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BARRY COUNTY

DRAIN COMMISSIONER'S RULES

PROCEDURES AND DESIGN CRITERIA FOR
STORMWATER MANAGEMENT SYSTEMS

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Part 1: General Provisions

I. PREFACE

Barry County is known for its diverse natural features, prime agricultural lands, and many lakes. Single family residential growth is the result of proximity to Grand Rapids and Battle Creek, lake development, and the appeal of "hometown" communities. Growth can enhance the County's economy, but it also can have a negative environmental impact. The Drain Commissioner realizes controlled growth is critical to preserving the unique environmental amenities within Barry County as it continues to grow. To help the County achieve controlled, well-planned growth these rules have been created to guide stormwater management.

The Drain Commissioner will review proposed growth plans to help minimize adverse effects from development to adjacent property, downstream flooding, and the environment due to stormwater runoff. To create consistent review procedures these rules have been developed based on the previous "Subdivision Drainage Rules" created September 8, 1992, and recent technology from the Michigan Department of Environment, Great Lakes and Energy's "Guidebook of BMP's for Michigan Watersheds." These new rules will supersede the current rules.

The Drain Commissioner's objective is to provide adequate stormwater drainage and to manage its quantity and quality. Development alters a watershed's hydrologic characteristics by filling low areas, and paving pervious areas, both of which had provided infiltration. Storm sewer, and curb and gutters collect more runoff and direct it to streams, lakes, or wetlands faster than predevelopment conditions. This produces greater runoff volumes with higher and more frequent flood peaks. It also increases pollutants entering the watercourses. These Rules are meant to minimize the adverse impacts on both downstream and upstream properties and resources.

These Rules do not relieve any professionals involved with the project from their responsibilities and obligations as required by statute and standard practice of their respective professions. The Drain Commissioner is attempting to provide controlled, well managed growth that impacts drainage, public health, and welfare. Individual designs and recommendations for each project by the Proprietor's consultants must provide due diligence. Discretion and professional judgement, standard to the industry will still be necessary.

It is suggested by these Rules that the developer and their Engineer and/or Surveyor contact the Drain Commissioner prior to preparing a submittal package to discuss drainage plans. This allows for the Drain Commissioner and his/her consultant if needed, to point out items that will need modified or addressed in the submittal. This will save time for the developer.

Severability Clause: Any portion of these Rules found to be invalid by a court or arbitration board shall not affect the enforcement/authority of the remaining portions.

The Drain Commissioner reserves the right to grant variances to the Rules on an individual basis and to require more than these Rules if he/she feels it is necessary to protect the health and welfare of the public and the environment.

Any request for a discharge to a County Drain shall be reviewed and possibly permitted under the provisions of Public Act 40 of 1956, commonly referred to as the "Drain Law."

II. PURPOSE

It is the purpose of these site development rules to establish a uniform set of stormwater management standards with the following objectives:

- Ensure stormwater drainage systems and best management practices (BMPs) are adequate within a proposed development and protect the drainage, property, and water rights of landowners outside of the proposed development.
- Reduce flood damage due to poorly planned development.
- Minimize the degradation of existing watercourses.
- Control non-point source pollution.
- Maintain site hydrology to avoid detrimental changes in the balance between stormwater runoff, groundwater recharge, and evapotranspiration.

A. Compliance with State Land Division Statute

Public Act 288 of the Michigan Public Acts of 1967, known as the Subdivision Control Act (as amended by PA 591 of 1996) which is now known as the Land Division Act regulates the development of lands being split into multiple parcels. All plats recorded with the Register of Deeds must conform to this act. The Drain Commissioner is required by this act to review drainage and give approvals or reasons for denial.

B. Preferred Stormwater Management Strategies

Regional Stormwater Management (Off-site Mitigation)

The management of stormwater on a regional basis is encouraged where practical. Off-site mitigation for channel protection is allowed where physical constraints of individual sites may prevent effective on-site treatment. Off-site locations may allow for the use of superior performing BMPs that require more space and can be sited strategically to address a known water quality issue.

Low Impact Development

The Low Impact Development Manual for Michigan was used to develop this manual. A Low Impact Development (LID) approach provides benefits in terms of preservation of natural areas and often leads to increased property value and potential cost savings. Developers can reduce the size of storage facilities and stormwater infrastructure by incorporating LID principles into a site design up front.

III. AUTHORITY

A. Land Division Act

Under this Act, the Drain Commissioner is responsible for ensuring that the stormwater drainage system of a subdivision is adequate to address stormwater management needs within the proposed subdivision and for protecting downstream landowners. 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.

B. Mobile Home Commission Act

Pursuant to Public Act 96 of 1987, as amended (the Mobile Home Commission Act), the County Drain Commissioner is to review preliminary plans of proposed Mobile Home Parks to determine if the drainage outlet is acceptable. This Act does not require the submittal of detailed construction plans however it does allow each individual County to publish and enforce their own standards (rules). Barry County has developed these Rules, which require the submission of construction plans and calculations for Drain Commissioner review of preliminary plans for Mobile Home Parks.

Once all appropriate information is submitted, the Drain Commissioner will perform a review and prepare an approval or denial letter. The letter will be prepared within 30 days of receipt of all necessary information and will be sent to the Proprietor of the proposed Mobile Home Park.

C. Condominium Act

The development of lands using Public Act 59 of 1978, as amended, commonly known as Subdivision Condominiums and site plans do not require Drain Commissioner approval unless it is required by local ordinance. If the municipality of jurisdiction requires approval by the Drain Commissioner, then the approval process will be like that of the Preliminary Plat. Private stormwater facilities that are never meant to be part of Drain Commissioner jurisdiction will not need a 433 Agreement.

Approval of a Subdivision Condominium by the Drain Commissioner will be based on the same requirements as the Preliminary Plat approval section of these Rules. If the stormwater management system is to remain private no maintenance account fee will be necessary. Final approval of a Subdivision Condominium will be in writing within 30 days of the receipt of the proper documents unless a letter of disapproval is sent to the Proprietor.

Since the Drain Commissioner's review of Subdivision Condominium is based on local ordinance requirements, the municipality may choose to enforce or reject all or part of the Drain Commissioner's approval recommendations.

D. Drain Code

All drainage easements and detention (or retention) areas are to be under the jurisdiction of the Barry County Drain Commissioner and the Drain District created for the final plat being considered. This will be accomplished by utilizing Section 433 of the Michigan Drain Code of 1956, Public Act No. 40, as amended. The purpose of Section 433 is to establish an agreement to create a Drain and Drain District within the plat. This type of agreement is commonly known as a "433 Agreement." Appendix A has Barry County's standard 433 agreement and will need to be fully executed to the Drain Commissioner's satisfaction prior to Final Plat approval. The 433 Agreement and appropriate fees and certificates must be submitted with the Final Plat information for approval consideration.

E. Review Authority Granted by Local Municipalities

All developments where review authority is granted to the Drain Commissioner by the local municipality (i.e. township, city, village) via resolution or site plan review conditions shall conform to the requirements herein. The Drain Commissioner’s review of private drainage systems will focus on the discharge of stormwater offsite but will also include review of the internal drainage and the accommodation of surface water from upstream areas.

Approval or denial of the plan by the Drain Commissioner will be sent in the form of a letter to the municipality within 30 days of receipt of all necessary information. If approval is granted it shall be effective for 2 years from the date of the letter. The Drain

Commissioner will conduct a final inspection of the construction site if a final site plan approval is required by the municipality or jurisdiction. Drain Commissioner must be contacted prior to final completion to conduct final inspection.

F. Provision for Requirements in Addition to Minimum Standards

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. Proposed site plans shall complement any local stormwater master plans that may exist and/or comply with any ordinance in effect in the municipalities where the site development is located. The Drain Commissioner reserves the right to determine site-specific requirements other than those herein, based upon review of the plans. Any deviations from these standards shall be subject to approval by the Drain Commissioner and will be done so with input from the affected municipality.

IV. APPLICABILITY

A. Review Required

These standards apply to private and public development projects. The following types of developments shall be subject to review under these standards:

- Plats
- Mobile home communities with public streets
- Site condominiums with County Drains
- Sites that discharge directly into a County Drain
- Sites that disturb at least one or more acres
- Other private developments that require site plan review at the request of the municipality

B. 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.

C. Redevelopment

Redevelopment and additions requiring site plan review at the local level 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 where there is or may be significant impact to drainage or water quality off-site.

V. 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.

VI. PERMITS FOR WORK IN COUNTY DRAINS

A. Utilities

If any utilities are to be located within the drainage easement of the proposed development, the Design 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. A sample application, checklist, and permit for “Utility Work in a County Drain and/or County Drain Easement” is available upon request.

B. Encroachments

Permission is required to place an encroachment within an existing Drain Easement. A sample application and checklist for “Encroachment in County Drain Easement” is available upon request.

C. Crossing and Maintenance

A permit is required for maintenance to a County Drain including installation of crossings and shall be presented at the same time as construction drawings. A sample application, checklist, and permit to “Perform Work in a County Drain and/or County Drain Easement” is available upon request.

D. Modifications

Agreements for modification (deepening, widening, straightening, relocating), tiling or adding a branch or extension to a County Drain shall follow the procedures under “Section 425 Application and Petition.”

E. Tapping (Footing and Floor Drains)

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. A sample application, checklist, and permit for “Connection to a County Drain” is available upon request.

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

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.

GPS coordinates for discharge points into the drain shall be provided along with a drawing of approximate location of tile discharge points.

VII. FEES

Schedule of Fees

REVIEW (The following fees cover the review of the first submittal. Additional submittals and reviews will be billed to the developer at a rate of $300 per review. Additional costs will be billed prior to final approval.)	
Subdivisions	$1200
Condominiums	$1200
Business/Building/Commercial Development	$800
Utility Drain Crossing	$600
Land Divisions	$350
Inspection Fee	Based on hourly rate of inspector
DRAIN PERMITS	
A permit is required to locate a utility within a County Drain Easement, cross a County Drain with utilities, roads, drives, etc., or connect to a County Drain. Fees shall be paid with the permit application submittal prior to construction drawing approval. No fees are required for connecting stormwater discharges to a County Drain; however, the Drain Commissioner reserves the right to charge a fee for connection of discharges other than stormwater runoff or tile drainage/footing drains.	
Utility crossing	$600 Permit required, plans must be submitted and approved.
Discharging private agricultural drain tiles directly into a County Drain	$350; provided marking signs, GPS coordinates & height from the bottom of the ditch are provided for the outfall. Stabilization measures must also be provided
Placing or replacing a culvert in a County Drain	Equal to the cost of a Surveyor to check grades & obtain coordinates. Engineer's inspection also required as culvert is set. $600.00 deposit required; remaining fee to be paid before final approval is given.
Placing a bridge of under 6 feet in width over a drain; no disruption to the banks	None; provided GPS coordinates are provided for bridge location, the bridge sits on top of the ditch banks, the banks are not disrupted to place the structure, & the structure would not aggravate flooding
Dewatering into a drain (tap fee)	$100.00 for up to 30 days, Best Management Practices must be utilized.
DEDICATION AGREEMENT 425 or 433	
Maintenance Fee (required by Michigan Drain Code)	Lesser of $2,500.00 or 5% of construction
Surety for Work Completed after Final Plat Approval or for Regional Storm Water Facility (Off-Site Mitigation)	110% of uncompleted project

Maintenance fee shall be paid prior to final plat approval and/or execution of the 433 Agreement. Surety shall be posted prior to final plat or site plan approval and must be in the form of a cashier's check or irrevocable letter of credit.

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 30 days of invoice by the Drain Commissioner. Payment of all fees is prerequisite to approval. Failure to make timely payments constitutes a violation, permits will be revoked, and the deposit will be forfeited. Development 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 2: Procedures for Plan Submission and Approval

I. SUBMISSION AND APPROVAL

These procedures have been developed in the context of the plat requirements specified in the Land Division Act, which lays out a two-step submittal and approval process. A preliminary plat and final plat are required by statute.

For other types of developments, submittal of a condominium subdivision plan, preliminary plan, or site plan is required, which will typically culminate in a final set of construction drawings.

Developments located entirely within a municipality retaining stormwater review authority within their jurisdiction shall follow the procedures enacted by that municipality.

A. Concept Review Meeting

The Land Division Act allows for a pre-application review meeting, which may be requested by the Proprietor for the purpose of an informal review of the concept plan for the preliminary plat. A site evaluation may also be requested. By statute, the review meeting shall take place not later than thirty (30) days after the request and concept plan are received.

A concept review meeting between the Proprietor and/or the Design Engineer, Drain Commissioner, Road Commission and local municipality is recommended prior to submittal of a site plan. The purpose of the concept review meeting is to initiate communication and provide uniform direction to the Proprietor to maximize efficiency in design and reduce costs.

The Proprietor is responsible for contacting the Drain Commissioner's Office to request the meeting, submit the concept plan, and coordinate the location, date and time for the meeting with all parties involved. Information provided by the Proprietor in the concept plan shall include at a minimum the items on the Stormwater Review Checklist.

If the conceptual layout of the drainage plan is approved, the Proprietor may begin completing design plans and calculations for application submittal under these rules.

B. Submission

The following submittals are required for Drain Commissioner review and approval prior to the start of any work on the proposed development requiring review under these rules. Soil borings and test pits, soil testing, vegetative cutting solely for land surveys, and normal maintenance shall not be considered a start of work under these rules. An application packet is included in Appendix A.

Site Plan Review

1. Site Plan Review Application.
2. Stormwater Worksheet and calculations prepared by a Professional Engineer licensed in the State of Michigan.
3. Drawings. Two (2) prints and one (1) electronic PDF file containing the information on the Stormwater Review Checklist.
    a. Preliminary plat or site plan: Prepared by a Professional Engineer or Surveyor licensed in the State of Michigan.
    b. Construction drawings: Sealed by a Professional Engineer licensed in the State of Michigan.

4. Applicable fee (refer to Part 1 section "Fees").
5. Other required submittals per these rules as applicable:
    a. Submittal Checklist for Private Developments.
    b. Submittal Checklist for County Drain Systems.

Final Plat

1. Evidence of preliminary plat approval. 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.
2. Final plat. The Land Division Act requires that one (1) true copy of the final plat be delivered to the Drain Commissioner for review. Final plats must be prepared in accordance with the requirements of the Land Division Act. Final plat mylars of the number and type are directed by the Michigan Department of Commerce. One (1) electronic file of the plat meeting County GIS digital submission requirements (refer to Stormwater Review Checklist) shall be submitted to the Drain Commissioner.
3. Construction Records. Acceptable construction record drawings and certification from the Design Engineer must be submitted along with the final plat. 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 (refer to Part 2 section "Surety").

Staged Development

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.

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.

C. Changes and Resubmission

Changes made without resubmission and approval may result in revocation of approval.

Preliminary Plat

Approval of the preliminary plat by the local governing body is 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, 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.

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. Resubmission is required even though the original layout may have already been approved.

Construction Drawings
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 are required as a result, such revisions shall be made by the Proprietor and the drawings resubmitted to the Drain Commissioner for approval.

D. Approval

Payment of all fees is prerequisite to approval (refer to Part 1 section “Fees”).

Preliminary Plat
The Drain Commissioner within thirty (30) days after receipt of the preliminary plat will approve it, approve it subject to conditions, or reject it. If the preliminary plat is approved, the Drain Commissioner will note its approval on the copy to be returned to the Proprietor, or by letter if the Proprietor does not need the preliminary plat to be returned. If the preliminary plat is approved subject to conditions or rejected, the reasons for rejection and requirements for approval shall be given in writing to the Proprietor and each of the other officers and agencies to which the Proprietor was required to submit the preliminary plat.

Construction Drawings
The Land Division Act gives no time limit in which final construction plans must be reviewed. The Drain Commissioner will approve or reject construction drawings in writing within thirty (30) days of receipt of a complete submittal.

Final Plat
Final 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.

E. Expiration of Approval

Preliminary Plat
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.

Construction Drawings
Approval of construction drawings by the Drain Commissioner's Office is valid for two (2) calendar years. 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 fees.

F. Revocation of Approval

Any approval issued by the Drain Commissioner under these rules may be revoked or suspended for a violation of the conditions of approval, or a misrepresentation or failure to disclose relevant facts in the application submittal. The Drain Commissioner will provide the Proprietor written notice of any revocation of approval.

G. Submission of Construction Record Drawings

Construction record drawings ("as-builts") shall be submitted to the Drain Commissioner for developments reviewed under these rules. A letter of certification by a Professional Engineer shall accompany the construction record drawings or may be accepted in lieu of record drawings for some projects at the Drain Commissioner's discretion. An acceptable certification form is available upon request.

One (1) print, one (1) electronic PDF file, and one (1) electronic file meeting County GIS digital submission requirements shall be submitted, and contain the information listed on the Stormwater Review Checklist.

Construction record drawings must be submitted prior to release of any review deposit. The Drain Commissioner will review construction record drawings for completeness, and respond with written comments or acceptance within thirty (30) days of submittal or resubmittal.

II. STORMWATER DRAINAGE REQUIREMENTS

A. Site Plan

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

Stormwater 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. As such, drainage easements and facilities at the rear of lots are discouraged.

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

- Post-development discharge shall not exceed the capacity of the existing infrastructure.
- Post-development discharge shall not cause adverse impact to offsite property due to concentrated runoff or ponded water of greater height, area, and duration.
- Discharge shall not cause downstream erosion.
- 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:
    - Stabilize or upsize the existing conveyance system or establish a County Drain to provide the needed design level of flood protection.
    - Obtain flooding easements for measurable increases in water levels determined to cause an adverse impact.
    - Provide additional on-site stormwater controls.
- Additional impacts (such as increased temperature, pollutant load, or groundwater recharge) may also need to be mitigated.

It is the Proprietor's obligation to meet this standard. Should a stormwater 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 stormwater management facilities. Such additional facilities will be subject to the Drain Commissioner's review and approval.

B. Regional Stormwater Management Facility

Regional stormwater management facilities are designed to serve multiple developments or parcels and can provide water quality treatment, channel protection and flood control. Regional facilities shall be sited and designed to serve an identified area defined as a regional stormwater management district. Sites located within a regional stormwater management district would be approved for off-site mitigation to meet the channel protection standard (i.e. offsite mitigation is provided within the same jurisdiction and/or watershed/sewer shed). The Drain Commissioner may pursue projects within a Drainage District through the petition process to construct facilities to serve a stormwater management district or may approve facilities proposed to be constructed by individual Developers.

The regional facility should be constructed first when possible. When development or redevelopment occurs in a stormwater management district prior to construction of the regional facility, temporary on-site measures must be installed and financial surety provided to ensure that the regional facility will be constructed within 24 months of the original project site construction.

A regional facility serving more than two individual parcels shall be dedicated as a County Drain with associated easements granted to the Drainage District to allow for operation and maintenance in perpetuity.

