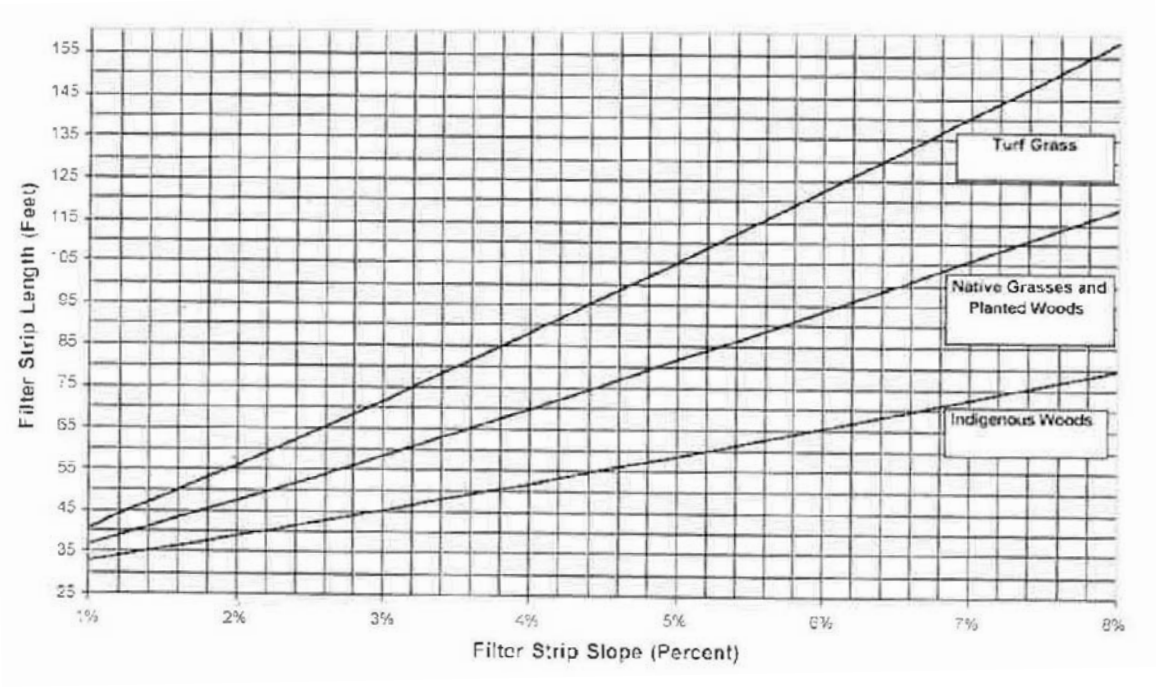
Figure 8c – Filter Strip Length (Sandy Clay Loam soils with HSG C)



Source: Figure 7.55, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (*New Jersey Stormwater Best Management Practices Manual*, 2004)

Vegetated Filter Strip (continued)

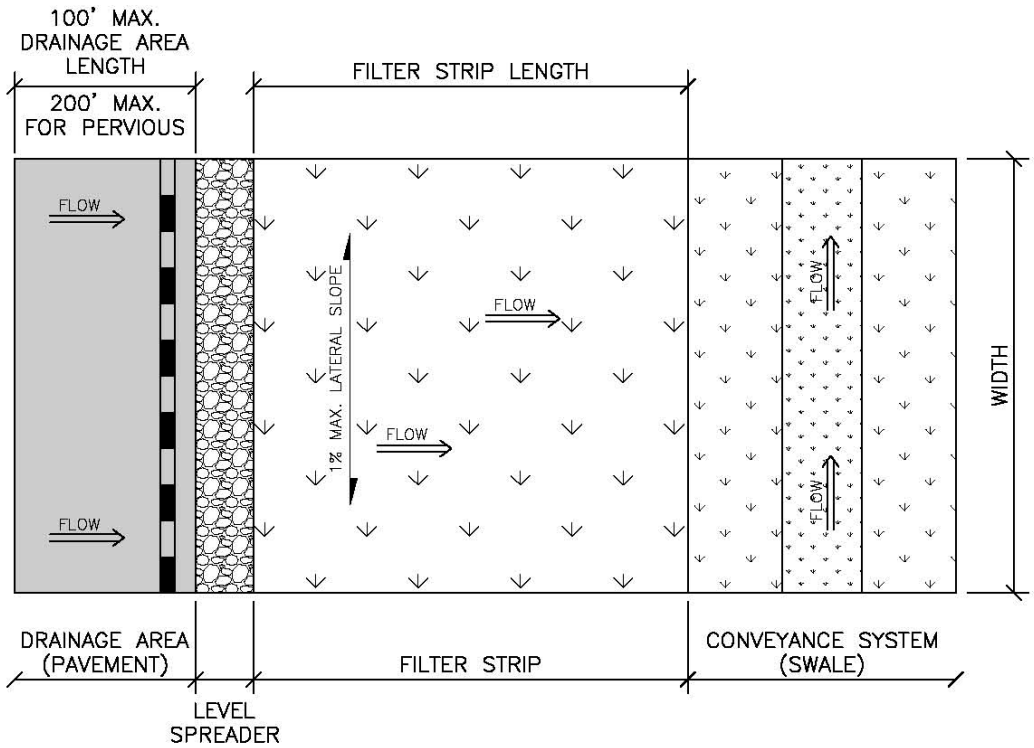
Figure 8d – Filter Strip Length (Clay Loam, Silty Clay, Clay soils with HSG D)



Source: Figure 7.56, *Low Impact Development Manual for Michigan,* SEMCOG, 2008. (*New Jersey Stormwater Best Management Practices Manual*, 2004)

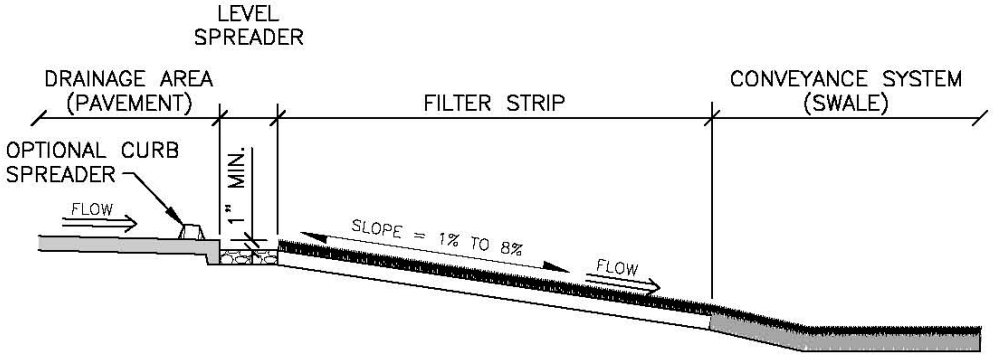
D. Design Schematics

VEGETATED FILTER STRIP



MIN. FILTER STRIP AREA = 1/6 DRAINAGE AREA.

PLAN VIEW



PROFILE

Level Spreader

A. Summary

Description:	Used with other BMPs to disperse concentrated storm water flows
Types:	Inflow (prior to BMP); Outflow (at outlet of BMP)
Pretreatment Required:	No. This BMP provides pre-treatment
Maintenance Plan:	Yes
Easement Required:	Yes
Calculation Credits:	
Volume Reduction	None
Rate Reduction	None
Water Quality	None

B. Sizing Calculations

1. The level spreader shall be sized to pass the 10-year peak flow.

2. Calculate 10-year peak flow rate using the equations given in "Calculating Runoff" (page 39).

C. Design Requirements

1. Siting

   a. Slopes below outflow level spreaders should be no greater than 8% in the direction of flow to discourage channelization.

2. Sizing and Configuration

   a. Construct level spreaders in compacted fill or of other non-erodible material.

   b. Minimum length: 10 feet.

   c. A bypass may be required for higher flows.

3. Material

   a. Level spreaders may be constructed of compacted earth, rock, stone, concrete, treated timber or perforated pipe in stone.

Appendix 1
General Application Package

- **Site Plan Review Application**
- **Site Plan Review Checklist**

SITE PLAN REVIEW APPLICATION

KALAMAZOO COUNTY DRAIN COMMISSIONER
201 WEST KALAMAZOO AVENUE
KALAMAZOO, MICHIGAN 49007
(269) 384-8117 - FAX: (269) 383-8920

PROJECT NAME:_____

PROJECT LOCATION: _____

TOWNSHIP/CITY: _____ **SECTION:** _____ **QUARTER SECTION:** _____

PROJECT ADDRESS: _____ **PARCEL NO.:** _____

NO. OF ACRES: _____ **NO. OF LOTS/UNITS (if applicable):** _____

DEVELOPMENT TYPE:

PLAT	SITE CONDO	PARCEL SPLIT
APARTMENT COMPLEX	CONDOMINIUM	DUPLEX
MOBILE HOME PARK	CHURCH	SCHOOL
BUSINESS PARK	COMMERCIAL	INDUSTRIAL
INDUSTRIAL PARK	OTHER: _____	

CHECK ONE:
_____ PRIVATE
_____ 433 AGREEMENT
_____ 425 AGREEMENT

REVIEW TYPE:
_____ PRELMINARY
_____ CONSTR. DWG.