C. Restrictive Covenants

For plats and site condominiums, a copy of restrictive covenants or master deed language related to drainage shall be provided to the Drain Commissioner along with construction drawings for approval. Covenants and deeds shall be recorded prior to release of posted surety.

Block Grading Plan

A block grading plan shall be incorporated in the restrictive covenants of the plat or master deed to ensure proper drainage of individual lots. In addition, the Proprietor shall provide an electronic copy of the block grading plan to the Drain Commissioner and the municipality for their permanent files. The block grading plan shall include the Lowest Allowable Floor Elevation and Lowest Allowable Opening Elevation for each lot, and include the “basement type” for each lot (e.g. walkout, daylight, or standard basement) as indicated by the topography of each site and according to the approved design plans. 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. No changes will be made in the grading of any lot areas used for drainage which would later affect surface runoff drainage patterns without the prior written consent of the Drain Commissioner for all portions of the drainage system. Finish grading for home construction shall be completed in conformance with the master drainage plan for the development and in such a manner so as not to create the excessive ponding of stormwater on the sites within the development.”

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 or master deed, including benchmark references. Lots not impacted by high groundwater or potential flooding from a 100-year storm event as determined by the Design Engineer shall be so noted as well. A certification by the Design Engineer that the minimum floor and opening elevations do not pose a risk of flooding for up to the 100-year storm shall be provided for each development or phase of development prior to approval. Documentation to support allowable minimum floor and opening elevations shall be submitted with construction drawings.

Criteria for determining the Lowest Allowable Floor Elevation includes:

1. Proximity to detention/retention facilities due to groundwater mounding (which may not be apparent until after construction).
2. Groundwater elevations from monitor wells, test pits and/or soil borings including any soil mottling noted in the soil profile.
3. Regional and cyclical groundwater levels available online.
4. Hydro-geologic studies and groundwater modeling.

Criteria for determining the Lowest Allowable Opening Elevation includes:

1. Proximity to open drain or natural watercourse, pond, or wetland and the 100-year flood elevation.
2. Proximity to detention/retention basin and design high water level.
3. Proximity to drainage swales and/or flood routes designed to convey the 100-year storm event runoff including overflows from detention/retention basins.
4. Proximity to an enclosed storm sewer system with open ends or catch basins that could surcharge during the 100-year storm event.
5. Type of building foundation (e.g., walkout, daylight, or standard basement) as dictated by the topography of each site.

It is the responsibility of the Proprietor to provide enough benchmarks (NAVD 88 datum) to use as a reference for establishment of minimum floor and opening elevations for all lots. The restrictive covenant shall state:

"The lowest allowable floor elevations are set at 1-foot 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 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 and benchmark locations and elevations are indicated on the Block Grading Plan."

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:

"Water from such sources as eaves troughs and footing drains shall be directed to footing drain laterals provided for the lots. Water from footing drains shall be discharged to the lateral via a sump pump with check valve system, or a gravity system with a double flap

gate valve for backflow prevention. If no lateral is provided, the lot owner shall discharge said water in such a manner as to not impact neighboring land or public streets." "Floor drains, 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."

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 features. No dumping of grass clippings, leaves, brush, or other refuse is allowed within a drainage easement. These items obstruct drainage, restrict flow, and plug culverts. This can lead to higher maintenance costs and cause flooding situations."

Soil Erosion and Sedimentation Control Permits

It is the responsibility of the Proprietor to contact the County Planning Department (269-945-1290) to determine which lots if any need Soil Erosion and Sedimentation Control Permits. The restrictive covenant shall state:

"Each individual lot owner will be responsible for the erosion control measures necessary on their lot to keep loose soil from their construction activities out of the street, catch basins, and off adjacent property. If any sedimentation in the street, catch basins, or adjacent lots results from construction for a site, it is the responsibility of that lot owner to have this cleaned up. This applies to ALL lot owners. A Soil Erosion and Sedimentation Control Permit must be obtained from the County Planning Office prior to excavation for lots _____ through _____. All conditions set forth by permit shall be met throughout construction activity until permit can expire."

Responsibility for Maintenance of Open Water Bodies

The restrictive covenant shall state: *"Lot owners are responsible for the management and maintenance of open water bodies for aesthetics, aquatic habitat, recreation and water quality, including liability and costs."*

III. DRAINS UNDER JURISDICTION OF DRAIN COMMISSIONER

A. Responsibility for Stormwater System Ownership and Maintenance

Plats

All plats shall be established as County Drains under the jurisdiction of the Drain

Commissioner.

Other Developments

Site condominiums and other multi-lot developments with public roads shall be established as County Drains under the jurisdiction of the Drain Commissioner. The Drain Commissioner may accept drainage jurisdiction over other multi-lot developments with private roads when a single private entity with responsibility for operation and maintenance does not exist.

Roadside Ditches

In general, the Drain Commissioner will not accept responsibility for roadside ditches. The County Road Commission maintains these if located within the right-of way of a public road. When required by the County Road Commission, roadside ditches may be established as County Drains.

Maintenance by Drain Commissioner

The Drain Commissioner shall be responsible for maintenance of all established County Drains, including stormwater BMPs dedicated as part of the County Drain system. The costs for maintenance shall be assessed to the Drainage District under the provisions of the Michigan Drain Code.

Maintenance Plan

A maintenance plan must be prepared by the Proprietor and delivered to the Drain Commissioner with the dedication agreement documents. A maintenance plan template is available from the Drain Commissioner's Office. The Drain Commissioner will not accept ownership and maintenance of any decentralized stormwater BMPs (e.g. rain barrels for individual houses, green roofs, and pervious pavement) as part of the County Drain system. All portions of a County Drain system must have dedicated easements.

Maintenance Agreement

A maintenance agreement 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. A maintenance plan shall be included with the executed maintenance agreement and recorded with the subdivision agreement or legally binding documents such as the property deed or condominium master deed. A maintenance plan template is available from the Drain Commissioner's Office.

B. Easements

Easements will be required over all stormwater facilities including those located within road rights-of-way. Structures, septic tank drain fields, pools, etc. will not be allowed within the easements. If the Drain Commissioner determines that additional space is needed these minimum widths will be increased. Reductions may also be made only at the discretion of the Drain Commissioner.

Existing Easements

The liber and page (or document number) 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. In this case, affidavits of easements may be employed. 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 (or release of rights-of-way) shall be indicated on the plans and designated with the name of the Drain.

Proposed Easements

An easement, 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.

- 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. Private (exclusive) easements for drainage 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] [Flooding] [Name of BMP] to the _____ Drain Drainage District." Separate, recordable easements must be provided in a form acceptable to the Drain Commissioner. Sample easement forms can be provided upon request. 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 Proprietor releasing an easement to the Drainage District, the Proprietor 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.
- Outside the Plat or Site Development: 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. A sample release of right-of-way form for County Drains can be provided upon request. Recordable Drain Easements shall be submitted to the Drain Commissioner prior to construction drawing approval and recorded prior to release of surety. Easements will not be required through public rights-of-way (e.g. County roads).
- Flooding Easements: When concentrated stormwater is proposed to be discharged over, onto, or across private property (other than that owned by the Proprietor), 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. A sample Flooding Easement form can be provided upon request. Such an agreement shall be submitted to the Drain Commissioner prior to construction drawing approval and recorded prior to release of surety.

Easement Width

Minimum easement widths for new stormwater 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:

- Open Channels and Watercourses: Open channels shall have a minimum of 15 feet on each side of the top of bank and a total minimum width of 50 feet.

- Open Swales: Open swales shall have a total minimum width of 30 feet
- Enclosed Drains: Easement widths for pipes shall conform to the following table:

Table 1 – Enclosed Drains: Easement Widths for Pipes

Depth to Invert (feet)	Easement Width (feet)
0-7	20
7.1-12	30
12.1-17	40
>17	50

- Detention and Retention (Infiltration) 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.
- Other Stormwater BMPs: A minimum of 10 feet around the perimeter of stormwater BMPs (e.g. bioswale/rain garden, infiltration trench) must be granted to access and maintain the BMP.
- Exceptions: Generally, the above widths shall govern; however, if the Review Engineer determines that additional easement width is required for proper construction, or because of special circumstances, such facts shall be made known to the Proprietor upon review by the Review Engineer.

C. Surety

The Proprietor shall post a performance surety prior to construction drawing approval. The performance 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 an amount equal to 110% of the uncompleted portion of the project, or $10,000, whichever is greater. Valid existing contracts for construction of the stormwater 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. In the event the Proprietor has not contracted for the construction of the stormwater management system (Proprietor is the contractor), the Design 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 surety.

A rebate to the Proprietor may be made as the work progresses with approval by the Drain Commissioner. The amount of the rebate will be equal to the cost of the completed work minus a 10% retainage. In no case shall the surety amount be reduced to less than $10,000.

Upon final inspection, completion of all punch list items, receipt of acceptable construction record drawings and post-construction certification from the Design Engineer, the Drain Commissioner will execute and agreement granting final approval of the plat and/or final acceptance of the County Drain and shall subsequently release the balance of any surety deposit to the Proprietor. A sample Agreement for Drain Commissioner Approval of Development Infrastructure is available upon request.

If the Proprietor does not complete the approved drainage improvements as agreed, the Drain Commissioner will draw on the surety and proceed to fulfill the Proprietor's obligation

at such time and in such manner as the Drain Commissioner may determine appropriate.

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.

Section 433

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 Intercounty 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. The property of any adjoining landowner who refuses to sign cannot be included in the Drainage District for assessment purposes. However, the Proprietor must accommodate surface and subsurface runoff from adjoining properties.

Submittals:

1. Agreement

   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 by the Proprietor in coordination with the Drain Commissioner and stipulate conditions of transfer and responsibilities of parties. Sample Section 433 Agreement forms are available upon request. The Drain Commissioner's legal council will help determine which agreement form will be necessary. 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 Design Engineer shall provide centerline descriptions for each Drain or branch to be dedicated.

   b. Drainage District: The Design Engineer shall provide a shape file of the Drainage District boundary meeting County GIS digital submission requirements and a description of the contributing Drainage District benefiting from such improvements. One (1) electronic file in .pdf format, and one (1) paper copy of a 24-inch by 36-inch Drainage District map showing the Drainage District boundary line, route & course of the drain, roads, lot and parcel lines with numbering, townships and sections, and 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.

3. Certification
4. The Design Engineer shall include a sealed and dated statement attesting that:
    a. 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, or
    b. that the outlet for the existing drain is the only reasonably available outlet and attesting to the adequacy of the outlet. A certification form is available upon request.
5. Specifications for construction
6. Copy of the Master Deed
7. A copy of the 433 Agreement shall be attached to the Master Deed, and the Master Deed shall state:

    _____ DRAIN DRAINAGE DISTRICT

    Attached as Exhibit __ is an Agreement establishing the ____ Drain Drainage District pursuant to Section 433 or Act No. 40 of the Public Acts of 1956 as amended. A copy of the 433 Agreement is recorded in the Barry County Register of Deeds at Liber ____ Page ____.

    When a 433 Agreement is accompanied by a maintenance agreement, the master deed shall also state:

    Attached as exhibit __ is a maintenance agreement outlining the maintenance responsibilities of the Association for the Drain. A copy of the maintenance agreement is recorded in the Barry County Register of Deeds at Liber __ Page __.

    Note: Exhibit A is typically by-laws and Exhibit B is typically condominium plans.

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 final plat approval and/or execution of the 433 Agreement. 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 stormwater system consisting solely of gravity components. Systems with non-gravity components are subject to fees above and beyond $2,500.

Section 425

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. A Section 425 Agreement is required when a Proprietor wishes to relocate, improve, and/or enclose a County Drain on their own property at their expense. The Proprietor must petition the Drain Commissioner or Intercounty Drainage Board for permission to construct or improve the additional drainage for public use.

Submittals:

1. The Drain Commissioner’s legal counsel will draft the agreement with the Proprietor responsible for all costs. A sample agreement is available upon request.
2. Legal Descriptions

3. The Design Engineer or Surveyor shall provide the centerline (route & course) descriptions for the branch drain or extension.
4. Certification
5. The Design Engineer shall include a sealed and dated statement attesting to the adequacy of existing receiving drains. An acceptable certification form is available upon request.
6. Specifications for construction

E. Construction

Governmental Accounting Standards (GASB Statement 34) require the County to report the value of their drain infrastructure. The Proprietor shall submit documentation relative to the contract covering the work to be performed including the cost of construction with an itemized breakdown.

The Drain Commissioner may request a pre-construction meeting be held with all involved parties.

The Proprietor shall submit an inspection fee (refer to Part 1 section “Fees”).

Upon request of the Drain Commissioner, the Proprietor shall retain a qualified inspector, supervised by the Design 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.

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 Review Engineer are to verify the proper construction of the drainage system. Inspection by the Drain Commissioner or the Review Engineer shall not relieve the Design Engineer or the Municipal Engineer of their obligations.

The Drain Commissioner will complete a final inspection jointly with the County Road Commission. The Drain Commissioner will issue a letter to the Proprietor upon final acceptance.

A post-construction letter of certification from the Design Engineer that certifies construction of the County or Intercounty Drains in accordance with the approved construction drawings shall be submitted to the Drain Commissioner. An acceptable certification form is available upon request.

Construction record drawings shall be submitted by the Proprietor to the Drain Commissioner in accordance with the submission requirements (refer to Part 2 section “Submission of Construction Record Drawings”).

Part 3: Stormwater Management Requirements

I. SUMMARY

The following stormwater management requirements shall apply to all new development and redevelopment:

1. Protection: The design process shall begin by identifying environmentally sensitive areas located on the site and laying out the site to maximize protection of the sensitive areas.
2. Runoff Reduction: BMPs are required for protection of environmentally sensitive areas on the site and may also be used to reduce the amount of stormwater runoff routed to a collection system.
3. Stormwater Management: Stormwater shall be managed using minimum standards to protect both water resources and real property. Stormwater standards are summarized in Table 2.
4. Regional Stormwater Management Facilities: Regional stormwater management facilities are encouraged, particularly where site constraints preclude effective on-site treatment of stormwater. Regional facilities may be used to provide off-site mitigation to meet channel protection performance standards at a 2:1 (off-site: on-site) mitigation ratio. Regional facilities serving more than two parcels must be dedicated as County Drain.
5. Groundwater: The highest known groundwater elevation and extent of mounding from infiltration BMPs shall be determined to ensure no adverse impacts internal and external to the development.
6. Soils: Soil borings are required for most structural BMPs to determine soil classification, depth to groundwater and the presence of other site constraints. Field permeability testing is not generally required but may be conducted to allow the use of a higher infiltration rate for design or may be required in certain cases to confirm field infiltration rates.
7. BMP Design: BMPs must be designed to meet the minimum criteria provided. BMPs selected to meet the water quality treatment standard must also be shown to reduce total suspended solids in stormwater runoff by at least 80% or to a concentration of no greater than 80 mg/L. The following additional requirements apply to stormwater systems established as County Drains, including but not limited to plats, site condominiums and other multi-lot developments dedicated by agreement under Section 433 of the Michigan Drain Code, and County Drain extensions, branches or modifications performed by agreement under Section 425 of the Michigan Drain Code:
8. Easements: Easements are required for County Drains and associated BMPs accepted by the Drain Commissioner.
9. Maintenance Agreement: A maintenance agreement between the Developer and the Drain Commissioner is required for stormwater systems established as County Drains when a private entity or organization wishes to conduct the maintenance.

This section sets the design standards that will be used by the Drain Commissioner when reviewing a proposed development's stormwater management system. Stormwater conveyance systems and storage systems shall be designed using the criteria in this

section to minimize negative effects of development to a watershed.

Retention systems (on-site disposal) allow stormwater to infiltrate into the ground which more closely matches predevelopment conditions and will therefore be the highest priority for stormwater storage. If conditions such as poor ("heavy") soils, high ground water, or ground water mounding dictate the need for a detention (outlet flow) system, then establishment of a proper outlet will be required, and treatment of the runoff will be necessary.

New land developments in Barry County shall provide stormwater storage management utilizing detention or retention systems. Detention systems temporarily store stormwater and have an outlet that slowly empties the basin into an acceptable downstream system. Retention systems allow stormwater to infiltrate into the soils and have no other outlets. Storage systems also provide water quality benefits. This component will be emphasized in areas designated by the Drain Commissioner as "environmentally sensitive." Outlets from detention basin(s) will be reviewed very closely. The Proprietor is responsible for obtaining permission from downstream authorities and properties.

Assuring that the flow velocity, and rate meet their requirements of these Rules, is the sole responsibility of the Proprietor. It is the Proprietor's responsibility to have design and construction of the stormwater management system done to meet all requirements of these Rules. If as-built conditions show that differences exist, then the Proprietor at his/her expense will perform or have performed any necessary additional work to bring the system into compliance.

Table 2 - Minimum Required Stormwater Standards

Standard / Where Required	Criteria
Water Quality "first flush" All sites	Treat the runoff generated from 1 inch of rain over the project site (i.e. the 90% annual non-exceedance storm). Treatment may be provided through settling (permanent pool or extended detention), filtration or infiltration, absorption, or chemical/ mechanical treatment.
Channel Protection Surface water discharges	Retain on-site the increase between the pre-development (defined as meadow and/or woods) and post-development runoff volume and rate for all storms up to and including the 2-year, 24-hour rainfall event; OR where site conditions preclude infiltration, an alternative approach may be allowed after all other on-site retention options are exhausted: extended detention of runoff from the 2-year, 24-hour storm for a period of 24 hours with a drawdown time no greater than 72 hours.
Flood Control All sites, unless exception is allowed	Collection and Conveyance: Design storm sewers and swales for the 10-year storm, and open channels for the 25-year storm. Detention: Store runoff from the 100-year storm with a maximum release rate of 0.13 cfs/acre. If retention of the total channel protection volume is provided, the maximum release rate may be increased to the pre-development 100-year peak runoff rate; or Retention: Store and infiltrate runoff from the 100-year storm. Emergency Overflow Routes: Identify overland flow routes and the extent of high-water levels for the 100-year flood to ensure no adverse impacts offsite or internal to the site. Where overland flow routes do not exist, detention/retention basins shall be increased in size to store a total of 2 times the flood control volume. Adequate Outlet: The design maximum release rate, volume or concentration of stormwater discharged from a site shall not exceed the capacity of the downstream stormwater infrastructure or cause impairment to the offsite receiving area.
Pretreatment Refer to Table 4	Forebay: Minimum volume equal to 15% of water quality volume (required for detention/retention basins); Vegetated Filter Strip, Vegetated Swale; or Water Quality Device.
Hotspot Industrial and commercial land uses; Part 201 and Part 213 sites	Isolate transfer and storage areas to minimize need for treatment. Pretreatment BMP with impermeable barrier above groundwater and provisions for the capture of oil, grease, and sediments. Minimum spill containment volume: 400 gallons.
Coldwater Streams	Incorporate strategies to promote groundwater recharge and/or reduce temperature of surface discharge water.