DISTANCE TO NEAREST COUNTY DRAIN/WATERCOURSE: _____

NAME OF COUNTY DRAIN/WATERCOURSE: _____

DEVELOPER: _____

MAILING ADDRESS: _____ **PHONE:** _____

CITY/STATE/ZIP: _____ **FAX:** _____

CONTACT PERSON: _____ **EMAIL:** _____

ENGINEER: _____

MAILING ADDRESS: _____ **PHONE:** _____

CITY/STATE/ZIP: _____ **FAX:** _____

CONTACT PERSON: _____ **EMAIL:** _____

FEES MUST BE SUBMITTED WITH COMPLETED APPLICATION PRIOR TO PROCESSING

Preliminary Plat and Construction Drawing Review

Submittal Fee: $_____

Review Deposit: $_____

County Drain Review

Permit Fee: $_____

Maintenance Fee: $_____

Recording Deposit: $_____

Final Plat Review

Submittal Fee: $ _____

SITE PLAN REVIEW CHECKLIST

for Preliminary Plats/Site Plans and Construction Drawings

Development Name: _____	Date: _____
Location: _____	Reviewed By: _____

PRELIMINARY PLAT OR SITE PLAN DRAWINGS

The following information shall be included on all preliminary plats or site plans submitted for approval by the Drain Commissioner. Sheets shall be no larger than 24" x 36" at a scale no smaller than 1" = 100.'

		Provided/ Satisfactory	Comments
General			
1.	Development name/subdivision number.	_____	_____
2.	North arrow and scale.	_____	_____
3.	Name, address, and telephone number of proprietor.	_____	_____
4.	Name, address, telephone number, signature, and seal of a professional engineer or surveyor licensed in the State of Michigan.	_____	_____
5.	Description of location (including section and fractional portion thereof, Town and Range, township, city or village and county, Michigan).	_____	_____
6.	Location map.	_____	_____
7.	Legend.	_____	_____
Site Layout			
8.	The number of acres to be developed.	_____	_____
9.	Development boundary with metes and bounds property description tied to government corners.	_____	_____
10.	Identification of all adjoining parcels (for sub-divisions show lot number, subdivision name, liber, and page numbers; for metes and bounds parcels show permanent parcel number).	_____	_____
11.	Proposed street, alley, and lot layouts with dimensions (scaled or computed).	_____	_____

		Provided/ Satisfactory	Comments
12.	Lot numbers.	_____	_____
13.	Building setback lines.	_____	_____
Easements			
14.	Utility easements (with dimensions and type of utility).	_____	_____
15.	Existing and proposed easements with dimensions (private drainage, county drain, flooding, conservation, etc.).	_____	_____
16.	Offsite drain rights-of-way and flooding easements.	_____	_____
Existing Site Features			
17.	Existing buildings (label those under construction with address).	_____	_____
18.	Existing roads (with name, ROW width, and type of surface.	_____	_____
19.	Existing drainage structures (with proper labeling as to type, size, and invert elevations).	_____	_____
20.	The location and description of any other on-site and adjacent off-site features that may be relevant in determining the overall requirements for the development. For example: railroads, high tension power lines or underground transmission lines, sanitary sewers, water mains, septic fields, wells, cemeteries and parks.	_____	_____
21.	Riparian buffers, natural flow pathways, wetlands, floodplains and other sensitive areas.	_____	_____
22.	Existing contours (no greater than a 2' interval inside the plat; no greater than a 10' interval outside the plat.	_____	_____

		Provided/ Satisfactory	Comments
Proposed Site Features			
23.	Proposed contours.	_____	_____
24.	Proposed roads (label road as “Public Road” or “Private Road”).	_____	_____
25.	Proposed drainage systems (clearly identify all open and enclosed portions), non-structural and structural storm water BMPs.	_____	_____
26.	Minimum house grade and basement opening elevation for each lot.	_____	_____
Soils			
27.	Soil type(s) from County Soil Survey.	_____	_____
28.	Soil borings indicating seasonally high groundwater elevations are required at the sites of proposed infiltration practices, areas of proposed excavation for detention and as needed in areas where high ground water tables exist.	_____	_____

CONSTRUCTION DRAWINGS

The following additional information shall be included on all construction drawings submitted for approval by the Drain Commissioner. Sheets shall be no larger than 24” x 36” at a scale no smaller than 1” = 50’ and sealed by a professional engineer licensed in the State of Michigan.

1.	Benchmark locations and elevations.	_____	_____
2.	Plans, profiles, cross-sections, and details of all roads, storm sewers, footing drain laterals, open channel drains and other storm water BMPs.	_____	_____
3.	Details of storm sewer and culverts shall include: numbering of manholes/catchbasins, invert and casting elevations, pipe length (center-to-center of structure), pipe diameter, pipe material, pipe slope, pipe class, pipe joints, special backfill and bedding, inlet/outlet protection, profile of the hydraulic grade line.	_____	_____
4.	Typical lot grading plan (detail, statement, or drainage arrows).	_____	_____

		Provided/ Satisfactory	Comments
5.	Plans and details of SESC measures and staging schedule.	_____	_____
6.	Protected sensitive areas, minimal disturbance areas and other "non-structural" BMPs.	_____	_____
7.	Location of all proposed drain fields. (Drain fields shall comply with isolation distance requirements.)	_____	_____

DESIGN CALCULATION PACKAGE

1.	A topographic map with site delineated in relation to watershed.	_____	_____
2.	Calculations of runoff from the upstream watershed area (100-, 10- and 2-year storms).	_____	_____
3.	A drainage area map that clearly shows boundaries, acreages and flow paths of tributary areas to inlets, culverts, and other storm water BMPs.	_____	_____
4.	Calculations required to demonstrate an adequate outlet.	_____	_____
5.	Storm Water Worksheet.	_____	_____
6.	Sizing and volume calculations.	_____	_____
7.	BMP design calculations.	_____	_____
8.	Design summary notes illustrated on the drawings, including at a minimum design high water levels, hydraulic grade line, peak discharges, required volume, volume provided.	_____	_____

COMMENTS: _____

_____

_____

_____

_____

_____

Appendix 2
Private Development Package

- **Submittal Checklist for Private Developments**
- **Maintenance Agreement (for Private Developments)**
- **Maintenance Plan (for Private Developments)**

SUBMITTAL CHECKLIST
for Private Developments

Development Name: _____	Date: _____
Location: _____	Reviewed By: _____

	Date Received	Date Accepted
Initial Reviews		
1. PRELIMINARY: Preliminary site plan, application, calculation package and fees (submittal fee and review deposit)	_____	_____
2. CONSTRUCTION: Construction drawings, application, calculation package and fees (submittal fee and review deposit if preliminary review omitted)	_____	_____
Prior to Construction Drawing Approval and Issuance of a Grading (SESC) Permit		
3. Copies of Restrictive Covenant or Master Deed language	_____	_____
4. Recordable rights-of-way for downstream properties or flooding easement agreement (use forms in Appendix 3)	_____	_____
5. Certification of Adequate Outlet (use form in Appendix 3)	_____	_____
- OR -		
Approval has been given for any maintenance required to existing county drains	_____	_____
6. Copy of recordable Maintenance Agreement (use forms in Appendix 2)	_____	_____
7. All additional fees paid for engineering review	_____	_____
Upon Completion of Construction and Prior to Release of Review Deposit		
8. Copies of recorded documents (restrictive covenants/deeds, easements and Maintenance Agreement)	_____	_____
9. Construction record drawings	_____	_____
10. Certification that county drains have been maintained in accordance with approved construction drawings	_____	_____
11. Drain Commissioner releases remaining review deposit (posted per item no. 1 or 2)	_____	_____

MAINTENANCE AGREEMENT

(for Private Developments)

THIS AGREEMENT is made and entered into effective the _____ day of _____, 20___, by and between the _____ *[Community Name]*, at _____, hereinafter referred to as "the Community" and _____, of _____, its assigns and successors in interest, hereinafter referred to as "the Owner."

_____, as "Owner(s)" of the property described below, in accordance with _____ [Community Regulations], agrees to install and maintain storm water management practice(s) on the subject property in accordance with approved plans and conditions. The Owner further agrees to the terms stated in this document to ensure that the storm water management practice(s) continues serving the intended function in perpetuity. This Agreement includes the following exhibits:

Exhibit A: Legal description of the real estate for which this Agreement applies ("Property").

Exhibit B: Location map(s) showing a location of the Property and an accurate location of each stormwater management practice affected by this Agreement.

Exhibit C: Long-term Maintenance Plan that prescribes those activities that must be carried out to maintain compliance with this Agreement.

Note: After construction has been verified and accepted by the _____ *[Community Name]* for the storm water management practices, an addendum(s) to this agreement shall be recorded by the Owner showing design and construction details and provide copies of the recorded document to the _____ *[Community Name]*. The addendum may contain several additional exhibits.

Through this Agreement, the Owner(s) hereby subjects the Property to the following covenants, conditions, and restrictions:

1. The Owner(s), at its expense, shall secure from any affected owners of land all easements and releases of rights-of-way necessary for utilization of the storm water practices identified in Exhibit B and shall record them with the [Community] Register of Deeds. These easements and releases of rights-of-way shall not be altered, amended, vacated, released or abandoned without prior written approval of the [Community].

2. The Owner(s) shall be solely responsible for the installation, maintenance and repair of the storm water management practices, drainage easements and associated landscaping identified in Exhibit B in accordance with the Maintenance Plan (Exhibit C).

3. The Owner(s), its successors and assigns, hereby grant permission to the [Community], its authorized agents and employees, to enter upon the property and to inspect the storm water BMP facilities whenever the [Community] deems necessary. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facility including storm water reuse facilities, pervious pavement and vegetated roofs. When deficiencies are noted, the [Community] shall notify the Owner, its successors and assigns, and provide information from the inspection, its findings, and its evaluations and conclusions.

4. No alterations or changes to the storm water management practice(s) identified in Exhibit B shall be permitted unless they are deemed to comply with this Agreement and are approved in writing by the [Community].

5. The Owner(s) shall retain the services of a qualified inspector (as described in Exhibit C – Maintenance Requirement 1) to operate and ensure the maintenance of the storm water management practice(s) identified in Exhibit B in accordance with the Maintenance Plan (Exhibit C).