II. DESIGN PROCESS

A. Identify Sensitive Areas

If any portion of the proposed plat is within 500 feet of a lake, stream, pond or jurisdictional wetlands as defined by the Michigan Department of Energy, Great Lakes and Environment (EGLE) the plat will be considered by the Drain Commissioner to be within an "environmentally sensitive area" and will require more care for any surface runoff leaving the site. Treatment of surface water prior to discharge off-site using one or more of EGLE's recommended BMP's (Best Management Practices) will be required. The Drain Commissioner may consider other BMP's at his/her discretion. Other areas may be determined to be environmentally sensitive for reasons such as a unique upland ecosystem.

For these rules, sensitive areas include:

- Sand dunes
- Natural drainage ways
- Floodplains (and flood prone areas)
- Soils and topography (erodible, steep)
- Riparian areas
- Woodlands
- Susceptible groundwater supplies
- Threatened and endangered species habitat

Sensitive areas are determined on a site-specific basis through site survey, delineation, aerial photographs, or maps. Sensitive areas must be shown on the site map or on the drawings. The total acreage of protected areas must also be indicated. The Developer must demonstrate a good faith effort to maximize protection of sensitive areas.

B. Minimize Stormwater Runoff

Nonstructural BMPs are required to meet sensitive area protection requirements and may be used to reduce the size of the collection and conveyance system and other stormwater controls necessary for the site.

C. Determine Standards

Adequate stormwater runoff controls are required to meet pollutant removal goals, reduce channel erosion, maintain groundwater recharge, and prevent overbank flooding. Minimum standards are given in Table 2.

Manage stormwater on-site by meeting all the following standards:

- Water Quality
- Channel Protection
- Flood Control

Identify any additional standards required for the site. Additional standards are required for:

- Pretreatment
- Hot Spots

- Coldwater Streams

D. Confirm Adequate Outlet

The design criteria specified in this manual is generally protective of the receiving waterbody. However, the Developer must always demonstrate an adequate outlet exists downstream of the development to receive the design rate, volume, and concentration of the post-development site runoff. Discharge from the site, including discharge from emergency overflow spillways and pipes, must not cause adverse impact to downstream properties or infrastructure (refer to Part 2 section “Stormwater Drainage Requirements”).

III. STANDARDS

A. Water Quality

Treatment of the water quality volume is required for all sites to capture and treat the “first flush” of stormwater runoff that typically carries with it the highest concentration of pollutants. Most 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 (e.g. nutrients due to overuse of fertilizer; nutrients and bacteria due to overuse by wild/domestic animals).

Capture and treatment of the runoff from the 90% annual non-exceedance storm is required for the project site. Treatment of this volume with properly designed BMPs has been found to generally meet EGLE pollutant load targets of 80% decrease in total suspended solids (TSS) or discharge concentrations of TSS less than 80 mg/L. Natural areas of the site left undisturbed and BMPs that provide water quality treatment need not be included in the calculations. This effectively results in the directly connected impervious areas and disturbed pervious areas of the site being used to calculate the water quality volume.

Treatment BMPs

- Permanent Pool: The volume of a permanent pool incorporated into a stormwater BMP can be counted as water quality volume. This is the volume below the ordinary static water level.
- Extended Detention: The storage volume provided by extended detention can be counted as water quality volume. Extended detention is defined as holding the stormwater runoff volume and releasing it gradually over a period of 24 hours with a drawdown time no greater than 72 hours.
- Filtration: The volume of stormwater runoff routed through a BMP that provides filtration (i.e. an underdrained BMP) can be counted as water quality volume.
- Infiltration: The volume of stormwater runoff infiltrated into the ground through a stormwater BMP can be counted as water quality volume.
- Absorption and Chemical/Mechanical Treatment: The volume of stormwater runoff routed through a proprietary water quality device can be counted as water quality volume on sites where a maintenance agreement between the Developer and the local municipality is provided.

B. Channel Protection

Channel protection is required for discharges to natural watercourses either directly or by a

storm sewer or ditch.

- The post-development runoff rate and volume shall not exceed the pre-development rate and volume for all storms up to and including the 2-year, 24-hour storm. On-site retention of the volume increase is required.
- 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 frequency.) 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 or reuse.
- Pre-development is defined as meadow or woods (if woods presently exist) in good condition. Using this definition of pre-development in lieu of "the last land use prior to the planned new development or redevelopment" (i.e. existing conditions) is necessary to protect sensitive streams and improve hydrologic conditions for channels that have already experienced degradation due to changes associated with development.

Alternative Approach

Where site constraints limit infiltration, an alternative approach may be allowed after all other on-site retention options are exhausted. A Stormwater Worksheet signed by the Design Engineer must be submitted for approval before the alternative approach can be used.

Site constraints that limit the use of infiltration may include:

- Poorly draining soils (<0.24 inches per hour, typically hydrologic soil groups C and D)
- Bedrock
- High Groundwater, or the potential of mounded groundwater to impair other uses
- Wellhead protection areas
- Brownfield sites and areas of soil or groundwater contamination

The alternative approach shall consist of extended detention of the 2-year, 24-hour storm for a period of 24 hours with a maximum release rate no greater than the existing 2-year peak discharge, and a drawdown time no greater than 72 hours.

If the allowable opening size from an extended detention basin becomes too small for practical design, an underdrained bioretention BMP (e.g., bioretention/rain garden, planter box, water quality swale) may be used to protect the orifice.

C. Flood Control

Where Required

Flood control is required for all sites.

Standard

Detention or retention of the 100-year storm with a maximum release rate of 0.13 cfs per acre is required.

Note: The 100-year storm is selected to further decrease flood risk when reviewed against the economics from federal studies comparing the cost of flood damage to storm return interval. The release rate of 0.13 cfs per acre is selected to be generally protective of

floodplains in downstream watercourses and is based on results found in previous hydrologic studies in Michigan streams. When volume control is not provided, an extremely low release rate is required to prevent an increase in peak flow rates in downstream watercourses or storm sewers. The increased volume and prolonged duration of runoff from multiple detention basins can have a cumulative effect to increase peak flow rate and duration in downstream reaches.

An alternate maximum release rate may be allowed under certain conditions, including, but not limited to:

1. Redevelopment sites discharging to a municipal storm sewer where the municipality has determined the sewer has adequate capacity for the existing peak runoff rate from the site. Detention need only be provided for any increase in impervious area.
2. Direct discharges to waterbodies or watercourses where the Developer demonstrates that the receiving waters possess capacity to convey the post-development discharge safely and with no negative downstream impacts due to increased flow rates, water levels or velocities. In addition, the peak flow of the receiving waters cannot be increased by the proposed development (i.e. there is a sufficient difference in the timing of the two hydrographs).
3. When the site is located adjacent to or within a floodplain, excavation of new floodplain in lieu of standard stormwater detention may be required. The excavated volume shall be equal to the standard detention basin storage volume. Only the volume above the 2-year and below the 100-year floodplain elevation can be counted to meet the volume requirement.
4. When the volume of runoff discharged from the developed site is equal to or less than the volume of runoff from the existing site for the 100-year design storm, the maximum allowable release rate may be increased to the pre-development 100-year peak discharge rate. If detention is already in use on a redevelopment site, the existing controlled release rate governs.

Note: This approach is effective in maintaining peak flow rates and floodplain levels in downstream watercourses, since it better mimics the predevelopment hydrology of a site and eliminates the large volume increases associated with increased flooding.

Overflow Routes for Extreme Flood

Overflow routes and the extent of high water levels for the 100-year flood shall be identified for the site and for downstream areas between the site and the nearest acceptable floodway or outlet. Provisions shall be made to ensure no adverse impacts off-site or internal to the site. Where acceptable overflow routes do not exist:

1. Buildings shall be protected from flooding by two separate enclosed drainage systems, a primary and a redundant system, each independently protecting the building from flooding during the 100-year storm. Runoff shall be directed to the inlets of the primary system for up to a 10-year storm, to minimize the accumulation of debris over the redundant inlets; and
2. Detention and retention basins shall be increased in size to store two (2) times the flood control volume.

Note: The intent of the extreme flood criteria is to prevent flood damage from large but infrequent storm events by identifying and/or designing overland flow paths that are clear of structures and have grades below the lowest openings of structures. Overflow routes may include floodplains along open channels, overbank areas along vegetated swales, curb

jumps in drives and parking lots, and other flow paths flood waters will take to reach an outlet, whether overland or underground.

D. Pretreatment

Pretreatment is required for detention basins, retention basins, infiltration practices, bioretention/rain gardens, constructed filters and water quality swales to preserve the longevity and function of the stormwater BMP. Pretreatment provides for the removal of fine sediment, trash, and debris.

Methods of pretreatment include:

- Forebays (including spill containment cells and level spreaders)
- Vegetated filter strips (including buffers and green roofs)
- Vegetated swales (including natural flow paths)
- Water quality devices

A minimum pretreatment volume equivalent to 15% of the water quality volume is required for sediment forebays using gravity. This is a conservative approximation of 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.

Vegetated filter strips and vegetated swales must meet minimum length, slope, and vegetated cover requirements to be accepted.

E. Hot Spots

Where Required

Sites considered to be stormwater hot spots include activities with a high potential to cause contamination, and sites that have existing contamination. More specifically:

1. Industrial and commercial land use activities involving the production, transfer, storage, and/or use of hazardous materials in quantities that pose a high risk to surface and groundwater quality (exceeding 55 gallons aggregate for liquids and 440 pounds aggregate for dry weights), as defined in Part 5 Rules: Spillage of Oil and Polluting Materials, Water Resources Protection (Part 31, Act 451, PA 1994).
2. “Brownfield” sites with soil or groundwater contamination under Part 201 Environmental Remediation and Part 213 Leaking Underground Storage Tanks (Act 451, PA 1994).

Standard

Pretreatment volume with a minimum of 400 gallons required for spill containment from hot spot land use activities.

Note: The minimum spill containment volume provides a reasonable capture size (e.g. 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.

Pretreatment BMPs must have an impermeable barrier between the treated material and the groundwater and have provisions for the capture of oil, grease, and sediments.

Treatment BMPs

Specific stormwater management strategies for hotspots include the following:

1. Isolate transfer and storage areas from permeable surfaces and reduce exposure to stormwater.
2. Identify opportunities for use of infiltration BMPs in other areas of the site.
3. Where storage and transfer areas exposed to stormwater cannot be avoided:
    a. Infiltration of runoff from pavement surfaces is discouraged in favor of a surface water discharge.
    b. Pervious pavements that infiltrate into the groundwater are not permitted because they do not allow for any pretreatment or spill containment.
    c. Perforated pipes for infiltration are not permitted due to the difficulty in isolating an accidental spill.
    d. A standard catch basin and outlet pipe with a downturned end is not permitted because the area of the permanent pool is insufficient to prevent the captured low-density fluids from becoming entrained in the water when surface inflow enters the structure.

Evaluation Procedure

Brownfield sites must be evaluated before an infiltration approach can be approved so as not to exacerbate existing conditions. The following steps must be followed for sites with known contamination:

1. Include a qualified environmental consultant on the design team.
2. Show areas of known contamination on the site map.
3. Specify on the drawings how contractor is to address any contamination which may be found during construction.
4. The site evaluation process must follow the document entitled *Implementing Stormwater Infiltration Practices at Vacant Parcels and Brownfield Sites* (EPA, 2013).
5. Submit supporting documentation of the site evaluation process with the stormwater review package.
6. Contact EGLE Remediation and Redevelopment Division (RRD) staff for consultation as necessary.

F. Coldwater Streams

Coldwater streams require an adequate and stable base flow to maintain their designation and support a cold-water fishery. See also maps provided on the Michigan Department of Natural Resources (MDNR) website:

http://www.michigan.gov/dnr/0,4570,7-153-10364_63235-211883--,00.html

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 to the cold-water stream. Strategies must be identified on the site plan and/or submittal package.

- Protect riparian buffers.

- Stormwater disconnection.
- Incorporate heat-reducing BMPs such as green roofs and re-forestation.
- Implement structural BMPs that control volume through infiltration.
- If detention ponds are used, detention times must be limited to a maximum of 12 hours.
- Wet ponds should draw water from near the pond bottom to maintain a cooler discharge water temperature.

Part 4: Stormwater 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
- Existing soil borings, wells, or geotechnical report on the site
- On-site septic percolation testing
- Cyclical groundwater levels (http://waterdata.usgs.gov/mi/nwis/gw)

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 3:

Table 3 - Minimum Number of Soil Tests Required

Type of BMP	Test Pit/Soil Boring	Depth of Test Pit/ Soil Boring	Field Permeability Test
Retention basin Infiltration bed Rain garden Pervious pavement	1 soil boring per 5,000 square feet of bottom area; 2 minimum	10 feet below proposed bottom	1 test per soil boring
Infiltration trench Bioswale	1 soil boring per 100 linear feet of BMP; 2 minimum	10 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 basin	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 retention 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 field permeability testing be performed on questionable sites. Acceptable field tests include:

- Infiltration Rate of Soils in Field Using Double-Ring Infiltrometers (ASTM D3385).

The minimum number of field permeability tests shall be determined from Table 3.

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 ground is frozen.

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

F. Design Infiltration Rate

The procedure used to determine a design infiltration rate is summarized in **Table 4**. The resulting design infiltration rate shall be the limiting value of the underlying soil or filter media.

Table 4 – Determination of a Design Infiltration Rate

Description	Source	Maximum Design Infiltration Rate
1. Underlying Soil		
Field permeability testing conducted	Test value divided by 2	10 in/hr
No testing; retention basins used for flood control	Table 5	3.6 in/hr

The infiltration rate determined from field permeability testing shall be divided by 2 to calculate the design infiltration rate, up to a maximum design infiltration rate of 10 inches per hour. The least permeable soil horizon within 4 feet below the proposed BMP bottom elevation shall be used to determine the design infiltration rate.

Where field permeability testing is not performed, and for all retention basins used for flood control, the design infiltration rates provided in Table 5 shall be used to calculate the storage volume and minimum infiltration area of the BMP necessary to drain in the allotted drawdown time.

Note: A conservative value for the infiltration rate is used for retention basins due to the high probability for diminished performance due to clogging and the risk of failure.

Table 5 - Design Infiltration Rates by USDA Soil Texture Class Soil Texture Class

Soil Texture Class	Effective Water Capacity[1] (inches per inch)	Design Infiltration Rate[2] (inches per hour)	HSG1
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: Maryland Department of Environment (2000). Maryland Stormwater Design Manual, Appendix D.13, Table D.13.1 (Rawls, Brakensiek and Saxton, 1982).

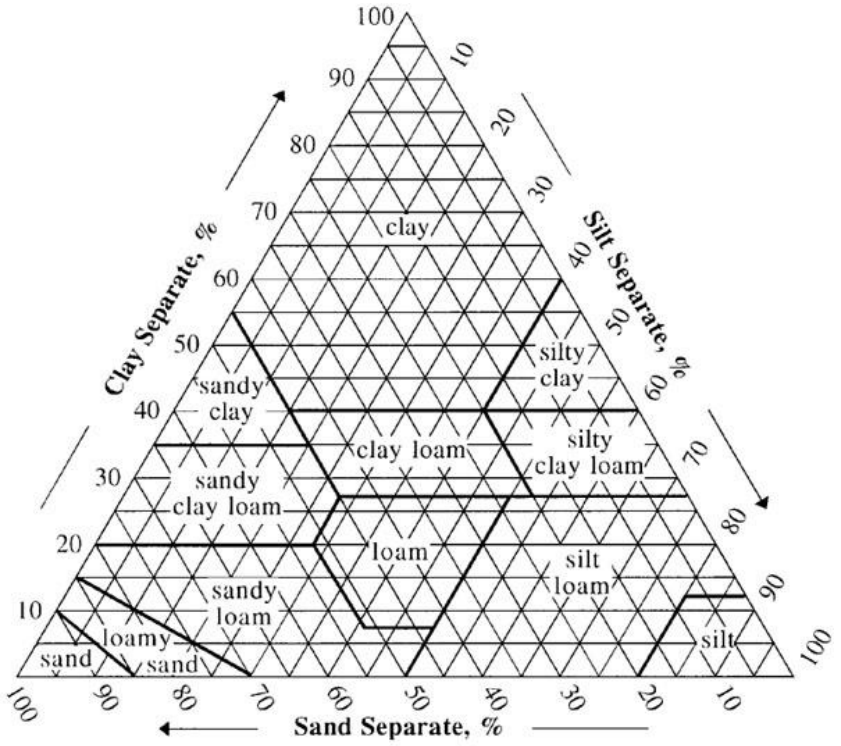
2 Source: Wisconsin Department of Natural Resources (2004). Site Evaluation for Stormwater Infiltration (1002), Table 2 (Rawls, 1998). Note: Values are reduced by approximately a factor of 2 from those given in Table D.13.1.

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.

Soils with design infiltration rates as low as 0.24 inches per hour (Medium Loam) may be used for LID and Small Site BMPs if suitable supplemental measures are included in the design. Supplemental measures may include subsoil amendment, or underdrain placed at the top of the storage bed layer.

Figure 1 - USDA Soil Textural Triangle (https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/?cid=nrcs142p2_054167)



II. CALCULATION METHODOLOGY

The Rational Method and the NRCS Runoff Curve Number Method are typically used to calculate stormwater runoff, peak discharges, and runoff volumes for design of stormwater conveyance and storage systems. The NRCS method is presently the only acceptable method to calculate the channel protection volume. The Small Storm Hydrology Method is used to calculate runoff volumes from the smaller rainfall amounts used for water quality treatment.

A. Calculating Runoff

1. The Rational Method may be used to calculate stormwater runoff volumes and peak discharges to size conveyance and storage systems for contributing drainage areas of 40 acres or less. The peak runoff rate is given by the equation:

$$Q = CIA \qquad (4.1)$$

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). Use rainfall amounts from Table 9 and divide by the duration in hours to obtain the average rainfall intensity (I).

A = drainage area (acres).

Runoff coefficients sizing conveyance systems shall be selected from Table 6.

Table 6 - Rational Method Runoff Coefficients (10- to 100-year rainfall frequencies)

Character of Surface	Return Period (years)		
	10	25	100
Asphalt and Concrete Pavement/Roofs	0.95	0.97	0.98
Brick Pavement and Gravel Surface	0.85	0.88	0.91
Lawns and Open (HSG A)*	0.15	0.17	0.2
Lawns and Open (HSG B)	0.2	0.27	0.38
Lawns and Open (HSG C)	0.35	0.45	0.55
Lawns and Open (HSG D)	0.5	0.57	0.67
Water	1.00	1.00	1.00

Source: Runoff coefficients are calculated to match 24-hour runoff volumes from CN Method with antecedent moisture condition II and initial abstract (Ia) = 0.2S using CNs for "Open Spaces, Good Condition" for Lawns and Open, and a CN of 95 for Brick Pavement and Gravel Surface.

*The runoff coefficient for Lawns and Open (HSG A) is adjusted to match values in American Society of Civil Engineers and the Water Pollution Control Federation (1969). Design and Construction of Sanitary and Storm Sewers, as the calculated value is less than 0.01. Frequency adjustment factors of 1.1 and 1.25 have been applied for the 25- and 100-year frequencies respectively, with a maximum value of 1.00. Adjustment factors from Mays (2001). Stormwater Collection Systems Design Handbook.

Time-of-concentration for the Rational Method is the sum of overland flow and channel flow. A minimum of 15 minutes shall be used.

2. The Runoff Curve Number Method developed by the NRCS may be used to calculate stormwater runoff volumes and peak discharges to size conveyance and storage systems. This method must be used when it is necessary to calculate runoff volumes for channel protection. The formulas are as follows:

$$Q_v = \frac{(P-0.2S)^2}{(P+0.8S)} \qquad (4.2)$$

Q_V = surface runoff (inches). Note: Qv=0 if P ≤ 0.2S

P = rainfall (inches).

S = potential maximum retention after runoff begins (inches).

and where:

$$S = \frac{1000}{CN} - 10 \qquad (4.3)$$

Surface runoff (Qv) is calculated separately for impervious and pervious areas. Total runoff volume can then be calculated by the formula:

$$V_t = (Q_{v_{perv}} A_{perv} + Q_{v_{imp}} A_{imp}) \qquad (4.4)$$

Vt = runoff volume of the design storm (cubic feet).

Qv= surface runoff (inches); separate for pervious and impervious surface.

A = contributing site area (acres).

3630 = factor to convert acre-inches to cubic feet.

Curve Number (CN) values are provided in Table 7.

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

Land Use Description		Curve Number[1]			
	Hydrologic Condition[2]	Hydrologic Soil Group			
Cover Type		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: U.S. Department of Agricultural Soil Conservation Service (1986). *Urban Hydrology for Small Watersheds, Technical Release No. 55.*
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 the 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
* SEMCOG (2008). *Low Impact Development Manual for Michigan.*

Time-of-concentration for the Runoff Curve Number Method shall be calculated using NRCS TR-55 methodology. A minimum of 0.1 hour (6 minutes) shall be used.

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

3. The Small Storm Hydrology Method is used to calculate the water quality treatment volume. The method was developed to estimate the runoff volume from urban land

uses for relatively small storm events where the Rational and NRCS Methods prove less accurate. Water quality volume is calculated by the formula:

$$V_{wq} = AR_v(1)(3630) \qquad (4.6)$$

V_{wq} = minimum required water quality volume (cubic feet).

A = area (acres); the developed portion of the site, both impervious and pervious, not receiving treatment with a non-structural BMP.

R_v = area-weighted volumetric runoff coefficient (from Table 8). 1 = 90% non-exceedance storm rainfall amount (inches). 3630 = factor to convert acre-inches to cubic feet.

The Volumetric Runoff Coefficients (R_v) provided in Table 8 are like the Rational runoff coefficient but are exclusive to the rainfall amount (1-inch).

Table 8 - 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 SEMCOG (2008). *Low Impact Development Manual for Michigan*, Table 9.3. (R. Pitt (2003). *The Source Loading and Management Model (WinSLAMM): Introduction and Basic Users).*

B. Rainfall

The rainfall duration-frequency table provided in Table 9 shall be used with the Rational Method to determine rainfall intensity for rainfall duration equal to the time-of-concentration. The 24-hour rainfall amounts provided in Table 9 shall be used with the Runoff Curve Number Method. An MSE4 rainfall distribution shall be used when a unit hydrograph approach is used (e.g. WinTR-20 computer program).

Table 9 - Rainfall Depths

PDS-based precipitation frequency estimates with 90% confidence intervals (inches)							
	Average Recurrence Interval						
Duration	1-year	2-year	5-year	10-year	25-year	50-year	100-year
5-min	0.31	0.37	0.46	0.54	0.65	0.74	0.84
10-min	0.46	0.54	0.67	0.78	0.95	1.09	1.23
15-min	0.56	0.66	0.82	0.96	1.16	1.32	1.50
30-min	0.81	0.94	1.18	1.38	1.68	1.92	2.17
60-min	1.02	1.21	1.54	1.83	2.25	2.59	2.95
2-hr	1.24	1.48	1.90	2.27	2.81	3.26	3.73
3-hr	1.35	1.63	2.10	2.53	3.15	3.67	4.22

6-hr	1.60	1.89	2.42	2.90	3.62	4.23	4.89
12-hr	1.92	2.19	2.70	3.19	3.95	4.60	5.31
24-hr	2.23	2.53	3.08	3.60	4.40	5.08	5.83
Source: NOAA, Atlas 14, Precipitation-Frequency Atlas of the Unit States, Volume 8, Version 2.0 Rainfall amounts from: Hastings, Michigan							

C. Calculating Storage Volumes and Release Rates

Water Quality

Treatment of the runoff generated from 1 inch of rain (the 90% annual non-exceedance storm) over the developed portion of the site is required. Water quality volume is calculated using the Small Storm Hydrology Method.

Treatment can be provided by settling (permanent pool or extended detention), filtration or infiltration, absorption, or chemical/mechanical treatment to meet the 80% TSS removal efficiency standard.

Pretreatment

Pretreatment volume may be included in the total water quality volume, and is calculated as:

$$V_{pt} = 0.15(V_{wq}) \qquad (4.7)$$

V_{pt} = minimum required pretreatment volume (cubic feet).

V_{wq} = water quality volume (cubic feet).

The pretreatment volume may need to be provided in a separate BMP to protect the integrity of the BMP providing treatment.

Channel Protection

a. Retention

Channel protection consists of retaining on-site the net increase in runoff volume between pre-development and post-development conditions for a 2-year, 24-hour storm using the Runoff Curve Number Method. Channel protection volume is calculated with the following equation:

$$V_{cp} = Vt_{post} - Vt_{pre} \qquad (4.8)$$

V_{cp} = minimum required channel protection volume (cubic feet).

Vt_{post}= runoff volume of the 2-year, 24-hour storm for post-development conditions.

Vt_{pre}= runoff volume of the 2-year, 24-hour storm for pre-development conditions.

Pre-developed (baseline) conditions for calculating channel protection volume shall consist of a “Meadow” cover type for all existing land covers other than woods and impervious surfaces. For existing woods, use the “Woods” cover type in “good” hydrologic condition. For existing impervious surfaces, use the “Open Spaces” cover type in “fair” hydrologic condition.

The “Open Spaces” cover type in “fair” hydrologic condition shall be used for post development pervious areas that are not receiving non-structural BMP credits.

b. Extended Detention

If retention of the total channel protection volume is not possible due to site constraints, an alternative approach using extended detention may be allowed. The storage volume of an extended detention basin shall be sized for that part of the 2-year volume difference not met by retention, with a maximum release rate that results in a 24-hour detention time. The peak discharge for a 24-hour detention time may be calculated assuming triangular inflow and outflow hydrographs with a lag between the peaks of 24 hours. If the inflow peak occurs 12 hours into the 24-hour inflow hydrograph, then the outflow peak should occur 36 hours into a 72-hour outflow hydrograph. The extended detention peak discharge can then be computed with the following equation:

$$Q_{pED} = (V_{cp} - V_{ret}) / (36 \times 3600) \qquad (4.9)$$

Q_{pED} = peak extended detention release rate (cubic feet per second).

V_{cp} = total channel protection volume required (cubic feet).

V_{ret} = channel protection volume met by retention (cubic feet).

36 x 3600 = half of the base time of outflow hydrograph (seconds).

The 2-year peak discharge after extended detention (Q_{pED}) must be equal to or less than the existing 2-year peak discharge. (Exceptions may be made for HSG A, where extended detention has been approved due to site constraints, but existing runoff is zero.) Reduce the required treatment volume and recalculate until this requirement is met. Simply selecting the lower existing release rate will violate the 72-hour drawdown time.

Flood Control

a. Detention

Detention of the 100-year rainfall event with a maximum allowable release rate of 0.13 cfs per acre is required.

If the volume of runoff released from the developed site is less than or equal to the volume of runoff from the existing site for the 100-year design storm, a maximum release rate no greater than the pre-development 100-year peak runoff rate may be used.

- Rational Method

If the Rational Method is used, the minimum required storage volume shall be calculated by the “Modified Chicago” Method.

Runoff Coefficients for use in detention storage calculations shall be selected from Table 6 to account for rainfalls exceeding a 10-year frequency. Frequency adjustment of factors of 1.1 and 1.25 have been applied for the 25- and 100-year frequencies respectively, with a maximum value of 1.00.

An additional adjustment factor of 1.25 shall be applied to the calculated storage volume since this method tends to underestimate the storage volume when compared to pond routing, particularly for short times-of-concentrations (15 to 30 minutes).

- Runoff Curve Number Method

  If the Runoff Curve Number Method is used, the minimum required storage volume shall be determined through routing, or may be calculated by the formula:

$$V_{fc} = \frac{(Q_p - Q_{out})}{Q_p} V_t - V_{bmp} \qquad (4.10)$$

  V_{fc} = minimum required storage volume for flood control (cubic feet).

  Q_p = peak runoff rate (cubic feet per second).

  Q_{out} = maximum allowable peak discharge (cubic feet per second).

  V_t = post-development runoff volume for the 100-year, 24-hour storm (cubic feet).

  V_{bmp} = total volume (storage + infiltration) provided by BMPs used to meet water quality and/or channel protection volume standards.

  This formula provides a conservative approximation of the required storage volume. Therefore, the volume of any upstream BMPs can be subtracted from the storage volume versus the total runoff volume.

Retention

Retention basins and other infiltration practices shall be sized for the 100-year, 24- hour rainfall event.

- Rational Method for Retention

  If the Rational Method is used, the minimum required storage volume shall be calculated by the “Modified Chicago” Method.

  Runoff Coefficients for use in detention storage calculations shall be selected from Table 6 to account for rainfalls exceeding a 10-year frequency. Frequency adjustment of factors of 1.1 and 1.25 have been applied for the 25- and 100-year frequencies respectively, with a maximum value of 1.00.

  An additional adjustment factor of 1.25 shall be applied to the calculated storage volume since this method tends to underestimate the storage volume when compared to pond routing, particularly for short times-of-concentrations (15 to 30 minutes).

  The discharge or exfiltration rate into the soil from the retention basin shall be calculated as:

$$Q_{out} = A \text{ x } i \; / \; (12 \times 3600) \qquad (4.11)$$

  Q_{out} = discharge rate (cubic feet per second)

  A = infiltration area (square feet)

  i = design infiltration rate (inches per hour) as shown in Table 5

  12 = factor to convert inches to feet

  3600 = factor to convert hours to seconds

- Runoff Curve Number Method for Retention

  If the Runoff Curve Number Method is used, the minimum required storage volume (V_s) shall be calculated by subtracting the volume infiltrated by the BMP during the

infiltration time (V_{inf}) from the flood control event runoff volume (V_t).

$$V_s = V_t - V_{inf} \quad (4.12)$$

The flood control event runoff volume (V_t) is calculated using Equation 4.4.

The infiltrating volume is calculated as:

$$V_{inf} = i \text{ x } A \text{ x } t_{inf} / 12 \quad (4.13)$$

V_{inf} = infiltrating volume (cubic feet)

i = design infiltration rate (inches per hour) as shown in Table 5

A = infiltration area (square feet)

t_{inf} = infiltration time (hours); the period when the BMP is receiving runoff and capable of infiltrating at the design rate

12 = factor to convert inches to feet

Based on extensive computer modelling, the infiltration time is found to be a function of the drain time through the BMP. An empirical formula was developed to model this function for drain times between 0 and 72 hours. Note: this is equation is not valid for drain times greater than 72 hours.

$$t_{inf} = 2.0 + t_d \, (0.222 - 0.553 \text{ x } log_{10} \, (t_d / 72)) \quad (4.14)$$

The drain time through the BMP is calculated as:

$$t_d = 12 \text{ x } V_S / (A \text{ x } i) \quad (4.15)$$

t_d = BMP drain time (hours)

V_S = storage volume of the BMP (cubic feet)

i = design infiltration rate (inches per hour) as shown in Table 5

A = infiltration area (square feet)

12 = factor to convert inches to feet

The volume of stormwater runoff stored and infiltrated by upstream retentive BMPs (V_{bmp}) may be subtracted from the flood control event runoff volume reaching the retention basin.

Retentive BMPs Sized for Water Quality and Channel Protection

This method shall be used to calculate the required storage volume of retentive BMPs used for water quality or channel protection by substituting the water quality or channel protection volume for Vt.

III. Structural Best Management Practices

Structural Best Management Practices (BMPs) are constructed measures that convey, store, and treat stormwater in a site-specific location and help mitigate the impact of stormwater runoff. BMPs shall be designed in accordance with these standards. Further information and examples for LID and Small Site BMPs are provided in the BMP Fact Sheets in Chapter 7 the Low Impact Development Manual for Michigan (SEMCOG, 2008).

Note: Design criteria for BMPs used primarily for SESC and channel stabilization (i.e. riprap, instream structures, natural channel design), and technical specifications for construction are beyond the scope of this manual.

A. Storm Sewer

Storm sewers, culverts, manholes, inlets, and end sections shall be constructed according to local governing specifications. In the event of no other governing specifications, the latest edition of the MDOT Standard Specifications for Construction will be observed. Specifications and details shown on the plans shall reflect the proper specifications.

Summary

- Description: Provides stormwater conveyance in an enclosed system.
- Types: Pipe (solid wall, perforated).
- Pretreatment Required: No.
- This BMP can provide spill containment.
- Maintenance Plan: Yes.
- Volume Reduction: Perforated pipe or leaching basin - Count storage volume below outlet pipe invert.

Sizing and Configuration

- Gravity flow during a ten (10) year storm must be provided in the pipe. The hydraulic gradient shall be no higher than the top of the inside of pipe.
- Storm sewer design velocities, capacities, and friction losses shall be based on Manning's equation:

$$Q = \frac{1.49 A R^{\frac{2}{3}} S^{\frac{1}{2}}}{n} \qquad (4.16)$$

  Q = discharge (cubic feet per second)

  A = wetted area (square feet)

  R = hydraulic radius (feet)

  S = slope (feet per foot)

  n = Manning’s Roughness Coefficient

- Manning's coefficients for closed conduit are included in Table 10.
- The Manning’s coefficient of roughness used for pipe sizing shall be 0.013 unless proof is provided to justify a different number. 0.021 shall be used for corrugated metal pipe.
- Pipes shall be free flowing and self-cleansing. Velocities of full flowing pipe shall be greater than two (2) feet per second. No portion of a pipe shall be permanently submerged.
- 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.
- The minimum pipe size shall be twelve (12) inches (interior diameter).

- The minimum depth of cover shall be 24 inches from grade to the top of pipe.
- Pipes shall be centered in a twenty (20) foot minimum width easement. The Drain Commissioner may require wider easements at his/her discretion to provide enough space for maintenance.

End Treatment

- All outlets will be provided with flared end sections and energy dissipation to assure no erosion/scour will take place.
- End section discharges from pipes shall be designed so that velocities will be appropriate to receiving waterways and will not cause damage to them.
- Calculations justifying the median (d_{50}) size riprap shall be provided. Riprap placement dimensions, and total quantity in square yards shall be determined based on pipe size, design velocity and discharge. All riprap shall have a geotextile underlay. The minimum thickness of riprap will be twice the median (d_{50}) dimension. Placement of riprap shall be designated to require the center is lower than the sides so that the stormwater will not flow around the outside edges of the riprap.
- 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 8 feet per second.

Table 10 - 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 & Seal coated)	0.011 to 0.015
Concrete (Monolithic) Smooth forms Rough forms	 0.012 to 0.014 0.015 to 0.017
Concrete Pipe	0.011 to 0.015
Corrugated-Metal Pipe (1/2 inch corrugated) Paved invert Spun asphalt lined	0.022 to 0.026 0.018 to 0.022 0.011 to 0.015
Plastic Pipe (Smooth)	0.011 to 0.015
Vitrified Clay Pipes Liner channels	0.011 to 0.015 0.013 to 0.017
Open Channels	
Lined Channels Asphalt Brick Concrete Rubble or riprap	 0.013 to 0.017 0.012 to 0.018 0.011 to 0.020 0.020 to 0.035

Vegetal	0.030 to 0.040
Excavated or Dredged	
Earth, straight & uniform	0.020 to 0.030
Earth, winding, & moderately 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 ft)	
Fairly regular section	0.030 to 0.070
Irregular section with pools	0.040 to 0.100
Source: American Society of Civil Engineers and the Water Pollution Control Federation (1969). *Design and Construction of Sanitary and Storm Sewers.*	

Table 11 – Minimum and Maximum Slopes for Storm Sewers

Pipe Size (inches)	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
Values for a Manning's "n" = 0.013		

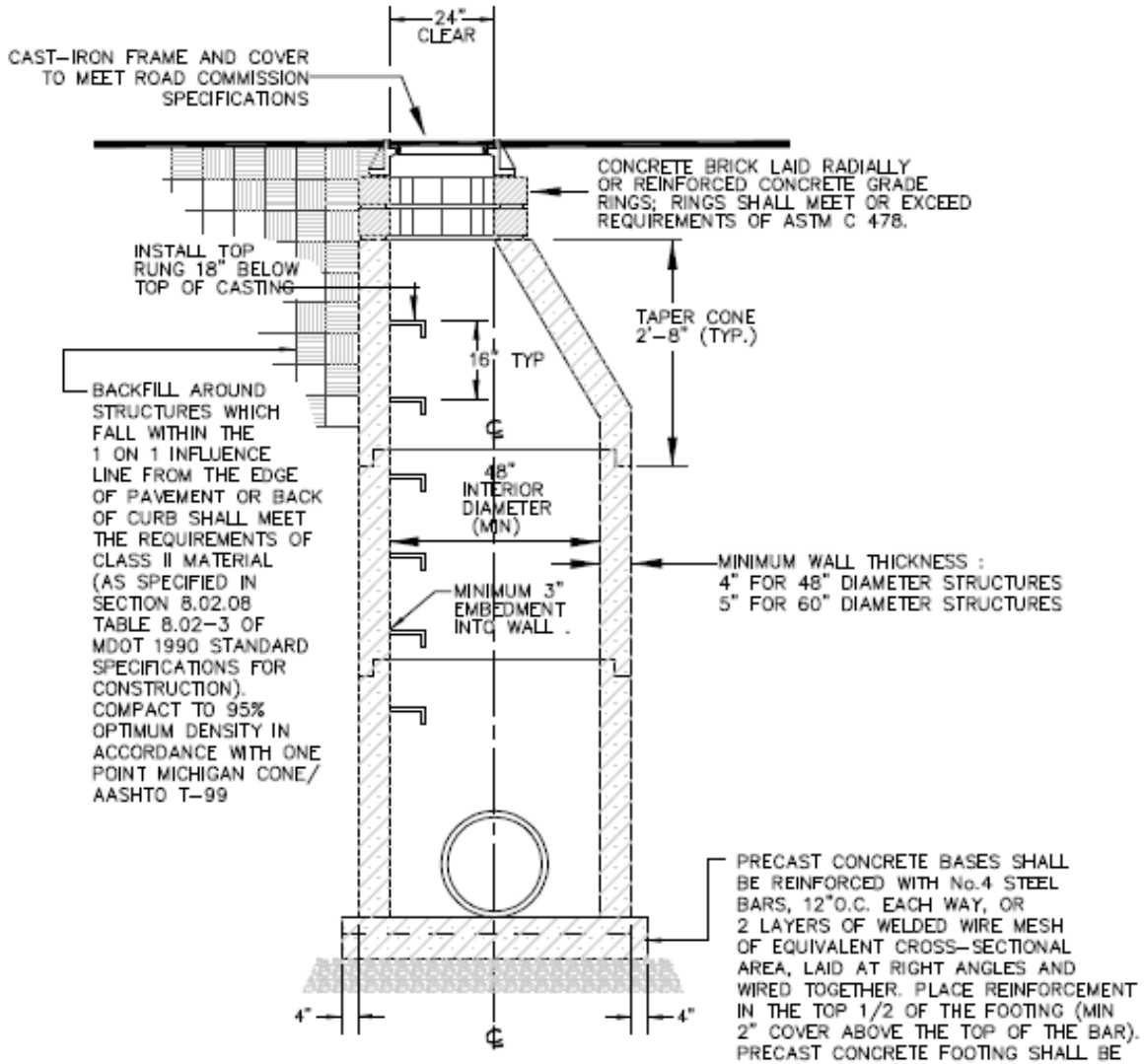
Manholes and Catch Basins

- Structures that intake stormwater at the surface and convey it to pipes (manholes, inlets, catch basins, etc.) shall be located to assure positive drainage of all areas within the development not designated as stormwater retention or detention areas. All low points of roads or rear yards (unless designated as a retention area) shall have an intake structure. Flow across pavement from one side of the road to the other will not be allowed unless super elevating curve is necessary.
- Drops inside any manhole from inflowing pipes to the outflowing pipe shall be limited to two (2) feet.
- Manhole spacing shall not exceed 400 feet for sewers less than 42 inches in diameter and 600 feet for larger sewers.