6. The Owner(s) shall annually, by December 30th, provide to the [Community] records (logs, invoices, reports, data, etc.) of inspections, maintenance, and repair of the storm water management practices and drainage easements identified in Exhibit B in accordance with the Maintenance Plan. Inspections are required at least after every major rain event.

7. The [Community] or its designee is authorized to access the property as necessary to conduct inspections of the storm water management practices or drainage easements to ascertain compliance with the intent of this Agreement and the activities prescribed in Exhibit C. Upon written notification by the [Community] or their designee of required maintenance or repairs, the Owner(s) shall complete the specified maintenance or repairs within a reasonable time frame determined by the [Community]. The Owner(s) shall be liable for the failure to undertake any maintenance or repairs so that the public health, safety and welfare shall not be endangered nor the road improvement damaged.

8. If the Owner(s) does not keep the storm water management practice(s) in reasonable order and condition, or complete maintenance activities in accordance with the Plan contained in Exhibit C, or the reporting required in 3 above, or the required maintenance or repairs under 4 above within the specified time frames, the [Community] is authorized, but not required, to perform the specified inspections, maintenance or repairs in order to preserve the intended functions of the practice(s) and prevent the practice(s) from becoming a threat to public health, safety, general welfare or the environment. In the case of an emergency, as determined by the [Community], no notice shall be required prior to the [Community] performing emergency maintenance or repairs. The [Community] may levy the costs and expenses of such inspections, maintenance or repairs plus a ten percent (10%) administrative fee against the Owner(s). The [Community] at the time of entering upon said storm water management practice for the purpose of maintenance or repair may file a notice of lien in the office of the Register of Deeds of the [Community] upon the property affected by the lien. If said costs and expenses are not paid by the Owner(s), the [Community] may pursue the collection of same through appropriate court actions and in such a case, the Owner(s) shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

9. The Owner(s) hereby conveys to the [Community] an easement over, on and in the property described in Exhibit A for the purpose of access to the storm water management practice(s) for the inspection, maintenance and repair thereof, should the Owner(s) fail to properly inspect, maintain and repair the practice(s).

10. The Owner(s) agrees that this Agreement shall be recorded and that the land described in Exhibit "A" shall be subject to the covenants and obligations contained herein, and this agreement shall bind all current and future owners of the property.

11. The Owner(s) agrees in the event that the Property is sold, transferred, or leased to provide information to the new owner, operator, or lessee regarding proper inspection, maintenance and repair of the storm water management practice(s). The information shall accompany the first deed transfer and include Exhibits B and C and this Agreement. The transfer of this information shall also be required with any subsequent sale, transfer or lease of the Property.

12. The Owner(s) agree that the rights, obligations and responsibilities hereunder shall commence upon execution of the Agreement.

13. The parties whose signatures appear below hereby represent and warrant that they have the authority and capacity to sign this agreement and bind the respective parties hereto.

14. The Proprietor, its agents, representatives, successors and assigns shall defend, indemnify and hold the [Community] harmless from and against any claims, demands, actions, damages, injuries, costs or expenses of any nature whatsoever, hereinafter "Claims", fixed or contingent, known or unknown, arising out of or in any way connected with the design, construction, use, maintenance, repair or operation (or omissions in such regard) of the storm drainage system referred to in the permit as Exhibit "C" hereto, appurtenances, connections and attachments thereto which are the subject of this Agreement. This indemnity and hold harmless shall include any costs, expenses and attorney fees incurred by the [Community] in connection with such Claims or the enforcement of this Agreement.

OFFICE OF KALAMAZOO COUNTY
DRAIN COMMISSIONER

_____
By:
Kalamazoo County Drain Commissioner

STATE OF MICHIGAN)
) SS.
COUNTY OF KALAMAZOO)

On this _____ day of _____, 20___, before me a Notary Public in and for said County, appeared _____, Kalamazoo County Drain Commissioner, on behalf of the _____ Drain Drainage District to me personally known to be the person described in and who executed the foregoing instrument and acknowledged the same to be his free act and deed.

_____
_____ , Notary Public
Kalamazoo County, Michigan
Acting in_____ County
My Commission Expires:_____

_____**, L.L.C.**

_____
By:
Its:

STATE OF MICHIGAN)
) SS.
COUNTY OF KALAMAZOO)

On this _____ day of _____, 20___, before me a Notary Public in and for said County, appeared _____ to me personally known to be the persons described in and who executed the foregoing instrument and acknowledged the same to be their free act and deed.

_____
_____ , Notary Public
Kalamazoo County, Michigan
Acting in_____ County
My Commission Expires:_____

Prepared by:
Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue, Room 107
Kalamazoo, Michigan 49007
Telephone: (269) 384-8117

MAINTENANCE PLAN

(for Private Developments)

_____[Responsible Entity Name]_____
Storm Water Management System Maintenance Plan
for

_____[Name of Develoment]_____

__[Name of Township or Municipal], Michigan__

1. Responsibility for Maintenance
   a. During construction, it is the developer's responsibility to perform the maintenance.
   b. Following construction, it will be the responsibility of _____ to perform the maintenance.
   c. If _____ fails to act within the time frame specified, the provisions of the Maintenance Agreement shall govern.

2. Time Frame for Corrective Action
   a. Routine Maintenance: Corrective action shall be completed within 30 days of regularly scheduled inspection or notification that action is required.
   b. Emergency Maintenance: Corrective action shall be completed within 36 hours of notification unless threat to public health, safety, and welfare requires even more immediate action.

3. Source of Financing
   a. _____ will pay for all maintenance activities on a continuing basis. The funding source will be:

4. Maintenance Tasks and Schedule
   a. See attached drawings of storm water management system.
   b. See attached Table No. 1 for tasks and inspection schedule.

5. Annual Maintenance Budget
   a. The annual maintenance budget for _____ development is itemized as follows:

1.	$
2.	$
3.	$
4.	$
5.	$
6.	$
TOTAL	$

6. Written documentation of maintenance inspections, maintenance activities, and expenditures will be kept on file at _____ *location*.

INSERT

TABLE No. 1
"XYZ" DEVELOPMENT
STORM WATER MANAGEMENT SYSTEM
MAINTENANCE TASKS AND SCHEDULE

Tasks	Protect Natural Flow Paths	Native Revegetation	Storm Sewer	Culvert or Bridge	Open Channel	Detention Basins	Retention Basins	Infiltration Practices	Bioretention / Rain Garden	Constructed Filter	Planter Box	Pervious Pavement	Capture Reuse	Vegetated Roof	Water Quality Device	Sediment Forebay	Spill Containment Cell	Water Quality Swale	Vegetated Swale	Vegetated Filter Strip	Level Spreader
Removals																					
Remove sediment accumulation	X		X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X
Remove trash and debris accumulation	X		X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X
Clean catch basins, inlets and pretreatment devices			X			X	X	X				X					X	X			
Pump and haul from spill containment																	X	X			
Vacuum surface												X									
Repair potholes												X									
Repair/Replace																					
Repair erosion	X			X	X	X	X	X	X			X				X		X	X	X	X
Replace riprap			X	X	X	X	X	X								X		X			X
Repair/replace structural components			X	X	X	X	X	X		X	X	X	X				X	X			
Brush and disinfect inside surfaces													X								
Refresh/replace infiltration/organic/filter media									X	X	X							X			
Till and/or aerate filter media/infiltration bottom							X	X		X								X			
Inspection Schedule	Twice a year (April and Oct)	Mow/burn every 2 - 5 years	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Inspect monthly for first year (April - Oct), twice a year thereafter	Twice a year (April and Oct)	Often (high maintenance required)	Once a year (April)	Twice a year (April and Oct)	Monthly for first year (April - Oct), twice a year thereafter (April Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Monthly for first year (April - Oct), once a year thereafter (July)	Twice a year (April and Oct)

Tasks	Protect Natural Flow Paths	Native Revegetation	Storm Sewer	Culvert or Bridge	Open Channel	Detention Basins	Retention Basins	Infiltration Practices	Bioretention / Rain Garden	Constructed Filter	Planter Box	Pervious Pavement	Capture Reuse	Vegetated Roof	Water Quality Device	Sediment Forebay	Spill Containment Cell	Water Quality Swale	Vegetated Swale	Vegetated Filter Strip	Level Spreader
Vegetation Management																					
Maintain vegetation/remove invasive species	X			X	X	X	X		X		X			X		X		X	X	X	
Water Vegetation									X		X			X						X	
Prune and/or weed vegetation/cut down perennial plantings at end of season		X							X		X			X							
Re-spread and/or replenish mulch									X		X										
Mowing/burning		X					X									X		X	X	X	
Trim or remove brush/trees	X			X	X		X		X							X			X	X	
Maintenance of wetland vegetation						X															
Apply herbicide		X			X																
Inspections																					
Assess bank stability	X			X	X	X	X									X					X
Inspect and drain containers													X								
Inspect underground bed and outlet (for underground systems)						X			X	X		X						X			
Evaluate drain-down time (max 72 hours allowed)							X	X	X	X		X						X			
Inspection Schedule	Twice a year (April and Oct)	Mow/burn every 2 - 5 years	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Inspect monthly for first year (April - Oct), twice a year thereafter	Twice a year (April and Oct)	Often (high maintenance required)	Once a year (April)	Twice a year (April and Oct)	Monthly for first year (April - Oct), twice a year thereafter (April Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Twice a year (April and Oct)	Monthly for first year (April - Oct), once a year thereafter (July)	Twice a year (April and Oct)

Appendix 3
County Drain Development Package

- **Submittal Checklist for Section 425 and 433 Agreements**
- **Irrevocable Commercial Letter of Credit**
- **Maintenance Agreement (for County Drain Systems)**
- **Maintenance Plan (for County Drain Systems)**
- **Release of Right-of-Way**
- **Drainage Easement**
- **Flooding Easement**
- **Certification of Adequate Outlet**
- **Application for Laying Out and Designating a County Drainage District under Section 425**
- **Agreement for the Establishment of a County Drain and County Drainage District Pursuant to Section 433**
- **Certificate of Construction**
- **Repair Bond**

SUBMITTAL CHECKLIST
for Section 425 and 433 Agreements

(Plats, developments with public roads, developments with a downstream drainage course to be established as a county drain, or a downstream drainage course that needs to be improved or added as a branch/extension of an existing county drain.)