- Manholes shall be placed at all changes in pipe direction, pipe size, all inlet connection locations, and at the end of the storm sewer.
- Where possible, pipe inverts at junctions shall be designed to minimize junction losses (match 0.8 points of pipe diameters).
- Minimum inside diameter of all manholes, catch basins, and inlet structures shall be 48 inches, except that a 24-inch diameter structure may be allowed for structures with a single 12-inch outlet pipe.
- A two (2) foot minimum sump will be required for all inlets.
- Catch basins shall be placed at low points of streets and yards. 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, and the following additional stipulations:
    - No more than 300 feet of pavement surface drainage will be allowed unless calculations are provided showing that further spacing will not result in more than one (1) cubic foot of stormwater per second to an individual intake structure (10 year storm). No more than 200 feet of surface drainage will be allowed for grades exceeding 4%.
    - Consideration shall be given to pedestrian crossings when siting catch basins in intersections. Catch basins shall be placed upstream of pedestrian crossings when practical.
    - No more than 150 feet of street drainage will be allowed to flow around a corner.
    - No flow will be allowed across a public street intersection.

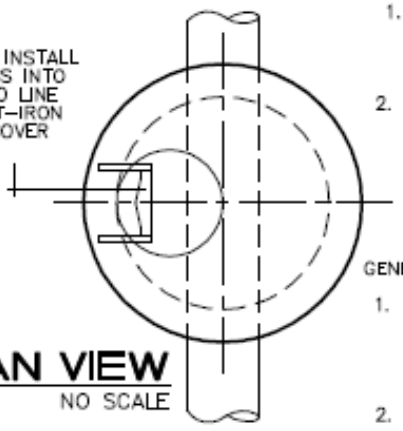
Materials

- Storm sewer pipe shall be reinforced concrete or smooth interior wall polyethylene in accordance with MDOT Standard Specifications. Other materials shall be subject to approval of the Drain Commissioner.
- Pipe joints shall be designed to prevent excessive infiltration or exfiltration.
- Pipe joints and connections to structures shall be premium silt tight.
- Manholes and catch basins shall be in accordance with MDOT Standard Specifications.
- Connections to manholes shall be made with a resilient connector for pipe diameters 24 inches or less. Concrete pipe connections shall be made by grouting the inside and outside wall of the structure.



TYPICAL PRECAST MANHOLE

NO SCALE



PLAN VIEW

NO SCALE

SEWER NOTES :

1. ALL JOINTS SHALL BE "O" RING TYPE WITH REQUIRED LUBRICANT TO MEET THE REQUIREMENTS OF ASTM C 443 JOINTS FOR CIRCULAR CONCRETE SEWER AND CULVERT PIPE WITH RUBBER GASKETS.
2. ALL PIPES FLOWING IN TO THE MANHOLE STRUCTURE SHALL BE CHANNELED INTO ONE OUTFLOW BY USE OF CONCRETE BENCHES AS SHOWN IN THIS DETAIL .

GENERAL NOTES :

1. WHERE BRICK IS USED UNDER CASTINGS IN LIEU OF GRADE RINGS, USE GRADE "A" CONCRETE BUILDING BRICK (MIN 2500 PSI COMPRESSIVE STRENGTH) LAID RADIALLY WITH ALL VOIDS FULLY MORTARED . PLACE CASTING ON A FULL BED OF MORTAR . MAXIMUM THICKNESS OF BRICK AND AND BEDDING SHALL NOT EXCEED 12" OR BE LESS THAN 8" .
2. SPACING BETWEEN PIPE ENTRANCE OPENINGS INTO MANHOLE SHALL BE A MINIMUM OF 6 INCHES.

ASTM STANDARDS AND STANDARD SPECIFICATIONS:

(1) C 443 JOINTS FOR CIRCULAR CONCRETE SEWER AND CULVERT PIPE WITH RUBBER GASKETS
(2) C 478 PRECAST REINFORCED CONCRETE MANHOLE SECTIONS.
(3) C 877 EXTERNAL SEALING BANDS FOR NON-CIRCULAR CONCRETE SEWER, STORM DRAIN AND CULVERT PIPE
(4) C 891 STANDARD PRACTICE FOR INSTALLATION OF UNDERGROUND PRECAST CONCRETE UTILITY STRUCTURES
(5) C 923 RESILIENT CONNECTORS BETWEEN REINFORCED CONCRETE MANHOLE STRUCTURES AND PIPES.
(6) D 449 ASPHALT USED IN DAMPPROOFING AND WATERPROOFING

PRECAST MANHOLE PRODUCT SPECIFICATIONS

A) PRECAST CONCRETE MANHOLES: ASTM C 478, PRECAST REINFORCED CONCRETE, OF DEPTH INDICATED ON THE PLANS, WITH PROVISION FOR RUBBER GASKET JOINTS, AND AS FOLLOWS:

(1) BASE SECTION: 6-INCH MINIMUM THICKNESS FOR FLOOR SLAB AND 4-INCH MINIMUM THICKNESS FOR WALLS AND BASE RISER SECTION, AND HAVING A SEPARATE BASE SLAB OR BASE SECTION WITH INTEGRAL FLOOR.

(2) RISER SECTIONS: 4-INCH MINIMUM THICKNESS; 48-INCH DIAMETER, AND LENGTHS TO PROVIDE DEPTH INDICATED.

(3) TOP SECTION: ECCENTRIC CONE TYPE, UNLESS CONCENTRIC CONE OR FLAT-SLAB-TOP TYPE IS INDICATED. TOP OF CONE TO MATCH GRADE RINGS.

B) GRADE RINGS: PROVIDE 2 OR 3 REINFORCED CONCRETE RINGS, OF 6 TO 9 INCHES TOTAL THICKNESS AND MATCH 24-INCH DIAMETER FRAME AND COVER.

C) GASKETS: ASTM C 443, RUBBER.

D) CONCRETE: PORTLAND CEMENT MIX, 3000 PSI.

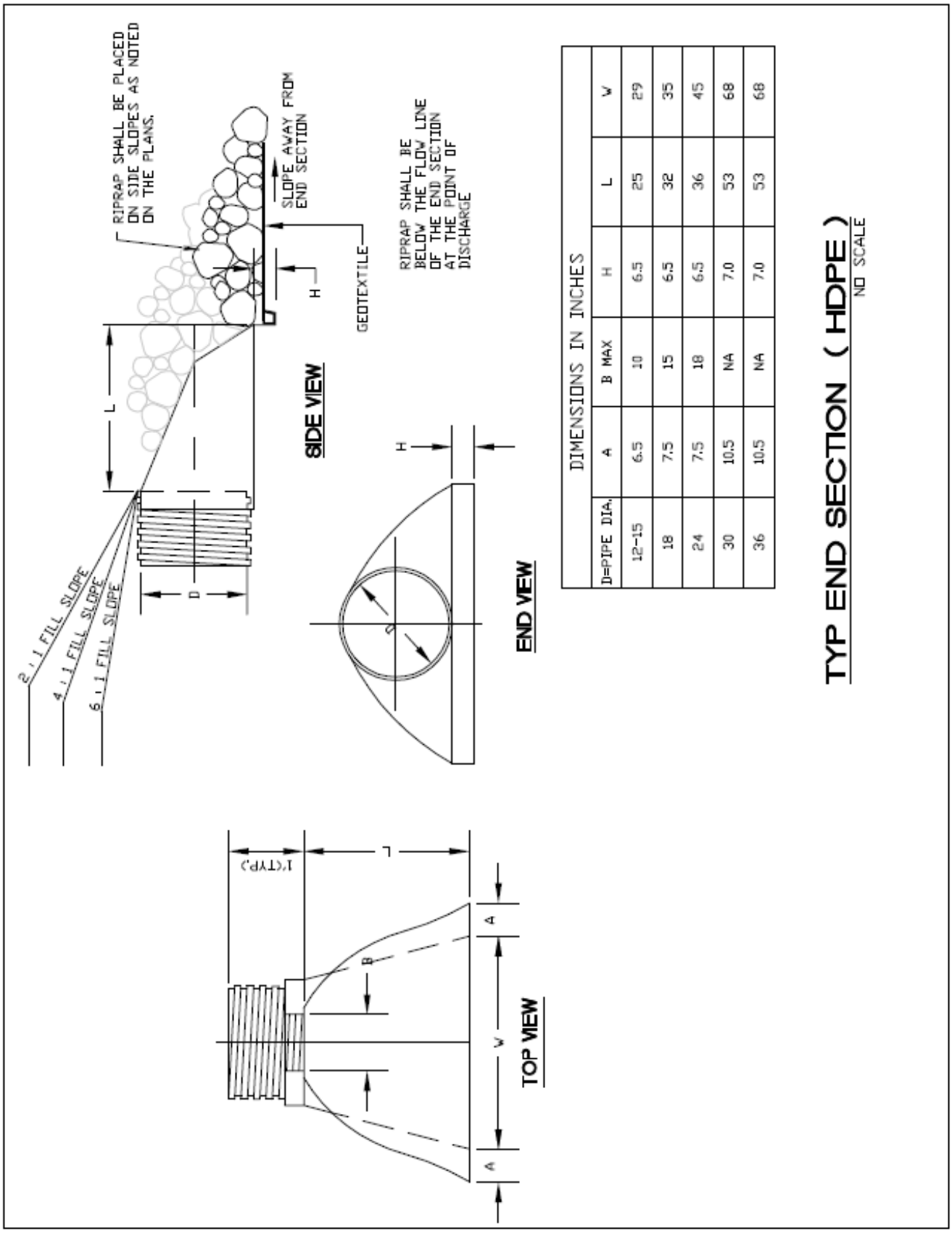
(1) CEMENT: ASTM C 150, TYPE II.
(2) FINE AGGREGATE: ASTM C 33, SAND.
(3) COARSE AGGREGATE: ASTM C 33, CRUSHED GRAVEL.
(4) WATER: POTABLE.

E) REINFORCEMENT: STEEL CONFORMING TO THE FOLLOWING:

(1) FABRIC: ASTM A 185, WELDED WIRE FABRIC, PLAIN.
(2) REINFORCEMENT BARS: ASTM A 615, GRADE 60, DEFORMED.

F) MANHOLE STEPS: CAST INTO BASE, RISER, AND TOP SECTIONS SIDEWALL AT 12- TO 16-INCH INTERVALS, AND SHALL BE WIDE ENOUGH FOR A MAN TO PLACE BOTH FEET ON ONE STEP, DESIGNED TO PREVENT LATERAL SLIPPAGE OFF THE STEP. INSTALLED RUNGS SHALL SUPPORT A MINIMUM CONCENTRATED LOAD OF 300 LBS AT ANY POINT ON THE STEP.

(1) EAST JORDAN IRON WORKS #8501 CAST ALUMINUM, OR APPROVED EQUAL.



DIMENSIONS IN INCHES

D=PIPE DIA.	A	B MAX	H	L	W
12-15	6.5	10	6.5	25	29
18	7.5	15	6.5	32	35
24	7.5	18	6.5	36	45
30	10.5	NA	7.0	53	68
36	10.5	NA	7.0	53	68

TYP END SECTION (HDPE)

NO SCALE

B. Culvert or Bridge

Summary

- Description: Provides stormwater conveyance through a crossing structure.
- Types: Pipe Culvert; Box Culvert; Bridge.
- Pretreatment Required: No.
- Maintenance Plan: Yes.

Sizing and Configuration

- Bridges shall be designed to provide a 4.3-foot minimum under clearance at normal flow for canoe traffic on navigable waterways, and 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.
- Culverts serving a drainage area of less than 2 square miles shall be designed for the 25-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.
- The effect of the 100-year storm shall be reviewed to ensure no adverse increase in water elevation off the development property or flooding of structures within the development.
- Sizing of culverts and bridges shall be performed using the Bernoulli Equation and include consideration of inlet and outlet control, entrance and exit losses, and tailwater condition. Published culvert nomographs and another computer software may be used.
- Minimum diameter of a drive culvert shall be 12 inches.
- Minimum diameter of a road crossing culvert shall be 18 inches or equivalent pipe arch.

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.
- 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 8 feet per second.

Materials

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

C. Open Channel

Summary

- Description: Stormwater conveyance in an excavated channel.
- Types: Channel; Ditch.
- Pretreatment Required: No.
- Maintenance Plan: Yes.

Sizing and Configuration

- The open channel shall be designed to convey the 25-year peak discharge.
- Open channel design velocities, capacities, and friction losses shall be based on Manning's equation:

$$Q = \frac{1.49AR^{\frac{2}{3}}S^{\frac{1}{2}}}{n} \qquad (4.17)$$

  Q = discharge (cubic feet per second)

  A = wetted area (square feet)

  R = hydraulic radius (feet)

  S = slope (feet per foot)

  n = Manning's Roughness Coefficient

- Manning's Coefficients shall be determined from Table 10. 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.).
- Minimum bottom width shall be 2 feet.
- Minimum longitudinal slope shall be 0.10%.
- Side slopes shall be no steeper than 2:1 (horizontal to vertical).
- The minimum velocity for open channels during the design event shall be 1.5 feet per second.
- The maximum velocity shall be 4 feet per second. Riprap protection or equivalent shall be used where the velocity exceeds 4 feet per second, up to maximum allowable design velocity of 8 feet per second.

Connections and Crossings

- Outlets into the open channel shall enter at an angle of 90 degrees or less with the direction of flow.
- A minimum clearance of 4 feet is required between open channel inverts and underground utilities unless special provisions are approved.

D. Detention Basins & Retention Basins

All runoff generated by proposed impervious surfaces, unless otherwise permitted by the Drain Commissioner, must be conveyed into a stormwater storage facility for water quality treatment and detention/retention prior to being discharged from the site. The following criteria will apply to the design of all stormwater retention and detention facilities.

- Public safety will be a paramount consideration in stormwater storage system design. Providing safe retention/detention is the Proprietor's responsibility. Basin designs will incorporate gradual side slopes, vegetative and barrier plantings, and safety shelves. Where further safety measures are required, the Proprietor is expected to include them within the proposed development plans. Fencing shall be required if basin side slopes are steeper than 4 to 1 (4 horizontal to 1 vertical). A four (4) foot chain link fence with gate is required.
- Sediment forebays (upper stage) will be provided at the inlet of all stormwater management facilities to provide energy dissipation and to trap and localize incoming sediments. The forebay will be a separate basin, which can be formed by gabions or a compacted earthen berm. Berm top width shall be a minimum of 12 feet. The capacity of the forebay will be equivalent to 5% of the required design storm volume based on the area tributary to the inlet. Direct maintenance access to the forebay for heavy equipment will be provided. Size forebay(s) for pretreatment using equation given in “Calculating Storage Volumes and Release Rates, Pretreatment.”
- For safety purposes and to minimize erosion, basin side slopes will generally not be steeper than one-foot vertical to three feet horizontal (3:1). For basins proposed to be under the jurisdiction of the Drain Commissioner, slopes steeper than one foot vertical to four feet horizontal, will be permitted only with the installation of a four-foot-high chain link fence surrounding the storage facility. In such cases, a 12-foot-wide access gate shall be provided. Installation of fencing on private systems shall be in accordance with local ordinance.
- All basins will have provisions for a defined emergency spillway, routed such that it can be picked up by the main outflow channel while not discharging directly over the outlet pipe. The emergency spillway will be set at an elevation six inches above the design high water elevation.
- Adequate maintenance access from public or private right-of-way to the basin will be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the riser/outlet.
- The placement of retention/detention basins within a floodplain of a stream, creek, or lake is prohibited.
- When a storage basin is proposed with a top elevation above any possible basement levels (existing or proposed) that are within reasonable influence of groundwater mounding a hydrogeological study shall be performed to verify that the proposed basin will not cause adverse effects on the basements. Groundwater mounding is the underground piling up of water as it tries to infiltrate through the soils. Usually the courser the soils the less mounding effect there is and vice versa.
- The use of underground retention/detention on new and existing developments is

strongly discouraged and prohibited on drains proposed to be under the jurisdiction of the Drain Commissioner. Exceptions may be granted if each of the following conditions exists:

- Extensive soils information is available to at least ten (10) feet below the bottom of the proposed system and the soils are classified as sand.
- A catastrophic property loss results in the need to rebuild an existing commercial facility that was not previously equipped with retention/detention, and the installation of an aboveground retention/detention, facility would significantly reduce the available square footage for a replacement structure.
- No public drainage system is available, within a reasonable distance, to tie into.
- The provision of aboveground retention/detention on an existing commercial parcel less than two acres in size would preclude development of the property under its current zoning.