Development Name: _____	Date: _____
Location: _____	Reviewed By: _____

		Date Received	Date Accepted
Initial Reviews			
1.	PRELIMINARY: Preliminary plat or site plan, application, calculation package and fees (submittal fee and review deposit)	_____	_____
2.	CONSTRUCTION: Construction drawings, application, calculation package and fees (submittal fee and review deposit if preliminary review omitted)	_____	_____
Prior to Construction Drawing Approval			
3.	Specifications for public drainage system components	_____	_____
4.	Copies of restrictive covenant or master deed language	_____	_____
5.	Recordable release of rights-of-way within the plat provided in the name of the drainage district	_____	_____
6.	Recordable release of rights-of-way for downstream properties, or flooding easement agreement	_____	_____
7.	Certification of Adequate Outlet	_____	_____
	- OR -		
	Approval has been given for any improvements required to existing county drains	_____	_____
8.	Drain permit application and fee	_____	_____
9.	425 Application	_____	_____
	- OR -		
	A drainage district has been established (adjusted) and a 433 Agreement submitted	_____	_____
	- OR -		
	A letter of commitment from the local municipality, governmental agency, or association has been executed	_____	_____

		Date Received	Date Accepted
10.	Maintenance fee (per Sections 425 and 433)	_____	_____
11.	Recording deposit	_____	_____
12.	All additional fees paid for engineering review	_____	_____
Prior to Issuance of a Grading (SESC) Permit and Construction		_____	_____
13.	Evidence of contractor's insurance coverage (for work on county drain only)	_____	_____
14.	Itemized cost of construction for county drain work	_____	_____
When Drain Commissioner Signs Final Plat Prior to Completion of Construction			
15.	The Proprietor has entered into an agreement with the Drain Commissioner and has posted surety for faithful performance of the agreement	_____	_____
Upon Completion of Construction			
16.	Inspection reports (for work on county drain only)	_____	_____
17.	Determine practicality and final acceptance of county drain by Drain Commissioner	_____	_____
18.	Acceptance of roads by County Road Commission (for public roads only)	_____	_____
19.	Certification that county drains and storm water system have been improved in accordance with approved construction drawings	_____	_____
20.	Construction record drawings	_____	_____
21.	Drain Commissioner releases surety (posted per item no. 15)	_____	_____
Prior to Final Plat Approval and/or Prior to Release of Recording Deposit			
22.	Evidence of municipal approval of preliminary plat	_____	_____
23.	Copy of recorded Restrictive Covenants or Master Deed Liber ____ Page _____	_____	_____
24.	Guarantee for repairs (repair bond or letter of credit) of any defects in the work for a period of one year	_____	_____
25.	Recorded Easements Liber _____ Page _____	_____	_____
26.	Recorded 433 Agreement Liber ____ Page _____	_____	_____
27.	Route and Course Description (for county drain)	_____	_____
28.	Drainage District Map and legal description	_____	_____
29.	Assessment Roll	_____	_____
30.	Copy of recorded Maintenance Agreement	_____	_____

		Date Received	Date Accepted
	(if association or corporate entity wishes to perform routine maintenance)	_____	_____
31.	Drain Commissioner signs final plat		
32.	Drain Commissioner returns remaining review and recording deposits (posted per item nos. 1 and 11)	_____	_____
One Year After Final Completion of Construction			
33.	Drain Commissioner returns repair bond or letter of credit (posted per item no. 24)	_____	_____

IRREVOCABLE COMMERCIAL LETTER OF CREDIT

For Construction Surety
Act 591, Public Act 1996 (Formerly Act 288, Public Act 1967)

Effective date of Agreement:

To:

Kalamazoo County Drain Commissioner
201 West Kalamazoo Avenue
Kalamazoo, Michigan 49007

RE:

Dear Sir/Madam:

We, the undersigned, represented by our Officer(s), hereby acknowledge and establish our Irrevocable Letter of Credit # _____, and authorize you to draw on us at sight for the account of [name of principle party] up to an aggregate total of $_____.

This Letter of Credit is given for the purpose of assuring the Drain Commissioner's Office that [describe project].

All drafts presented for payment must be marked "Drawn under Letter of Credit #_____ for [name principle party], dated _____."

This authorization expires at the close of business on _____.

We hereby agree with the drawers, endorsers, and bonafide holders of drafts drawn under and in compliance with the terms stated herein, that such drafts will be duly honored upon due presentation to the drawees negotiated on or before the expiration date of this letter, or upon presentation at this office together with this document on or before the stated date of expiration.

_____
(Officer's signature) (seal if required)

MAINTENANCE GREEMENT

(for County Drain Systems)

THIS AGREEMENT is made and entered into effective the _____ day of _____, 20____, by and between the Kalamazoo County Drain Commissioner's Office, at 201 West Kalamazoo Avenue, Kalamazoo, Michigan 49007, hereinafter referred to as "the Drain Commissioner" and _____, of _____ , its assigns and successors in interest, hereinafter referred to as "the Owner."

_____, as "Owner(s)" of the property described below, in accordance with Kalamazoo County Drain Commissioner "Site Development Rules," agrees to install and maintain storm water management practice(s) on the subject property in accordance with approved plans and conditions. The Owner further agrees to the terms stated in this document to ensure that the storm water management practice(s) continues serving the intended function in perpetuity. This Agreement includes the following exhibits:

Exhibit A: Legal description of the real estate for which this Agreement applies ("Property").

Exhibit B: Location map(s) showing a location of the Property and an accurate location of each storm water management practice affected by this Agreement.

Exhibit C: Long-term Maintenance Plan ("Plan") that prescribes those activities that must be carried out to maintain compliance with this Agreement.

Through this Agreement, the Owner(s) hereby subjects the Property to the following covenants, conditions, and restrictions:

1. Storm water runoff control facilities and measures have been constructed and will be perpetually maintained upon the Property in accordance with the Plan, and as hereinafter set forth, at the sole cost and expense of the Owner and all future owners of the Property until such obligation is released, discharged or modified by the Drain Commissioner.

2. The obligation of owners of the Property to maintain and continue the storm water runoff control facilities and measures in accordance with the Plan and as otherwise herein set forth shall be deemed to be a covenant running with the land and specifically enforceable against current and future owners of the Property.

3. The Owner, its successors and assigns, hereby grant permission to the Drain Commissioner, its authorized agents and employees, to enter upon the property and to inspect the storm water BMP facilities whenever the Drain Commissioner deems necessary. The purpose of the inspection is to assure safe and proper functioning of the facilities. The inspection shall cover the entire facility including storm water reuse facilities, pervious pavement and vegetated roofs. When deficiencies are noted, the Drain Commissioner shall notify the Owner, its successors and assigns, and provide information from the inspection, its findings, and its evaluations and conclusions.

4. In the event that the storm water facilities maintenance is not conducted, the Drain Commissioner shall notify Owner, specifying the necessary maintenance. Within thirty (30) days of the notice, Owner shall perform the specified routine maintenance, at its expense. Within thirty-six (36) hours of notice, Owner shall perform any specified emergency maintenance.

5. Owner, at its expense, shall secure from the affected owners of land, all necessary easements and releases of right-of-way for the storm water facilities, which easements and releases of right-of-way are to be recorded with the County Register of Deeds. The easements shall be granted to the established County Drain Drainage District.

6. In the event Owner fails to perform the maintenance so specified, the Drain Commissioner can either perform the maintenance or contract with third parties to perform the maintenance. In either instance, Owner shall be responsible for all actual costs and expenses incurred for the specified maintenance and Owner shall pay within thirty (30) days of the receipt of the statement. If Owner fails to pay the amount set forth in the statement the Drain Commissioner may place a lien, or encumbrance against the land described, to include an assessment to be made by the County Treasurer, as taxes due and owing or repayment of cost incurred by the Drain Commissioner. Drain Commissioner may also collect as an ordinary debt.

This Agreement and its attachments as affecting the Property shall be recorded in the office of the Register of Deeds or the County of Kalamazoo, State of Michigan. This Agreement is binding on the parties, their assigns and successors in interest and is intended and deemed to run with the land.

OFFICE OF KALAMAZOO COUNTY
DRAIN COMMISSIONER

_____
By:
Kalamazoo County Drain Commissioner

STATE OF MICHIGAN)
) SS.
COUNTY OF KALAMAZOO)

On this _____ day of _____, 20___, before me a Notary Public in and for said County, appeared _____, Kalamazoo County Drain Commissioner, on behalf of the _____ Drain Drainage District to me personally known to be the person described in and who executed the foregoing instrument and acknowledged the same to be his free act and deed.

_____
_____, Notary Public
Kalamazoo County, Michigan
Acting in_____ County
My Commission Expires:_____

_____**, L.L.C.**

_____
By:
Its:

STATE OF MICHIGAN)
) SS.
COUNTY OF KALAMAZOO)

On this _____ day of _____, 20___, before me a Notary Public in and for said County, appeared _____ to me personally known to be the persons described in and who executed the foregoing instrument and acknowledged the same to be their free act and deed.

_____
_____, Notary Public
Kalamazoo County, Michigan
Acting in_____ County
My Commission Expires:_____

Prepared by:
Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue, Room 107
Kalamazoo, Michigan 49007
Telephone: (269) 384-8117

MAINTENANCE PLAN

(for County Drain Systems)

_____

Responsible Entity Name

Storm Water Management System Maintenance Plan

for

_____

Name of Drain

Kalamazoo County, Michigan

1. Responsibility for Maintenance
   a. During construction, it is the developer's responsibility to perform the maintenance.
   b. Following construction, it will be the responsibility of _____ to perform the maintenance.
   c. If _____ fails to act within the time frame specified, the provisions of the Maintenance Agreement shall govern.

2. Time Frame for Corrective Action
   a. Routine Maintenance: Corrective action shall be completed within 30 days of regularly scheduled inspection or notification that action is required.
   b. Emergency Maintenance: Corrective action shall be completed within 36 hours of notification unless threat to public health, safety, and welfare requires even more immediate action.

3. Source of Financing
   a. _____ will pay for all maintenance activities on a continuing basis. The funding source will be:

4. Maintenance Tasks and Schedule
   a. See attached drawings of storm water management system.
   b. See attached Table No. 1 for tasks and inspection schedule.

5. Annual Maintenance Budget
   a. The annual maintenance budget for _____ development is itemized as follows:

1.	$
2.	$
3.	$
4.	$
5.	$
6.	$
TOTAL	$

6. Written documentation of maintenance inspections, maintenance activities, and expenditures will be kept on file at _____ *location*

RELEASE OF RIGHT-OF-WAY

For and in consideration of prospective benefits to be derived by reason of the locating, establishing, constructing, maintaining, and improving of a certain Drain under the supervision of the Drain Commissioner of the County of Kalamazoo and State of Michigan, as hereinafter described,

Note to Preparer: Grantee's marital status and rights of survivorship must come from the recorded deed.

_____and _____, [husband and wife], [as tenants by the entirety], of _____, [do/does] hereby convey and release to the _____ Drain Drainage District, the Right-of-Way for a certain Drain, hereinafter more particularly designated and described, over and across the following land owned by [him/her/them], and situated in the [City/Village/Township] of _____, County and State aforesaid, which lands owned are described as follows:

INSERT PROPERTY DESCRIPTION

The Right-of-Way or Easement is described as:

PERMANENT EASEMENT: _____ SEE EXHIBIT A.

Additional consideration of _____ Dollars ($_____) is paid herewith.

The Right-of-Way hereby conveyed and released is for the sole and only purpose of constructing, maintaining, and improving over and across said premises a certain Drain, petition for which in writing was made on _____, 20___, by _____ *[DEVELOPER]*, and the necessity for which has been determined by the _____ [*Drain Commissioner / Drainage Board]* on _____ *[DATE OF 425 OR 433 AGREEMENT]*, 20____, the route and course of said Drain is described as follows, to wit:

[MAIN:] [INSERT DESCRIPTION]; or
[SEE EXHIBIT B]

[BRANCH:]

[EXTENSION:]

This conveyance is based upon the above-described line of route and shall be deemed to include the extreme width of said Drain as shown in the survey thereof, to which survey reference is hereby made for a more particular description and includes a release of all claims to damages in any way arising from or incident to the operating and maintaining of said Drain across said premises; and also sufficient ground on either side of the center line of said Drain, for the construction thereof; and shall be deemed a sufficient conveyance to vest in the Drainage District an easement in said land for the uses and purposes of drainage together with such rights of entry upon, passage over, deposit of excavated earth and storage of material and equipment on such land, as may be necessary or useful for the construction, maintenance, cleaning out, and repair of such Drain.

WITNESS, our hands and seals, dated _____, 20___.

Sign: _____

type/print: _____

Sign: _____

type/print: _____

_____ DRAIN, _____ COUNTY, MICHIGAN

STATE OF MICHIGAN)
) SS.
COUNTY OF KALAMAZOO)

On _____ , 20__, before me, a Notary Public in and for said County, personally appeared _____, [husband and wife], to me known to be the persons/person described in and who executed the foregoing instrument, and [he/she/they] acknowledged that [he/she/they] executed the same as [his/her/their] free act and deed.

_____

_____ , Notary

_____ County, Michigan

Acting in _____ County

My commission expires: _____

Prepared by:

When Recorded Return to:

Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue
Kalamazoo, MI 49007
Phone (269) 384-8117

DRAINAGE EASEMENT

IN CONSIDERATION OF LESS THAN ONE HUNDRED DOLLARS ($100.00), _____, a corporation formed under the laws of the State of Michigan, whose address is _____ (hereafter referred to as the "Grantor"), conveys and releases to _____ Drainage District, whose address is _____ (hereafter referred to as the "District"), an irrevocable easement and right-of-way in which to construct, maintain, repair, replace, and/or remove drainage and storm water management practices, over, across, under and through the following parcel of land situated in the Township/City/Village of _____ , Kalamazoo County, Michigan, and legally described as follows:

LEGAL DESCRIPTION OF PARENT PARCEL

(hereafter referred to as the Parent Parcel), the easement and right-of-way to be located as follows;

LEGAL DESCRIPTION of EASEMENT and RIGHT-OF-WAY

The conditions of this easement are such that:

1. The District's rights and obligations are limited to the maintenance, repair, and replacement of the drainage and storm water management practices, in accordance with the provisions of the Drain Code. The cost of which may be assessed to the benefiting properties within the drainage district.

2. The Grantor shall retain all other property rights and obligations, including turf maintenance. No buildings, construction, or decorative landscaping of any kind or nature shall be placed within the easement and right-of-way described above. Fences placed within the easement and right-of-way shall not impede drainage or appreciably increase the District's obligations. If the District shall in the exercise of its rights disturb the easement and right-of-way, then the District shall only be obliged to restore the ground to its original grade, place four (4) inches of top soil, seed, fertilizer and mulch.

3. Should the District in the reasonable discharge of its obligations be required to enter upon the Parent Parcel it shall have the right to do so. If the District shall in the exercise of its foregoing powers disturb the Parent Parcel described above, then the District shall restore it to its original condition.

4. Prior to each exercise of rights granted herein, the District shall make reasonable efforts to serve notice on the Grantor of its intent to enter upon the easement and right-of way. In cases of emergency, no prior notice need be given.

5. By this conveyance the Grantor releases the District from any and all claims for damage arising from or incidental to the exercise of any of the foregoing powers.

This Grant of Easement is intended to run with the land and shall be binding upon and shall inure to the benefit of the parties hereto, their respective heirs, personal representatives, successors and assigns, and may not be amended or modified without prior written approval of the District. Any amendment or modification to this Grant of Easement shall be by an instrument in recordable form executed by both the Grantor and the District and recorded at the office of the Kalamazoo County Register of Deeds.

Dated this _____ day of _____, 20____.

GRANTORS:

_____

Sign: _____

Print : _____

Sign: _____

Print : _____

STATE OF MICHIGAN)
)ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this _____ day of _____, 20____ by _____ President and _____ Secretary/Treasurer of the _____ described herein, and who executed the above instrument, on behalf of said Corporation.

_____

_____ , Notary

[Name of Township or Mu County, Michigan

Acting in _____ County

My commission expires: _____

Prepared by:

When Recorded Return to:

Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue
Kalamazoo, MI 49007
Phone (269) 384-8117

FLOODING EASEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 20___, for and in consideration of $_____ and prospective benefits to be derived by reason of the construction, operating, improving, and maintaining of a certain Drain under the supervision of the Kalamazoo County Drain Commissioner as hereinafter described, _____, (the "Landowners") do hereby convey and release to _____, Kalamazoo County Drain Commissioner on behalf of the _____ County Drain Drainage District, (the "Drainage District") a public body corporate, of _____, an Easement for the _____ Drain situated in the County and State aforesaid. Landowners do hereby convey and release to Drainage District a Drainage Easement with an elevation of approximately feet above mean sea level, USGS datum, for drainage purposes and flood control.

WHEREAS, Landowners are the owners of lands in the aforesaid County described as:

WHEREAS, the Drainage District wishes to obtain an easement from Landowners in the event that there is an increase in the velocity or quantity of water flowing onto Landowners' property as a result of the construction, maintenance, improvement, or operation of the Drain.

NOW THEREFORE, the parties agree as follows:

1. Landowners hereby grant, convey, and release unto Drainage District as Easement over and upon their lands for the purpose of allowing for increases in velocity or quantity of water flow onto Landowners' property.

2. Said Easement is described separately as follows:

3. Landowners, their heirs, executors, administrators, successors, and assigns reserve their rights and privileges to the area encompassed by the Easement as may be used and enjoyed to include the planting and harvesting of agricultural crops so long as the use(s) do not interfere with or abridge the rights granted to and easement hereby acquired by the Drainage District;

4. Landowners, their heirs, executors, administrators, successors, and assigns hold Drainage District harmless to all claims to damages in any way arising from or incident to the drainage and any increased flow onto said premises by reason of the drain and maintenance or improvement thereof. During the time of maintenance and improvement of said drain, or at any time in the future, such release for damages releases the Drainage District, its successors and assigns from any damages whatsoever arising out of the flooding of said lands within the easement right-of-way to any depth at any time in the future by reason of the construction of such drainage improvements and the flooding caused by such construction or their use during the time of construction or at any time in the future;

5. This Easement may be terminated in whole or in part by written agreement of all of the parties;

6. This conveyance shall be deemed sufficient to vest in Drainage District and Easement in said lands for the uses and purposes of any increased flow onto Landowners' property.