- Setbacks shall be as follows:
  - Adjacent property line: 10 feet
  - Building foundation: 30 feet
  - Private well: 50 feet
  - Public well: 200 feet from Type I or Type II a wells, 75 feet from Type IIb or Type III wells (Safe Drinking Water Act, Act 399, PA 1976)
  - Septic system drain field: 100 feet
- Inlet Design
  - Inlet pipes shall not be fully submerged at normal pool elevations.
  - Any inlet pipes must enter the basin and discharge a minimum of one foot above the bottom of the basin.
  - 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 8 feet per second.
  - Pretreatment is required for each inlet and shall 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. Pretreatment for overland sheet flow entering the basin can be provided through a vegetated filter strip.
  - 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 pretreatment.
- Primary Overflow
  - All detention basins must have a primary overflow at the design high water level.
  - When possible, retention basins must have a primary overflow at the design high water level.
  - The primary overflow and downstream pipe shall be designed to convey the 10-

year peak inflow at the maximum design high water level. The depth of water at the crest of the secondary emergency overflow is the maximum design high water level.

- Hoods and trash racks shall be placed on riser pipes. Grate openings shall be a maximum of 3 inches on center.
- Riser pipes shall have a minimum diameter of 24 inches. Riser pipes greater than 4 feet in height shall be a minimum of 48 inches in diameter.
- 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 due to lack of durability.
- When possible, a drain for completely dewatering the retention basin shall be installed for maintenance purposes.
- Pipes placed through embankments shall have anti-seep collars.
- 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 8 feet per second.

- Secondary Emergency Overflow
  - There shall be assurance of no adverse effects downstream: The Proprietor (developer) shall be responsible for assuring that the required maximum outlet discharge rate is not exceeded after the system is built. A standpipe or orifice outlet system with an emergency over-flow capable of handling the 100-year storm is required.
  - An emergency overflow spillway shall be specified, and it must have permanent erosion protection. The spillway must be capable of passing flow equivalent to the 100-year storm rate. Calculations shall be submitted for each emergency overflow spillway.
  - The spillway shall be designed for the 10-year peak inflow with a maximum flow depth of 1 foot. The spillway shall be sized using the weir equation:

$$Q = 2.6\ L\ H^{\frac{2}{3}} \qquad (4.18)$$

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)

  - Freeboard: The top of berm elevation shall be a minimum of 0.5 foot above the design flow depth over the spillway. In no case shall the spillway depth (distance between spillway crest and top of berm) be less than 1 foot.
  - Overflow spillways shall be protected with concrete, riprap, or a permanent erosion control blanket (preferred) to prevent erosion of the structure. Protection shall extend across the entire spillway up to the top of berm, start on the basin side a minimum of 3-feet below the spillway crest and extend down the spillway to an apron a minimum of 6-feet beyond the toe of the spillway.

Detention Basins

The temporary storage of stormwater in a basin with a structural outlet that empties over a relatively short period of time will be allowed if a retention basin is not allowable and if proper provisions are made for an acceptable outlet. It shall be the Proprietor's responsibility to assure that the detention system performs according to these Rules. Detention basins are necessary to minimize stream bank erosion, sedimentation, flood, and pollutant increases that commonly occur because of development.

Summary

- Description: Provides stormwater storage with a surface outlet.
- Types: Dry Basin; Underground Vault; Extended Detention Basin; Wet Pond; Constructed Wetland.
- Pretreatment Required: Yes.
- Maintenance Plan: Yes.
- Rate Reduction: Calculated release rate.
- Water Quality: Dry Basin: Count volume detained. Underground Vaults: Count volume detained. Extended Detention: Count volume detained 24 hours. Wet Pond: Count volume of permanent pool. Constructed Wetland: Count volume of permanent pool.

Sizing Calculations

- Calculate the allowable release rate and the required storage volume for flood control as outlined in “Calculating Storage Volumes and Release Rates, Flood Control, Detention.”
- The volume of a detention basin in Barry County below the lowest point of outlet discharge shall be greater than the volume of a rainfall over its tributary area. This is called the "wet" volume and helps treat the "first flush" which usually contains a significant amount of pollutants.
- Detention Basins shall be sized by determining the difference in volumes between inflow and outflow. The inflow shall be calculated based on the 100-year storm and the rainfall duration frequency table whose duration matches the time of concentration of the basin's tributary area completely developed. Discharge that increases as the basin fills shall be limited as described below. Hydrology and hydraulic calculations shall be submitted verifying this.
- Detention basins shall have a controlled outlet system that limits discharge to the pre-development 2-year storm rate or 0.2 cfs/acre whichever is less.
- Extended detention volume provided for water quality treatment and/or channel protection may be included in the flood control volume. Where channel protection and water quality treatment are provided through upstream retention BMPs, these volumes may be subtracted from the total inflow volume.
- Detention basins without an acceptable surface water overflow route shall be designed for 2 times the required flood control volume.

Design Requirements

- Soil borings are required as outlined in “Soils Investigation.”

- A minimum of 2 feet is required between the bottom of dry detention basins and the highest known groundwater elevation.
- A minimum of 1 foot is required between the bottom of extended detention basins and the highest know groundwater elevation.
- Wet ponds and constructed wetlands shall have a reliable supply of baseflow or groundwater to support a permanent pool.
- A constructed wetland must have a minimum contributing drainage area of 10 acres (5 acres for a pocket wetland).
- 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.

- Off-site Water
  - Surface water flows from offsite land shall be routed around the development's on-site stormwater system unless otherwise approved by the Drain Commissioner.
  - If the detention basin discharges to private property, permission from this landowner will be necessary.
- General
  - Distances of flow paths between inlets and outlets shall be maximized. A minimum basin length-to-width ratio of 3 to 1 is required.
  - If site constraints preclude placing pipes at opposite ends of the basin or meeting the length-to-width ratio, baffles (berms) may be used to lengthen the flow path.
  - Where steeper side slopes than those specified are unavoidable, safety railing, fencing, or other access barriers may be approved.
- Dry Basin
  - The design high water depth should generally not exceed 10 feet above the bottom of the basin.
  - 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.
- Wet Pond
  - 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.
  - 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.
  - 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.
  - The design high water depth should generally not exceed 10 feet above the

permanent pool elevation.

- 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%.
- Warning signs prohibiting swimming and skating shall be posted for wet ponds.

- Constructed Wetland
  - 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.
  - 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.
  - 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.
  - The 100-year water surface elevation shall not exceed the normal water surface elevation by more than 4 feet.
  - 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.
  - A micro pool shall be located at the outlet of the stormwater 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.
  - A pocket wetland shall consist of a forebay and micro pool with safety ledges.
- The outlet shall consist of a multi-stage outlet and include a low flow orifice or multiple orifice openings, a primary overflow (typically provided through the top of a grated riser pipe), and a secondary emergency overflow spillway.
- Low Flow Outlet
  - The low flow outlet may be designed using the orifice equation, rearranged to solve for area.

$$A = \frac{Q}{c\sqrt{2gH}} \qquad (4.19)$$

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)

  - Other types of outlet devices shall have full design calculations provided for review.
  - The outlet shall be designed to prevent clogging.

- Pipes or orifice plates shall have a minimum diameter of 4 inches.
- Orifices used to maintain a permanent pool shall be designed to withdraw water a minimum of 2 feet below the normal water surface.
- 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.
- A gravel filtration jacket consisting of 3-inch washed stone and 1-inch washed stone must be placed around all riser pipes. The orifice configuration must be wrapped with hard wire mesh with an appropriate opening size to prevent any stone from passing through the orifice. The 3-inch stone must be placed immediately adjacent to the riser pipe with the 1-inch stone covering the larger stone. The gravel jacket must extend sufficiently above all orifice patterns.

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

Retention Basins

The temporary storage of stormwater in a basin with no outlet except infiltration into the soils and evapotranspiration will be encouraged as the storage system of choice provided soil conditions are proper. Constructed or natural low areas that have no way for stormwater to escape across the surface will be considered retention basins and shall conform to the following criteria.

Summary

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

Sizing Calculations

- Calculate the required storage volume for flood control as outlined in “Calculating Storage Volumes and Release Rates, Flood Control, Retention.”
- The total volume of the basin shall exceed the runoff volume from a 100-year storm, 24-hour duration, below the free board volume. The rainfall duration frequency table shall be used with the Rational Method to determine the rainfall intensity for a rainfall duration equal to the time of concentration. Calculations used to determine this volume must be submitted.
- Each retention basin shall be sized to store the entire 100-year storm volume. No credit or reduction in volume will be given for infiltration (unless Drain Commissioner determines that a variance is justified) or evaporation.
- Runoff coefficients used to determine the stormwater volume shall follow the recommendations. Weighted runoff coefficient determination calculations shall be

submitted for review.

- 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 from field permeability tests or Table 5.

$$A = \frac{12Vs}{i(t_d)} \qquad (4.20)$$

A = minimum infiltration area (square feet)

V_s = storage volume (cubic feet)

i = design infiltration rate of soil (inches per hour)

t_d = maximum allowable drawdown time (hours)

12 = factor to convert inches to feet

- All stormwater entering a retention basin must infiltrate into the soil within 72 hours. To assure this will happen, calculations must be submitted showing that the basin is sized and shaped so that water will be gone within 72 hours. The most limiting saturated hydraulic conductivity of the soils shall be used for these calculations. The method used to determine the hydraulic conductivity preferred by the Drain Commissioner is to use Table 5 which uses USDA soils classification terminology. Laboratory tests to determine the hydraulic conductivity sometimes do not represent the actual conductivity after construction equipment has run over the soils, and after some siltation therefore lab testing is discouraged. Once a saturated hydraulic conductivity is determined it is recommended that half of its value be used for the calculations. It is the Proprietor's sole responsibility to assure the stormwater infiltrates in less than 72 hours. If it does not, modifications including enlarging of the basin, will be required and the cost will be completely covered by the Proprietor. Retention basins will not be considered where the most limiting soil's saturated hydraulic conductivity rate is 0.52 inches per hour.
- The infiltration area shall be defined as the bottom of the basin, or the horizontal projection of the side slopes up to half of the design water depth above a permanent pool.
- Where channel protection and water quality treatment are provided through upstream retention BMPs, these volumes may be subtracted from the total inflow volume. If provided in the same retention basin, channel protection and water quality volumes are included in the flood control volume.
- Retention basins without an acceptable surface water overflow route shall be designed for 2 times the required flood control volume.

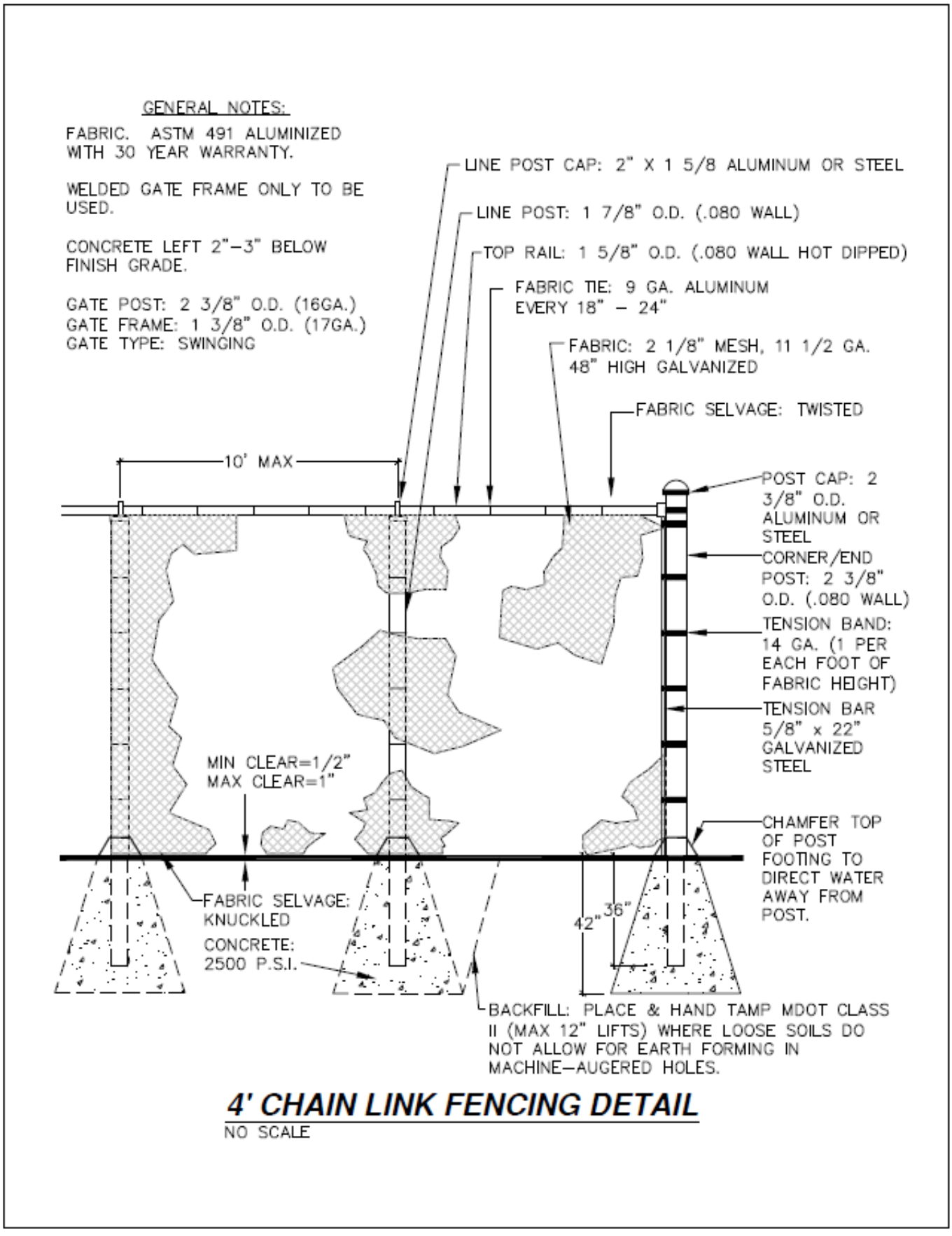
Design Requirements

- The total tributary area to a retention basin shall not exceed 50 acres unless the Drain Commissioner grants a variance to this rule. A sketch or drawing showing the tributary area to each basin must be submitted. The "developed" tributary area(s) should match the "pre-developed" tributary area(s) as closely as practical.
- A forebay for sediment removal shall be provided in each retention basin. The volume of this forebay shall be 5% of the 100-year, 24- hour duration storm. The forebay may be made by constructing a stable berm with erosion control gabion baskets, or other methods acceptable to the Drain commissioner. The overflow

elevation from the forebay into the remainder of the retention basin shall be lower than the invert elevation of the lowest inlet pipe.

- No basin volume will be considered if it is below the seasonal high groundwater level as determined by the design engineer.
- Credit for retention volume in flooded parking lots will not be allowed.
- Soil borings are required as outlined in "Soils Investigation."
    - A minimum of 3 feet is required between the bottom of dry retention basins and the highest known groundwater elevation.
    - Soil borings/backhoe cuts shall be performed in every retention basin area. A minimum of one shall be performed and for basins larger than one (1) acre one boring/cut shall be done for every acre of water surface area of the basin when full. The boring(s) /cut(s) shall extend to at least ten (10) feet below the proposed bottom (lowest elevation) of the basin. Soil logs must be submitted classifying each soil type encountered using USDA terminology.
- Dry Basin
    - The design high water depth should generally not exceed 7 feet above the bottom of the basin.
    - The bottom of dry retention basins shall be flat to encourage uniform ponding and infiltration.
    - The bottom of dry retention basins shall be scarified to a depth of 4 to 6 inches after final grading has been established.
    - Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.
- Wet Pond (no surface water outlet)
    - The design high water depth should generally not exceed 7 feet above the permanent pool elevation.
    - 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%.
    - Warning signs prohibiting swimming and skating shall be posted for wet ponds.
- Supplemental measures may be required to ensure that a retention basin drains sufficiently as the soil becomes less permeable with use. The need for supplemental measures may be based on several indicators including:
    - Soils with a design infiltration rate between 0.50 and 1.63 inches per hour (Sandy Loam).
    - High probability for sedimentation (particularly fines).
    - Larger regional basin where there is less control over contributing area runoff.
    - Probability of groundwater rising higher than minimum isolation distance.
- Supplemental measures may include:

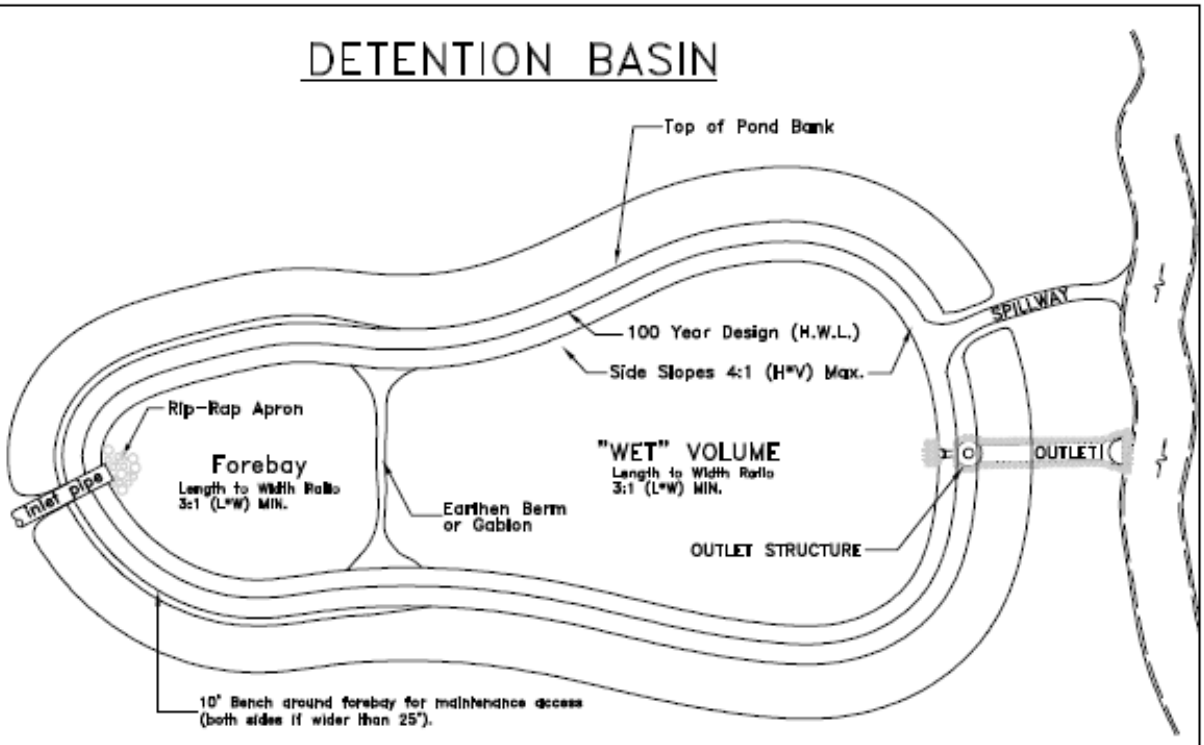
- Leaching basins or infiltration trench placed in the bottom of the basin.
- Valved outlet to drain basin.
- Conversion to a wet basin with sufficient storage volume provided above the permanent pool for reduced infiltration area.