In witness whereof, the parties hereto have executed this Agreement the day and year first above written.

LANDOWNERS:

Sign: _____

Name _____

Sign: _____

Name: _____

_____ DRAIN DRAINAGE DISTRICT

Sign: _____

Name: _____
Kalamazoo County Drain Commissioner

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this _____ day of _____ 20____, by _____ and _____.

_____
_____ , Notary
[Name of Township or Mu County, Michigan
Acting in _____ County
My commission expires: _____

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this _____ day of _____ 20____, by _____ and _____.

_____
_____ , Notary
_____ County, Michigan
Acting in _____ County
My commission expires: _____

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this ____ day of _____, 20____, by _____, on behalf of the Drain Drainage District.

_____
_____ , Notary
_____ County, Michigan
Acting in _____ County
My commission expires: _____

Prepared by:

When Recorded Return to:

Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue
Kalamazoo, MI 49007
Phone (269) 384-8117

CERTIFICATION OF ADEQUATE OUTLET

(Required for 425 and 433 Agreements)

_____

_____

Kalamazoo County, Michigan

"I, _____, a Licensed Professional Engineer in the State of _____, do hereby certify that:

1. The lands to be developed naturally drain into the area served by the existing drain, or that the existing drain is the only reasonably available outlet for the drainage from the lands to be developed.
2. There is adequate capacity in the existing drain to service lands to be developed without detriment or diminution of drainage service provided or to be provided in the foreseeable future to the area in the existing district.
3. Discharge from the development shall not cause adverse impact to offsite property due to concentrated runoff or ponded water of greater height, area, and duration.

Signature: _____

Print Name: _____

Date: _____

_____

Engineer's Seal

APPLICATION FOR LAYING OUT AND DESIGNATING
A COUNTY DRAINAGE DISTRICT UNDER SECTION
425 OF DRAIN CODE OF 1956
STATE OF MICHIGAN C.L. 70 280.433 (5) & (7)
AND PETITION TO LOCATE, ESTABLISH, AND CONSTRUCT A DRAIN

TO THE COUNTY DRAIN COMMISSIONER,
COUNTY OF KALAMAZOO, STATE OF MICHIGAN:

Your petitioner respectfully shows that [he/she] is the only freeholder and owner in the [City or Township] of _____, in the County of Kalamazoo, State of Michigan, of the lands included in this application and that the proposed drain shall be entirely located within the [City or Township] of _____, that all lands to be drained by said proposed drain are located in said [City or Township] of _____.

Your petitioner further respectfully shows that the person signing this petition constitutes the only freeholder and owner of land included in the application in the [City or Township] _____ which said proposed drain and the lands to be drained thereby are located and that as the owner of the land he/she is the only one liable to an assessment for the construction of the proposed drain.

Your petitioner further makes application and hereby respectfully asks you to lay out and designate a drainage district in the [City or Township] of _____, County of Kalamazoo, State of Michigan, under the provisions of Act 40 Public Acts of Michigan, 1956, as amended. The location and route of said proposed drain is to be set forth on the attached riders.

Your petitioner agrees to pay the cost incurred by the Drain Commissioner in establishing this drainage district.

Sign: _____

Name _____

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this _____ day of _____ 20____, by _____ and _____.

_____
_____ , Notary
_____ County, Michigan
Acting in _____ County
My commission expires: _____

AGREEMENT FOR THE ESTABLISHMENT OF A COUNTY DRAIN AND COUNTY DRAINAGE DISTRICT PURSUANT TO SECTION 433 OF ACT NO. 40 OF THE PUBLIC ACTS OF 1956, AS AMENDED

THIS AGREEMENT, made and entered into this _____ day of _____, 20___, by and between _____, KALAMAZOO COUNTY DRAIN COMMISSIONER, hereinafter referred to as "Drain Commissioner" on behalf of the proposed _____ Drain Drainage District; and _____, as owner(s) of land described in Exhibit A attached hereto, hereinafter referred to as "Landowner".

WITNESSETH:

WHEREAS, Section 433 of Act No. 40 of the Public Acts of 1956, as amended, authorizes the Drain Commissioner to enter into an Agreement with the Landowner and developer, if any, to establish a drain which was constructed by the Landowner or developer to service an area of its own land as a County Drain; and,

WHEREAS, Landowner, pursuant to Section 433 of Act No. 40 of 1956, as amended, wishes to provide drainage service to its own lands and has requested same to be established and dedicated as a County Drain under the jurisdiction of the Kalamazoo County Drain Commissioner; and,

WHEREAS, Landowner has been advised and understands and agrees to assume the total cost of the construction of the drain to include engineering, inspection, easement acquisition, legal, and administrative expenses and costs attendant to this Agreement; and,

WHEREAS, Landowner further understands that the Drain constructed, or to be constructed, pursuant to this Agreement, when finally accepted by the Drain Commissioner, will be known as the _____ Drain, and that the land to be known and constitutes as the _____ Drain Drainage District and will be subject to assessments, for costs of future operation, inspection, maintenance, and improvement; and,

WHEREAS, Landowner has agreed to assume and pay all costs as set forth herein; and

WHEREAS, Landowner has obtained, at its own expense, a certificate from a registered professional engineer satisfactory to the Drain Commissioner to the effect that the Drain has sufficient capacity to provide adequate drainage service without detriment to or diminution of the drainage service which the outlet currently provides. A copy of said certificate being attached hereto as Exhibit B.

NOW, THEREFORE, in consideration of the premises and covenants of each, the parties agree as follows:

1. The Landowner agrees to pay the costs of construction of said Drain and drainage facilities, including the acquisition of the necessary rights-of-way or easements, engineering, surveying, inspection, legal, and administration costs. In addition, the Landowner has deposited with the Drain Commissioner an amount of money equivalent to five (5%) percent of the costs of construction of the Drain, not to exceed Two Thousand Five Hundred and No/100 ($2,500.00) Dollars, which monies are to be deposited in a special drain fund to be used for future maintenance of the Drain, hereinafter referred to as "[Name of Township or Municipa Drain Maintenance Fund".

2. Landowner shall secure all necessary permits or authorizations as may be required by local, state, or federal law and provide copies to the Drain Commissioner. The Drain Commissioner shall be provided copies of all correspondence and reports involving any governmental agency with respect to the Drain.

3. The _____ Drain Maintenance Fund is agreed and understood as being for the sole benefit of the _____ Drain and use thereof may be made by the _____ Drain Drainage District at large, or part thereof, and that such payment shall not relieve the subject property from any future assessments levied pursuant to the Drain Code of 1956, as amended.

4. Landowner agrees to indemnify and hold harmless the Drain Commissioner for any and all claims, damages, lawsuits, costs, and expenses arising out of or incurred as a result of the Drain Commissioner assuming responsibility for the drain under federal, state, and/or local environmental laws and standards and specification and the administrative and judicial interpretation thereof.

5. Modification, amendments, or waivers of any provision of the agreement may be made only by the written mutual consent of the parties.

This Agreement shall become effective upon its execution by the Landowner and the Drain Commissioner and shall be binding upon the successors and assigns of each party.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed this _____ day of _____, 20___.

DEVELOPER:

Sign: _____

Name: _____

LANDOWNERS:

Sign: _____

Name _____

Sign: _____

Name: _____

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this _____ day of _____ 20____, by _____ and _____.

_____
_____ , Notary
_____ County, Michigan
Acting in _____ County
My commission expires: _____

_____ DRAIN DRAINAGE DISTRICT

Sign: _____

Name: _____
Kalamazoo County Drain Commissioner

STATE OF MICHIGAN)
) ss.
COUNTY OF KALAMAZOO)

The foregoing instrument was acknowledged before me this ____ day of _____, 20____, by _____, on behalf of the Drain Drainage District.

_____
_____ , Notary
_____ County, Michigan
Acting in _____ County
My commission expires: _____

Prepared by:

When Recorded Return to:

Kalamazoo County Drain Commissioner
201 W. Kalamazoo Avenue
Kalamazoo, MI 49007
Phone (269) 384-8117

CERTIFICATION OF CONSTRUCTION

[Development Name]

[Drain Name]

[Location]

Kalamazoo County, Michigan

"I, _____ a Licensed Professional Engineer in the State of _____, do hereby certify that construction of all storm water management facilities for the above-referenced development is complete and that:

1. I have supervised inspection of the construction.

2. All facilities have been installed in accordance with final construction plans approved by the Drain Commissioner, and all authorized contract modifications.

3. Construction record drawings, inspection reports and construction material testing reports have been submitted to the Drain Commissioner.

Sign: _____

Name: _____

Date: _____

_____

Engineer's Seal

REPAIR BOND

KNOWN ALL MEN BY THESE PRESENTS, that we, the undersigned, _____, as Principal, and _____, as Surety, are held and firmly bound onto the County Drain Commissioner, Owner, in the sum of _____ dollars ($_____) to be paid to the Owner for which payment will and truly to be made we jointly and severally bind ourselves, our heirs, our executors, administrators, and assigns, firmly by these presents.