4' CHAIN LINK FENCING DETAIL

NO SCALE

DETENTION BASIN

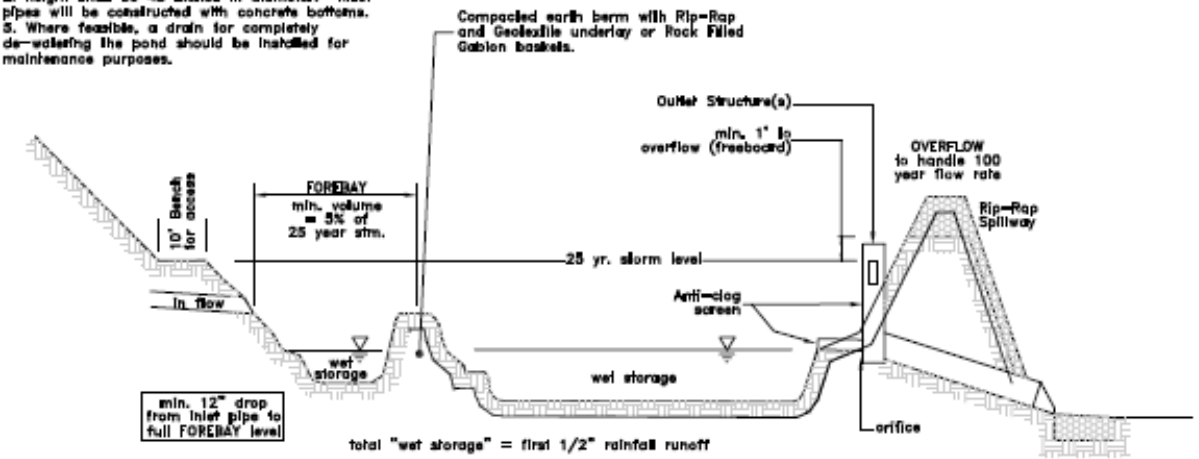


NOTE:
1. The use of a perforated standpipe-type riser structure or an orifice plate to assure an appropriate detention time for all storm events is required.
2. Hoods or trash racks shall be installed to prevent clogging. Grate openings shall be a maximum of three inches.
3. The riser shall be placed near the pond embankment to provide for ready maintenance access.
4. Barrels and risers will be constructed of materials that will reduce future maintenance requirements. The riser pipe shall be a minimum of 36 inches in diameter for riser pipes up to four feet in height. Riser pipes greater than four feet in height shall be 48 inches in diameter. Riser pipes will be constructed with concrete bottoms.
5. Where feasible, a drain for completely de-watering the pond should be installed for maintenance purposes.

PLAN VIEW
No Scale

NOTE:
A wedge shaped plan view area is preferred.

NOTE:
Total detention basin volume above lowest discharge elevation shall equal the total 25 year storm volume less allowable outlet volume. The 25 year storm used shall be the one that matches the tributary area's time of concentration.

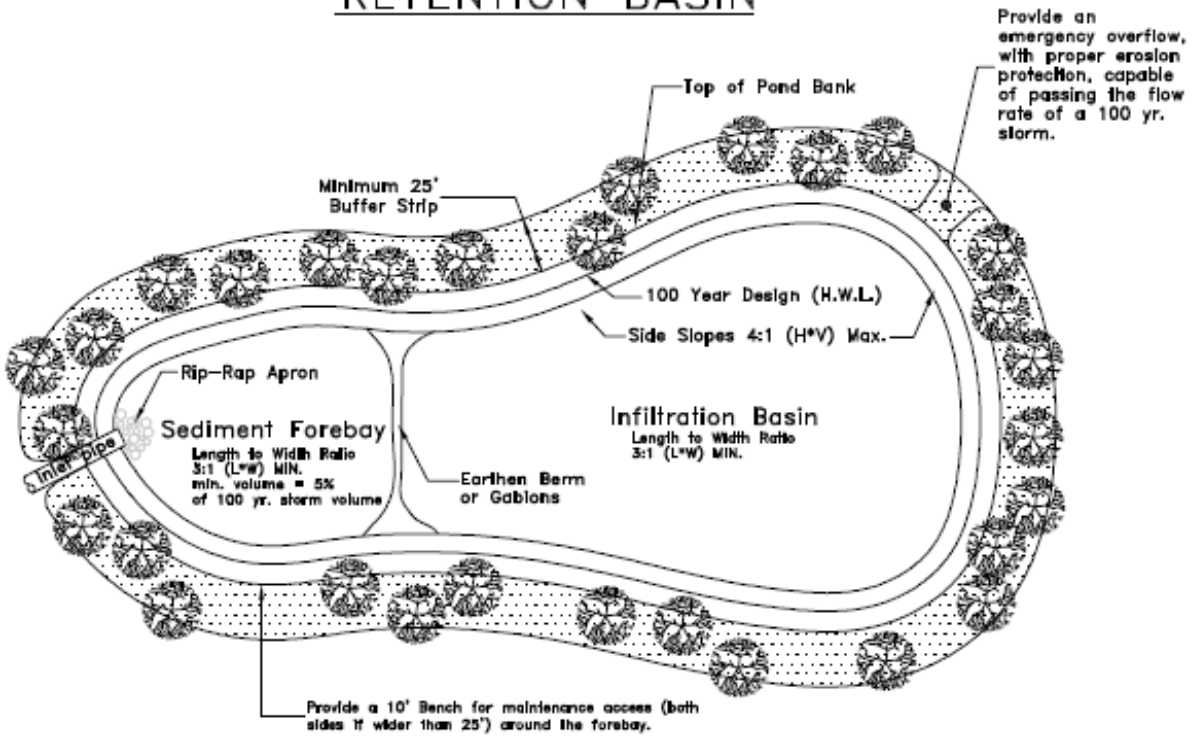


NOTE:
OUTLET DESIGN:
1. All outlets will be designed to be easily accessible for heavy equipment required for maintenance purposes.
2. All outlets will be designed to discharge at an elevation within two feet of the 100-year floodplain elevation for the receiving water body. Discharging at the "crest" of slopes will not be permitted.
3. Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet.

PROFILE VIEW
No Scale

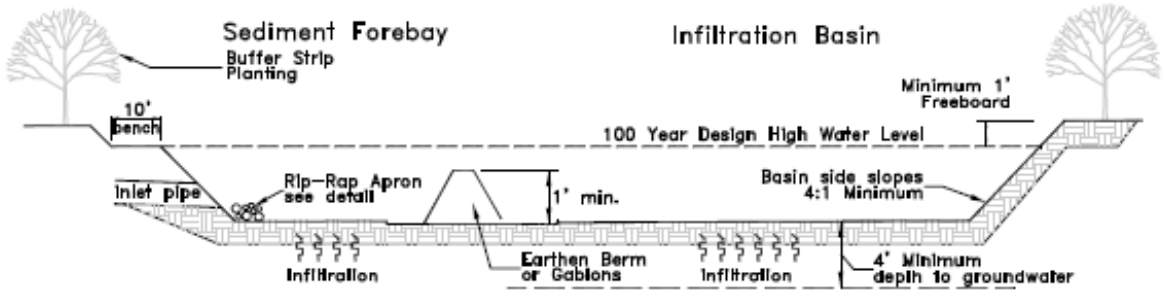
Proprietor responsible for outlet flow rate assurance

RETENTION BASIN



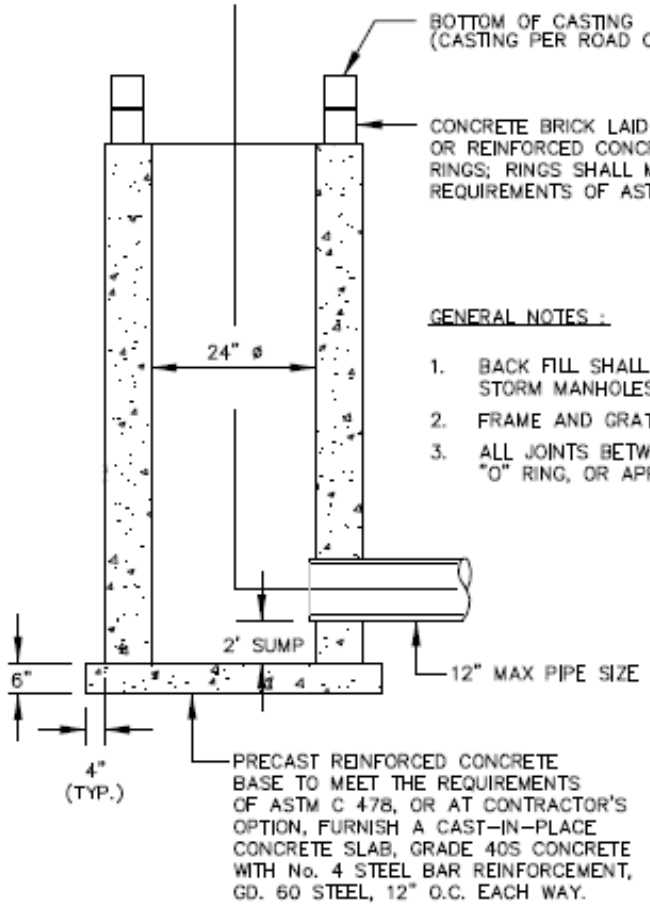
PLAN VIEW

No Scale



PROFILE VIEW

No Scale



GENERAL NOTES :

1. BACK FILL SHALL BE PLACED AS SPECIFIED FOR STORM MANHOLES
2. FRAME AND GRATE AS SPECIFIED FOR STORM MANHOLES
3. ALL JOINTS BETWEEN SECTIONS SHALL BE CEMENT, MASTIC, "O" RING, OR APPROVED EQUAL

24" DIA. INLET DETAIL

NO SCALE

E. Infiltration Practices

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

Sizing Calculations

- Infiltration practices may be sized for channel protection or water quality treatment. Use the methods outlined in “Calculating Storage Volumes and Release Rates” to calculate the required volumes. Use the SEMCOG Method to calculate the required storage volume of the BMP.
- Infiltration practices may be able to provide flood control for small drainage areas.
- Channel protection and water quality volumes may be included in the flood control volume.
- 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 from field permeability tests or Table 5.

$$A = \frac{12Vs}{i(t_d)} \qquad (4.21)$$

A = minimum infiltration area (square feet)

Vs = storage volume (cubic feet)

i = design infiltration rate of soil (inches per hour)

td = maximum allowable drawdown time (hours)

12 = factor to convert inches to feet

- 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.
- Infiltration area shall be defined as:
    - Dry Well/Leaching Basin: Bottom and sides (lateral)
    - Infiltration Trench: Bottom of trench (length x width) and 1/2 the height of each side
    - Infiltration Bed: Bottom area of the bed
    - Infiltration Berm: Ponding area (length of berm x average width of ponding behind berm)
- Calculate the storage volume of the BMP:

- 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, 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

- Leaching basins

  Storage Volume (cubic feet) = Π r 2 (square feet) x Depth (feet)

  r = radius of leaching basin (feet)

  Π = pi (approximately 3.14)

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

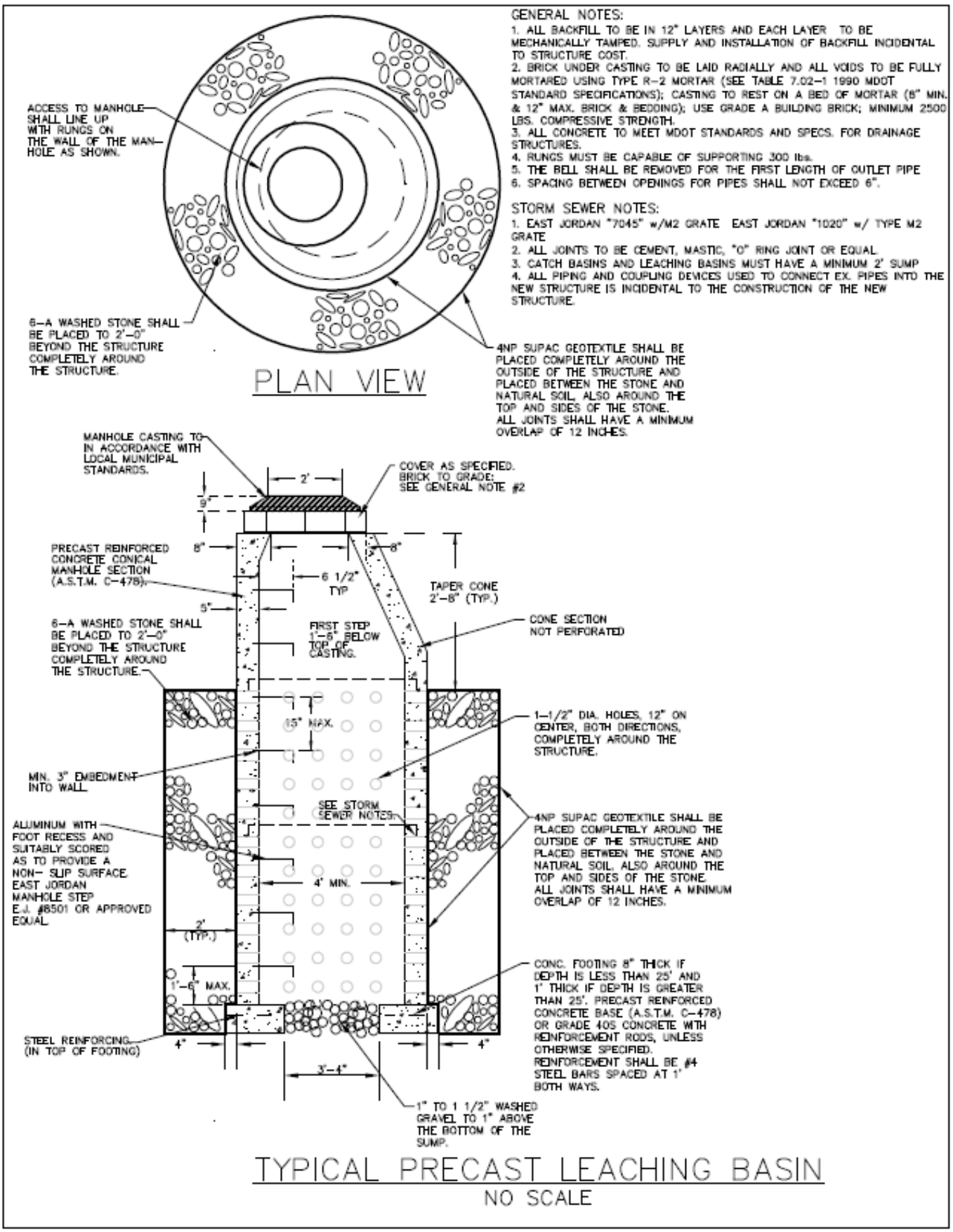
- Infiltration berm

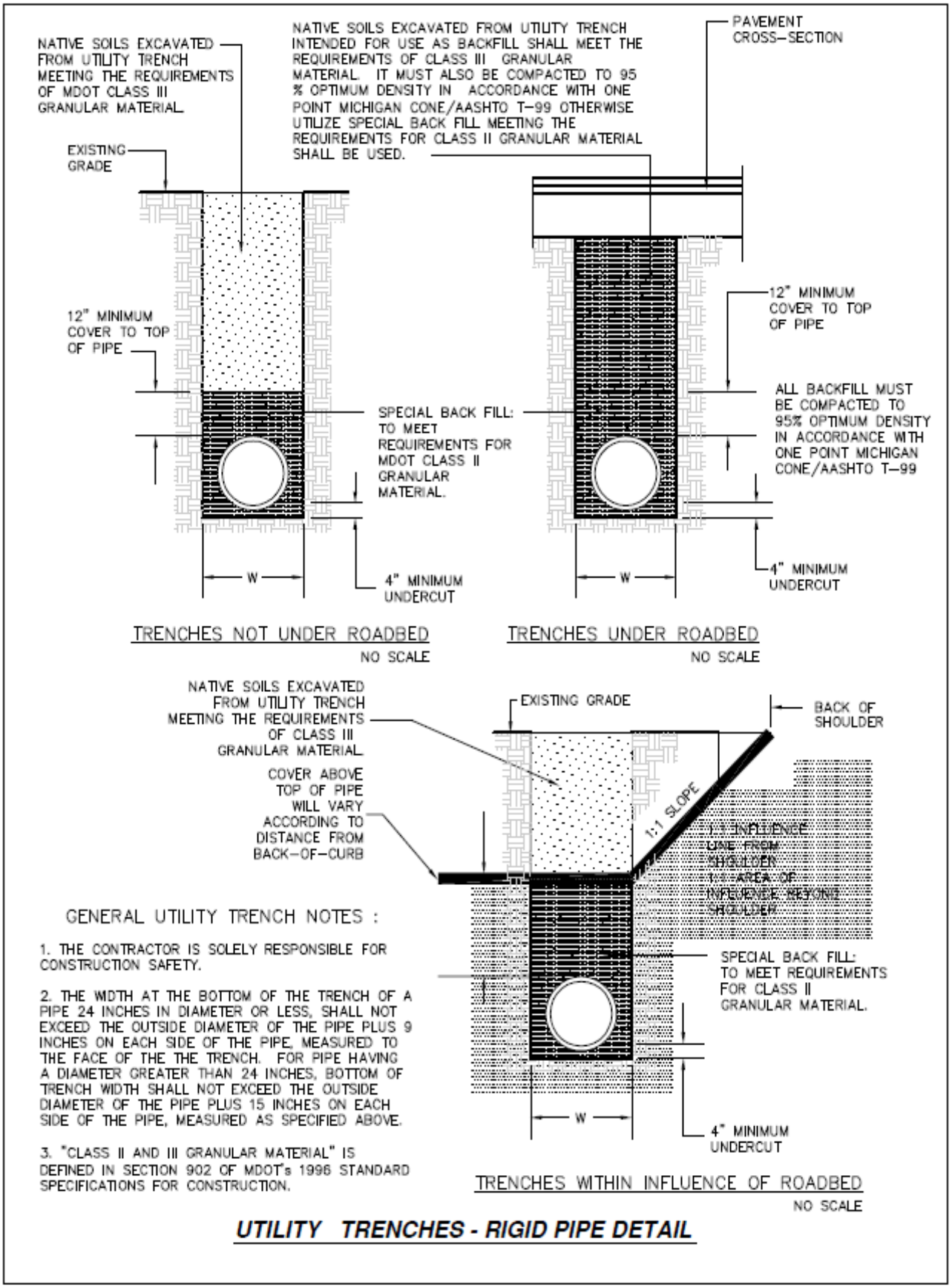
  Surface Storage Volume (cubic feet) = Average Ponding Area (square feet) x Design High Water Depth (feet)

Design Requirements

- Soil borings are required as outlined in “Soils Investigation.”
  - A minimum of 3 feet is required between the bottom of infiltration practices and the highest known groundwater elevation.
  - 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.
- Setbacks shall be as follows:
  - Adjacent property line: 10 feet
  - Building foundation: 10 feet
  - Private well: 50 feet
  - 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)
  - Septic system drain field: 50 feet
- Infiltration practices shall be located outside of the drip line of adjacent trees to avoid root intrusion.
- General
  - A combination of surface and subsurface storage may be used to provide the required storage volume.
- Dry wells, infiltration trenches and infiltration beds
  - Infiltration trench width shall generally be as follows: 3-foot minimum to 6-foot maximum.