Sealed with our seals and dated this _____ day of_____, 20_____

WHEREAS, the above named principal has entered into a certain written contract with the _____ Drain Commissioner dated _____, 20[Nan, wherein the principal agreed as follows:

NOW THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH that by and under said Contract, the above named principal has agreed with the Owner, for a period of one (1) year from the date of payment of the final estimate, to keep in good order and repair any defect in all work done under said Contract, either by the principal or his subcontractors, or his suppliers, that may develop during said period due to improper materials, defective equipment, workmanship or arrangements; any other work affected in making good such imperfections, shall also be made good, all without expense to the Owner, excepting only such part or parts of said work as may have been disturbed without the consent or approval of the principal after final acceptance of the work, and that whenever directed to do so by the Owner, by notice served in writing, either personally or by mail, on the Principal, legal representative, successor, or on the Surety, he/she will at once make such repairs as directed by the Owner; and in the case of failure to do so within one (1) week from the date of service of such notice, then the Owner shall have the right to purchase such materials and employ such labor and equipment as may be necessary for the purpose and undertake to do and make such repairs, and charge the expense thereof to and receive same from said Principal or Surety. If any repair is necessary to be made at once to protect life and property, then and in that case, the Owner may take immediate steps to repair or barricade such defects without notice to the Contractor. In such accounting, the Owner shall not be held to obtain the lowest figure for doing of the work or any part thereof, but all sums actually paid therefore shall be charged to the Principal or Surety. In this connection, the judgment of the Owner is final and conclusive. If the said Principal, for a period of one (1) year from the date of the final estimate payment, shall keep such work so constructed under the contract in good order and repair, excepting only such part or parts of such work as may have been disturbed without the consent or approval of said Principal after the final acceptance of the same, and shall, whenever notice is given as herein specified, at once proceed to make repair as in said notice directed or shall reimburse the Owner for any expense incurred by making such repairs should the Principal or Surety fail to do as hereinbefore specified, and shall fully indemnify, defend, and save harmless the said Owner from all suits and actions for damages of every name and description brought or claimed against it for or on account of any party or parties, by or from any of the acts or omissions or through the negligence of said Principal, servants, or employees, in the prosecution of the work included in the said Contract, and from any and all claims arising under the Workmen's Compensation Act, so-called, of the State of Michigan, then the above obligation shall be void, otherwise to remain in full force and effect.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed by their respective authorized officers this _____ day of _____, 20____.

Signed, Sealed, and Delivered in the presence of:

_____ (L.S.) _____ (L.S.)

_____ (L.S.) _____ (L.S.)

Appendix 4
County Drain Use Permit Package

- **Application and Permit for Utility to Cross or Parallel a County Drain**
- **Application and Permit to Install a Crossing or Modify a County Drain**
- **Application and Permit to Connect to a County Drain**
- **Insurance Certificate Requirements**

Office of the Drain Commissioner
201 West Kalamazoo Avenue · Kalamazoo, Michigan 49007
Phone: (269) 384-8117 · Fax: (269) 383-8920 · www.kalcounty.com/drain

APPLICATION FOR UTILITY TO CROSS OR PARALLEL A COUNTY DRAIN

NAME OF DRAIN: _____

APPLICANT:

Company: _____

Address: _____

_____

Phone: ( ) _____

Representative: _____

Owner ☐ Agent ☐

Applicant agrees to abide by current rules and specifications of the Kalamazoo County Drain Commissioner's Office (the Owner), and to hold the Owner and the named Drainage District harmless in the event of injury to persons, lands, and properties sustained during the permitted activity. Applicant agrees to promptly reimburse the Owner for costs incurred to defend against any action brought against the Owner or District by an aggrieved party resulting from the permitted activity.

Signature: _____ Date: _____

ACTIVITY (describe):

LOCATION:

City/Village _____ Township: _____ Section: _____

(Describe location to nearest section line and quarter post)

ATTACHMENTS (check):

☐ Construction Plans ☐ Other (name):

(Office Use Only)

Reviewed by: _____

Approved by: hgl _____ Date: _____

Fee: Y ☐ N ☐ Owner's Protective Policy: Y ☐ N ☐

Amount: $ _____ Date: _____

Insurance Company: _____

Final Inspection and Approval

By: _____ Date: _____

Office of the Drain Commissioner
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Phone: (269) 384-8117 · Fax: (269) 383-8920 · www.kalcounty.com/drain

PERMIT FOR UTILITY
TO CROSS OR PARALLEL A COUNTY DRAIN

The _____ Drain Drainage District, by and through the Kalamazoo County Drain Commissioner (hereinafter "Drain Commissioner"), does hereby grant permission to _____ of _____ and use of portion of the established right-of-way/easement for the _____ Drain in _____ Township(s), Kalamazoo County, Michigan. This permit is issued for the sole and only purpose of allowing Permittee the following use:

In consideration of granting this permit, Permittee does hereby agree to comply with all terms and conditions as set forth in this permit, together with the following rules and regulations as established by the Kalamazoo County Drain Commissioner:

1. Commencement of work set forth in the permit application constitutes acceptance of the permit as issued.

2. Failure to object within ten (10) days to the permit as issued constitutes acceptance of the permit as issued.

3. A minimum of seventy-two (72) hours notice is required to the Drain Commissioner's office prior to any construction that will involve a county drain.

4. Permit application must be completely filled out and accompanied with a detailed plan or sketch outlining the proposed activity.

5. Specifications:

    a. All utilities and/or facilities must be a minimum of four (4) feet below the established drain bottom (may be lower than existing drain bottom) when crossing or paralleling a county drain or right-of-way.

    b. Any structures removed such as headwalls, wingwalls, concrete slabs, riprap, erosion protection, tiling and culverts - metal or concrete, must be replaced with new material and reconstructed to original condition or better.

    c. All ditch banks, when disturbed, must be reshaped to original slope, compacted, topsoiled, and seeded, fertilized, and mulched or hydroseeded.

6. Equipment and materials may not be stored in any way so as to cause blockage of a county drain.

7. Permittee is responsible for maintaining all storm drainage during the time of construction, whether by use of pumping equipment or construction of a bypass system.

8. Prior to issuance of a permit, proof of Contractor's Liability Insurance must be filed with the Office of the Drain Commissioner, with the named insured, in compliance with the Kalamazoo County Drain Commissioner's Insurance Certificate Requirements.

9. This permit does not relieve applicant from meeting any application requirement of law or other public bodies or agencies, i.e., local, state, or federal. Additionally, the issuance of this permit does not relieve the utility of any future expense for relocation of said utility to accommodate for future drain improvements.

10. Permittee shall be responsible for and pay all costs for engineering and inspection services incurred by the Kalamazoo County Drain Commissioner in the review of the Permit Application and inspection of work performed hereunder. Payment is to be made within thirty (30) days of invoice.

11. Other: _____ further agrees, either to pay any increased cost to the Drainage District due to this utility occupying said drain, said cost to be determined as a separate bid item during construction or reconstruction, or if determined by the Kalamazoo County Drain Commissioner, the Utility Company occupying said drain right-of-way, shall relocate or lower if the location of the utility shall increase the cost of performing drain improvements or drain maintenance.

    All expenses pertaining to said relocations shall be paid for by the owner of the utility company. Relocation shall be completed within ninety (90) days from receipt of written request by the Drain Commissioner.

    Additional time may be granted by the Drain Commissioner if determined necessary.

Permittee does hereby acknowledge and agree that, in the event the area of the right-of-way for which this permit is granted is necessary for future maintenance and operation of the _____ Drain, Permittee at its own expense, shall remove all conflicting facilities, structures, pipelines, cables, and other appurtenances to said use in and during the time of the maintenance of said Drain. Upon request of the Drain district, said utility will be relocated within ninety (90) days from said request.

Further, Permittee shall hold harmless and indemnify the Kalamazoo County Drain Commissioner, the _____ Drain Drainage District, and their employees, agents or contractors from any injury to person or property sustained as a result of the placement of the uses specified herein.

Further, this permit is subject to additional terms and conditions as follows:

ACKNOWLEDGMENT AND AGREEMENT

The terms and conditions of this permit and attachments hereto are acknowledged by _____ _____ (Permittee) of _____.

Dated: _____

WHEREFORE this permit is granted this _____ day of _____, 20___.

_____
Kalamazoo County Drain Commissioner

Office of the Drain Commissioner
201 West Kalamazoo Avenue · Kalamazoo, Michigan 49007
Phone: (269) 384-8117 · Fax: (269) 383-8920 · www.kalcounty.com/drain

APPLICATION
TO INSTALL A CROSSING OR MODIFY A COUNTY DRAIN

Name of Drain: _____

Applicant's Name: _____

Mailing Address: _____

Phone Number: Home: _____ Work: _____

Parcel ID Number: _____

Contractor's Name: _____

Contractor's Address: _____

CROSSING

Crossing Type: Bridge _ _ Culvert _ _ Rock Ford ____ Other _____

Crossing Width x Height or Diameter: _____ Crossing Length: _____

PLEASE SUBMIT A LOCATION MAP AND SKETCH OF THE PROPOSED CROSSING

MODIFICATIONS

Deepening/Widening _ _ Relocation ____ Other _____

Length of Drain to be Modified: _____

PLEASE SUBMIT A LOCATION MAP AND SKETCH OF THE PROPOSED WORK

I do hereby make application for a permit for the above described work to be performed on the _____ Drain at the following location: _____ in the Township of _____, Kalamazoo County, Michigan.

Date: _____ Applicant's Signature: _____

Print Name: _____

Office of the Drain Commissioner
201 West Kalamazoo Avenue · Kalamazoo, Michigan 49007
Phone: (269) 384-8117 · Fax: (269) 383-8920 · www.kalcounty.com/drain

PERMIT
TO INSTALL A CROSSING OR MODIFY A COUNTY DRAIN

The _____ Drain Drainage District, by and through the Kalamazoo County Drain Commissioner (hereinafter "Drain Commissioner"), does hereby grant permission to _____ of _____ to use of a portion of the established right-of-way/easement for the _____ Drain in _____ Township(s), Kalamazoo County, Michigan. This permit is issued for the sole and only purpose of allowing Permittee the following use:

In consideration of granting this permit, Permittee does hereby agree to comply with all terms and conditions as set forth in this permit, together with the following rules and regulations as established by the Kalamazoo County Drain Commissioner:

1. Commencement of work set forth in the permit application constitutes acceptance of the permit as issued.

2. Failure to object within ten (10) days to the permit as issued constitutes acceptance of the permit as issued.

3. A minimum of seventy-two (72) hours notice is required to the Drain Commissioner's office prior to any construction that will involve a county drain.

4. Permit application must be completely filled out and accompanied with a detailed plan or sketch outlining the proposed activity. The sketch or drawing shall include a sectional view of the drain or crossing, construction details, and the location of the work on the property.

5. All crossings shall be designed in accordance with the Summary of Requirements for Installation of a Crossing Over a County Drain (attached).

6. Equipment and materials may not be stored in any way so as to cause blockage of a County Drain.

7. Permittee is responsible for maintaining all storm drainage during the time of construction, whether by use of pumping equipment or construction of a bypass system.

8. Prior to issuance of a permit, proof of Contractor's Liability Insurance may be requested by the Drain Commissioner in compliance with the Kalamazoo County Drain Commissioner's Insurance Certificate Requirements.

9. This permit does not relieve the applicant from meeting any other applicable requirement of law or of other public bodies or agencies, i.e., local, state, or federal.

10. Permittee shall hold harmless the Drainage District, the Drain Commissioner, or Drainage Board, and County of Kalamazoo for any liability or negligence connected with performance of the work.

11. Any failure of the work performed under this permit that causes an obstruction shall be subject to the provisions set forth under Section 280.421 of the Michigan Drain Code, Act 40 of the Public Acts of 1956, as amended.

12. Additional Permit Requirements:

ACKNOWLEDGMENT AND AGREEMENT

The terms and conditions of this permit and attachments hereto are acknowledged by _____ (Permittee) of _____.

Dated: _____

WHEREFORE this permit is granted to this _____ day of _____ 20____.

_____
Kalamazoo County Drain Commissioner

SUMMARY OF REQUIREMENTS
FOR
INSTALLATION OF A CROSSING OVER A COUNTY DRAIN

1. Sizing:
   (1) For drainage areas of 2 square miles or more, crossing must meet the requirements of the Floodplain Control Section, Part 31 of Act 451, PA 1994.

   (2) Bridges shall be designed to provide a 2-foot-minimum freeboard to the underside (low chord) of the bridge for a 100-year flood. Footings shall extend at least 4 feet below the bottom of the channel.

   (3) Culvert inverts shall be recessed below the design bottom elevation of the last drain project of record to a depth of 0.5 foot, or a depth not to exceed 15 percent of the total height of the culvert, whichever is less.

   (4) Culverts serving a drainage area of less than 2 square miles shall be designed for a minimum 10-year storm in the developed watershed with a maximum outlet velocity of 8 feet per second. A maximum of 1 foot of inlet submergence may be permitted if this does not back up water out of the easement. The effect of the 100-year storm will be reviewed to ensure no adverse increase in water elevation off the development property or flooding of structures within the development.

   (5) Sizing of culverts and bridges shall be performed using the Bernouli Equation and include consideration of inlet and outlet control, entrance and exit losses, and tailwater condition. Published culvert nomographs, HEC-5 charts, and other computer software may be used.

   (6) Minimum diameter of a drive culvert shall be 12 inches.

   (7) Minimum diameter of a road crossing culvert shall be 18 inches or equivalent pipe arch.

   (8) Clearspan structures are desirable and shall generally be required by the Drain Commissioner. Exceptions may be made at the Drain Commissioner's discretion. In all cases, the proposed structure shall span the base flow channel. Crossing lengths will be approved by the Drain Commissioner.

2. End Treatment:
   Headwalls, wingwalls, and all other end treatments shall be designed to ensure the stability of the surrounding soil. MDOT, County Road Commission, or manufacturer's designs may be used. Any structures removed such as headwalls, wingwalls, concrete slabs, riprap, erosion control devices, tiling, and culverts (metal, plastic, or concrete) must be replaced with new material and reconstructed to original condition or better.

3. The structure shall be firmly anchored in place.

4. All crossing shall be new and of suitable material unless otherwise inspected and approved by the Drain Commissioner. Culverts may be reinforced concrete pipe, corrugated steel pipe, or pipe arch in accordance with applicable ASTM specifications.

5. All reconstructed or disturbed ditch banks or side slope must be a minimum 2:1 slope (2 foot horizontal to each 1 foot vertical rise), compacted, topsoiled, seeded, and mulched. If the bank or side slope is less than a 2:1 slope, mechanical retaining devices such as headwalls, wingwalls, or riprap must be installed.

6. The Permittee is responsible to ensure that the proposed crossing is structurally sound and of sufficient width for the intended use and anticipated loads.

Office of the Drain Commissioner
201 West Kalamazoo Avenue · Kalamazoo, Michigan 49007
Phone: (269) 384-8117 · Fax: (269) 383-8920 · www.kalcounty.com/drain

APPLICATION AND PERMIT TO CONNECT TO A COUNTY DRAIN

The undersigned being owner of _____
(Description of Property)

does hereby make application to the Kalamazoo County Drain Commissioner for the privilege of tapping and connecting with the _____ Drain in the Township of _____, Kalamazoo County, Michigan.

This connection is for the purpose of connecting storm drainage only.

It is understood that the applicant will leave the connecting trench open until inspection has been made by the Kalamazoo County Drain Commissioner or his agent.

Date: _____

Signed: _____

Print Name: _____

Address: _____

_____

Permission granted _____, 20____.

_____
Kalamazoo County Drain Commissioner

Inspection of this connection has been made and found to be satisfactory, this _____ day of _____, 20____.

The Wye or opening for this connection is located:

_____
Inspector

SUMMARY OF REQUIREMENTS
FOR
CONNECTION TO A COUNTY DRAIN

1. Completed permit application.

2. Permit fee.

3. Adequate outlet evaluation.

4. Discharge requirements:

    a. Storm water connection: Rate and volume requirements for new and redevelopments
    b. Footing drain connection: None
    c. Floor drain connection: Pre-treatment (spill containment)

5. Type of connection:

    a. Ditch outlet to an open channel county drain
    b. Pipe outlet to an open channel county drain
    c. Ditch inlet to an enclosed county drain
    d. Pipe connection to an enclosed county drain

6. Layout and design:

a. Ditch Outlet to an Open Channel County Drain

(1) Grassed waterway flow velocities shall be neither siltative nor erosive. The minimum velocity for vegetated channels shall be 1.5 ft/s. The maximum velocity shall be 4 ft/s. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 ft/s, up to maximum allowable design velocity of 10 ft/s.

(2) Where maximum velocities are exceeded due to channel slope, rock check dams or grade control structures shall be used to reduce overall flow velocities.

(3) Erosion control blankets shall be used to protect bare channels.

(4) Permanent erosion protection will be placed at bends, drain inlets and outlets and other locations as needed in all open ditches.

(5) Outlets into the grassed waterway shall enter at an angle of 90 degrees or less with the direction of flow.

b. Pipe Outlet to an Open Channel County Drain

(1) Outlet protection shall be provided as necessary to prevent erosion, based on the maximum velocities given above.

(2) All outlets will be provided with flared end sections.

(3) Outlet protection shall employ engineered rip rap design. Median rip rap size, dimensions and total quantity in square yards shall be determined based on pipe size, design velocity and discharge. All rip rap shall be underlain with approved geotextile fabric. Other materials used to prevent scour will be reviewed and approved as necessary.

(4) The soils above and around the outlet shall be compacted and stabilized to prevent piping around the structure. Riprap protection shall extend a minimum of 1 foot above the top of the pipe.

(5) Outlets into the grassed waterway shall enter at an angle of 90 degrees or less with the direction of flow.

(6) Outlets to ditches will be placed within 2 feet of the average low water elevation of the water course.

c. Ditch Inlet to an Enclosed County Drain

(1) Grassed waterway flow velocities shall be neither siltative nor erosive. The minimum velocity for vegetated channels shall be 1.5 ft/s. The maximum velocity shall be 4 ft/s. Riprap protection or equivalent erosion control measures shall be used where the velocity exceeds 4 ft/s, up to maximum allowable design velocity of 10 ft/s.

(2) Where maximum velocities are exceeded due to channel slope, rock check dams or grade control structures shall be used to reduce overall flow velocities.

(3) Erosion control blankets shall be used to protect bare channels.

(4) Inlet protection shall employ engineered rip rap design. Median rip rap size, dimensions and total quantity in square yards shall be determined based on pipe size, design velocity and discharge. All rip rap shall be underlain with approved geotextile fabric. Other materials used to prevent scour will be reviewed and approved as necessary.

(5) A flared end section and rodent guard may be required for the inlet pipe.

d. Pipe Connection to an Enclosed County Drain

(1) Connections to manholes shall be made with a resilient connector for pipe diameters 24 inches or less.

(2) Special details will be required for manholes placed on pipe 48 inches in diameter and larger.

INSURANCE CERTIFICATE REQUIREMENTS

KALAMAZOO COUNTY DRAIN COMMISSIONER
201 WEST KALAMAZOO AVENUE
KALAMAZOO, MICHIGAN 49007
(269) 384-8117 - FAX: (269) 383-8920

Contractor

Contractor Liability Insurance

Bodily Injury	$1,000,000 each occurrence $2,000,000 aggregate
Property Damage	$1,000,000 each occurrence $2,000,000 aggregate

Automobile Liability	$1,000,000 combined single limit

Workman's Compensation

Employer's Liability Limit	$500,000 each accident $500,000 each employee $500,000 Policy Limit

Excess/Umbrella Liability	$1,000,000 each occurrence

Kalamazoo County Drain Commissioner and the appropriate Drainage District must be named as additionally insured.