  - Coarse 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.
  - 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.
  - Perforated pipes laid flat may be used to distribute runoff over the bottom of infiltration trenches and infiltration beds.
  - Cleanouts shall be provided at pipe ends.
  - Care must be taken during the excavation and finishing process to make sure that soil compaction does not occur.
- Leaching Basins
  - Leaching basins shall have a minimum diameter of 4 feet and meet the layout requirements for catch basins (refer to Part 4 section “Storm Sewer”).
  - 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.
  - 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.
- Infiltration Berms
  - Infiltration berms shall be constructed along (parallel to) contours at a constant level elevation.
  - Maximum berm height shall be 2 feet to prevent excessive ponding behind berm.
  - Berm top width shall be a minimum of 16 feet.
  - Side slopes shall not be steeper than 4:1 (H: V) to facilitate mowing and ensure stable side slopes.
  - Well compacted cohesive soil shall be used to construct the berm.
  - The berm shall be well vegetated to prevent erosion if overtopped.
- Inlet Design Pretreatment 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.
- Emergency Overflow
  - All infiltration practices must have a provision for overflow at the high-water level.
  - Infiltration practices without an acceptable surface water overflow route shall be designed for 2 times the required flood control volume.
- Access Inspection and maintenance access to the infiltration practice shall be provided.


GENERAL NOTES:
1. ALL BACKFILL TO BE IN 12" LAYERS AND EACH LAYER TO BE MECHANICALLY TAMPED. SUPPLY AND INSTALLATION OF BACKFILL INCIDENTAL TO STRUCTURE COST.
2. BRICK UNDER CASTING TO BE LAID RADIALLY AND ALL VOIDS TO BE FULLY MORTARED USING TYPE R-2 MORTAR (SEE TABLE 7.02-1 1990 MDOT STANDARD SPECIFICATIONS); CASTING TO REST ON A BED OF MORTAR (8" MIN. & 12" MAX. BRICK & BEDDING); USE GRADE A BUILDING BRICK; MINIMUM 2500 LBS. COMPRESSIVE STRENGTH.
3. ALL CONCRETE TO MEET MDOT STANDARDS AND SPECS. FOR DRAINAGE STRUCTURES.
4. RUNGS MUST BE CAPABLE OF SUPPORTING 300 lbs.
5. THE BELL SHALL BE REMOVED FOR THE FIRST LENGTH OF OUTLET PIPE
6. SPACING BETWEEN OPENINGS FOR PIPES SHALL NOT EXCEED 6".
STORM SEWER NOTES:
1. EAST JORDAN "7045" w/M2 GRATE EAST JORDAN "1020" w/ TYPE M2 GRATE
2. ALL JOINTS TO BE CEMENT, MASTIC, "O" RING JOINT OR EQUAL
3. CATCH BASINS AND LEACHING BASINS MUST HAVE A MINIMUM 2' SUMP
4. ALL PIPING AND COUPLING DEVICES USED TO CONNECT EX. PIPES INTO THE NEW STRUCTURE IS INCIDENTAL TO THE CONSTRUCTION OF THE NEW STRUCTURE.
ACCESS TO MANHOLE SHALL LINE UP WITH RUNGS ON THE WALL OF THE MAN-HOLE AS SHOWN.
6-A WASHED STONE SHALL BE PLACED TO 2'-0" BEYOND THE STRUCTURE COMPLETELY AROUND THE STRUCTURE.
4NP SUPAC GEOTEXTILE SHALL BE PLACED COMPLETELY AROUND THE OUTSIDE OF THE STRUCTURE AND PLACED BETWEEN THE STONE AND NATURAL SOIL, ALSO AROUND THE TOP AND SIDES OF THE STONE. ALL JOINTS SHALL HAVE A MINIMUM OVERLAP OF 12 INCHES.
PLAN VIEW
MANHOLE CASTING TO IN ACCORDANCE WITH LOCAL MUNICIPAL STANDARDS.
COVER AS SPECIFIED. BRICK TO GRADE: SEE GENERAL NOTE #2
2'
9"
8"
8"
PRECAST REINFORCED CONCRETE CONICAL MANHOLE SECTION (A.S.T.M. C-478).
6 1/2" TYP
TAPER CONE 2'-8" (TYP.)
5"
6-A WASHED STONE SHALL BE PLACED TO 2'-0" BEYOND THE STRUCTURE COMPLETELY AROUND THE STRUCTURE.
FIRST STEP 1'-6" BELOW TOP OF CASTING.
CONE SECTION NOT PERFORATED
15" MAX.
1-1/2" DIA. HOLES, 12" ON CENTER, BOTH DIRECTIONS, COMPLETELY AROUND THE STRUCTURE.
MIN. 3" EMBEDMENT INTO WALL
SEE STORM SEWER NOTES
ALUMINUM WITH FOOT RECESS AND SUITABLY SCORED AS TO PROVIDE A NON- SLIP SURFACE. EAST JORDAN MANHOLE STEP E.J. #8501 OR APPROVED EQUAL
4NP SUPAC GEOTEXTILE SHALL BE PLACED COMPLETELY AROUND THE OUTSIDE OF THE STRUCTURE AND PLACED BETWEEN THE STONE AND NATURAL SOIL, ALSO AROUND THE TOP AND SIDES OF THE STONE. ALL JOINTS SHALL HAVE A MINIMUM OVERLAP OF 12 INCHES.
4' MIN.
2' (TYP.)
1'-6" MAX.
CONC. FOOTING 8" THICK IF DEPTH IS LESS THAN 25' AND 1' THICK IF DEPTH IS GREATER THAN 25'. PRECAST REINFORCED CONCRETE BASE (A.S.T.M. C-478) OR GRADE 40S CONCRETE WITH REINFORCEMENT RODS, UNLESS OTHERWISE SPECIFIED. REINFORCEMENT SHALL BE #4 STEEL BARS SPACED AT 1' BOTH WAYS.
STEEL REINFORCING (IN TOP OF FOOTING)
4"
4"
3'-4"
1" TO 1 1/2" WASHED GRAVEL TO 1" ABOVE THE BOTTOM OF THE SUMP.
TYPICAL PRECAST LEACHING BASIN
NO SCALE



UTILITY TRENCHES - RIGID PIPE DETAIL

APPENDICES

APPENDIX A – Checklists:

- Preliminary Plat Review
- Construction Plans
- Final Plat Review
- County Drain Submittal
- Private Development Submittal
- Stormwater Review (and Stormwater Worksheet)

BARRY COUNTY DRAIN COMMISSIONER'S
PRELIMINARY PLAT REVIEW CHECK LIST

- ☐ Preliminary Plat plan shall be sealed by a Professional Engineer or registered Land Surveyor licensed by the State of Michigan.
- ☐ The Preliminary Plat plan shall be represented on 24" x 36" paper with a scale no smaller than 1" = 100' (1" = 200' is not acceptable).
- ☐ Submit four (4) copies of the Preliminary Plat, Construction Plans, Design Criteria/calculations, and appropriate fees.
- ☐ Indicate the plat name, Proprietor's name, and preparer's name (Engineer or Surveyor) along with mailing addresses, fax and telephone numbers, and email addresses (if available) for each.
- ☐ Included a location map showing section lines and numbers, town and range, roads and names, municipal boundaries, prominent water features, north arrow, legal description of the parcel to be platted, and an engineer's scale (if possible).
- ☐ Provide a Legend on each sheet of the plans.
- ☐ Show relevant features on the plans such as roads, right of ways, developments, easements, building setback lines, property lines, adjacent property ownership, structures, railroads, power lines, utilities, watercourses, wetlands, etc.
- ☐ Show all existing and proposed drainage courses and structures including pipes, swales, basins, erosion control measures, fences, outlets, soil borings, culverts, County Drains, and depressions with proper labeling as to type, size and invert elevations.
- ☐ Show lot dimensions (scaled or computed) and lot numbers on the plat plan.
- ☐ Include overall plat boundaries including all possible future expansions, phase to be approves clearly designates, and plat acreage.
- ☐ Provide a typical lot grading plan detail, with information regarding typical drainage, drainage arrows and the minimum house opening elevation.
- ☐ Show any offsite watershed areas that drain onto the proposed plat (with boundaries, land use and acreage's).
- ☐ Indicate the 100-year flood plain contour (existing and proposed).
- ☐ Indicate contour lines based on USGS datum at 2' intervals to a least 100' beyond the plat boundaries and further if adjacent property drains towards the proposed plat.
- ☐ A plan showing the future phases (if there are any) of the over-all development shall be provided.
- ☐ Indicate soil types using available soils data, and soil borings or backhoe cut results. Include logs and locations plus ground elevations and water table information. Soils shall be classified using USDA terminology.
- ☐ Show parcel numbers, Liber and Pages of recorded documents in and adjacent to the proposed plat.
- ☐ Provide a USGS (NGVD 88) benchmark description.
- ☐ Provide an overall metes & bounds property description (with ties to government corner) of the proposed plat.

BARRY COUNTY DRAIN COMMISSIONER'S
CONSTRUCTION PLAN CHECK LIST

General

- ☐ Provide electronic file (format shall be comparable with county's system) of plans once plans are approved.
- ☐ Submit 3 sets of 24" x 36" plans and 3 sets of design calculations along with fees.
- ☐ The minimum scale used on plans shall be: 1" = 50' (1" = 60' not acceptable; over- all hydrology plan may be larger) 1" = 40' for plan and profile plans
- ☐ Plans shall be sealed by a Professional Engineer licensed in Michigan.
- ☐ Provide name, address, and phone number for the Proprietor and engineer on the cover sheet.
- ☐ Show a sheet number, project name, revision date, north arrow, and graphic scale on each page.
- ☐ Provide a location map on the cover sheet.
- ☐ Show in large text the proposed development's name on the cover sheet, and in the border or title block of all other sheets.

Over-all Hydrology Plan

- ☐ Show the entire watershed that drains across the proposed development at whatever scale necessary.
- ☐ Indicate any phases for future growth of the development and clearly show which phase is requesting approval.
- ☐ Provide a legal description of the development with total acreage; provide approximate acreages for all phases.
- ☐ Show contour lines at no less than 2-foot intervals using USGS datum for the entire watershed. If the watershed extends more than 300 feet beyond the development boundaries USGS Quadrangle Topography can be used
- ☐ Indicate existing and proposed stormwater drainage flow patterns using arrows.
- ☐ Show existing utility, and transportation systems along with land uses, water features, and drainage courses.

Site Grading Plan(s)

- ☐ Provide at least one benchmark elevation, location, and description per sheet.
- ☐ 2 foot or less existing and proposed contour lines using USGS datum shall be shown.
- ☐ Indicate flow arrows showing surface water runoff directions.
- ☐ Show all stormwater conveyance items such as inlets, manholes, pipes, and swales, label elevation, sizes, types, and slopes.
- ☐ Show any 100-year flood plain, existing or proposed, that is within the boundary of the project. This includes stormwater storage basins and low areas that have no outlet.

- ☐ For all stormwater storage areas show the volume, top elevations, bottom elevation inlet structure details outlet structure details and freeboard.
- ☐ Indicate minimum basement opening elevations.
- ☐ Provide permanent and temporary erosion control measure locations, details, and specifications.
- ☐ Show specifications for establishing vegetation in all areas disturbed by construction.
- ☐ All proposed easements shall be shown, and stormwater related easements shall be dimensioned. A note stating that no septic tanks or drain fields may be placed within a stormwater related easement shall be provided (where public sanitary sewer is not going to be constructed only).
- ☐ Indicate tributary areas to each stormwater intake location unless a reduced version of this information is being provided with calculations.
- ☐ Calculations for storage basins shall be in accordance with the Design Criteria section of these Rules.
- ☐ Provide flood routing information to show what would happen if the conveyance systems were overloaded or plugged.
- ☐ Include typical cross-sections of swales, pipe trenches, structures, erosion control measures, etc. Provide details and specifications for erosion control in swales and at end sections. Indicate backfill and compaction specifications. All dimensions needed for construction shall be shown. Covers, materials, minimum depths, etc. will be required to be noted.
- ☐ Label pipe material type, class, length, slope (%), invert elevations, and burial depth for each pipe run.
- ☐ Provide sufficient information describing the outlet pipe system.
- ☐ Label rim or flow line elevations for every structure.
- ☐ Place stormwater intake structures every 300 feet or further if appropriate calculations are provided to show that flow to the structure is less than 1 cfs for a 10-year storm.
- ☐ The minimum pipe cover shall be 18" for 12" pipe. Minimum cover for larger pipe shall meet local authority specifications or MDOT's requirements.
- ☐ Designate the total tributary area to each stormwater storage basin. No tributary area to a basin shall exceed 50 acres unless a variance is granted by the Drain Commissioner.
- ☐ Show soil boring or backhoe cut locations on the plan (s). Provide soil-boring logs for each and classify soils using USDA terminology. A minimum of one boring/cut shall be performed per acre of storage basin. The boring/cut (s) shall extend a minimum of 10' below the proposed bottom of each basin.
- ☐ Show details and specifications for emergency overflow weirs of detention basins and design them to handle the 100-year flow rate.
- ☐ Provide details and specifications for flow rate control orifices (or other similar system).
- ☐ Provide proof of adequate outlet system for detention basins along with permission form appropriate agencies.
- ☐ Pipes entering a stormwater storage basin shall be a minimum of 12" above the bottom of the basin.

- ☐ If fence is required show its location along with appropriate gate and provide details and specifications.
- ☐ Some developments are intricate enough that plan and profile sheets and/or detail sheets will be necessary to communicate all information about the stormwater facilities. If public sewer or water is proposed in the development, plan and profile sheets at 1" = 40' scale will be required.
- ☐ If details, specifications, storage basin data, etc. need a separate sheet(s) to clearly explain what is proposed, then they shall be included. Retention basins can be man-made or an existing low area. If the existing low area is wetland, an EGLE permit may be required.
- ☐ On-site retention will be required of all developments unless a positive outlet is acquired to a natural stream approved by the DEQ, to a County Drain approved by the Drain Commissioner or to a roadside drainage system approved by the Road Commission or local municipality.
- ☐ In some cases, stormwater infiltrating into the soil may "stack-up" on top of ground water and cause adverse effects on adjacent property. This is known as ground water mounding. If the proposed development has the potential to do this the Drain Commissioner will require a hydrogeological study. This study must show that the ground water mounding will not affect easements, structures, lawns, etc. for the proposed basin location to be considered. The study must be performed by a qualified professional.

Plan and Profile Plans(s)

- ☐ If plan and profile drawings are necessary, they shall be prepared at a horizontal scale of 1" = 40' and vertical scale of 1" = 4'. All pipes shall be shown and labeled.

BARRY COUNTY DRAIN COMMISSIONER'S
FINAL PLAT REVIEW CHECK LIST

- ☐ Submit two (2) sets of prints and one (1) set of mylars of the proposed Final Plat along with fees.
- ☐ To perform initial maintenance on the stormwater management facilities after the plat has been recorded, a maintenance fund will be set up by the Drain Commissioner in the name of the Drain District (usually the plat lot owners). A $2500.00 fee will be required from the Proprietor prior to granting Final Plat approval to set up this account. The Drain Commissioner may require less if the plats' stormwater facilities are so minimal that a fund less than $2500.00 is warranted. This decision is solely at the Drain Commissioner's discretion.
- ☐ Provide two (2) copies of the recorded easements outside the plat boundaries. Liber and Page must be shown.
- ☐ Provide proposed deed restrictions.
- ☐ Provide evidence of municipal approval.
- ☐ Submit the fully executed "433 Agreement."
- ☐ Submit "As-Built" drawings on mylar.
- ☐ Provide the engineer's verification.
- ☐ Reconstruction approval; provide the following:
    1. Cost opinion of construction yet to be finished
    2. Copies of any permits required for construction
    3. Payment of the appropriate fees
    4. All items in the above check list except as-builts
    5. Acceptable financial surety

SUBMITTAL CHECKLIST

(County Drain)

Development Name: _____	Date: _____
Location: _____	Reviewed By: _____

		Date Received	Date Accepted
Required for Site Plan Approval			
1.	Completed Site Plan Review Application form.	_____	
2.	Preliminary Plat; or Construction drawings, including calculation package – one (1) print, one (1) electronic PDF file, and one (1) electronic XLSX file of calculations (if requested).		
3.	Restrictive Covenant or master deed language, including certification of minimum floor and opening elevations by Design Engineer.	_____	
4.	Maintenance Plan; and Maintenance agreement and exhibits (between Proprietor and Drain Commissioner, if maintenance is to be performed by private entity).	_____	
5.	Recorded Drain Easements provided in the name of the Drainage District.	_____	
6.	Performance surety.	_____	
7.	Section 433 Agreement; Section 425 Application; or letter of commitment from local municipality, governmental agency or association.	_____	
8.	Certification by Design Engineer of adequacy of receiving drains.	_____	
9.	Specifications for construction of drain components	_____	
10.	Review fees and deposit (if any).	_____	

SUBMITTAL CHECKLIST

(County Drain)

		Date Received	Date Accepted
Upon Completion of Construction			
11.	Itemized cost of construction for County Drain work.		
12.	Inspection reports (for work on County Drain only).		
13.	Final acceptance of County Drain by Drain Commissioner.		
14.	Acceptance of public roads by County Road Commission.		
15.	Certification by registered Professional Engineer that construction of County Drains has been completed in accordance with approved construction drawings.		
16.	Construction record drawings ("As-builts") - one (1) print, one electronic (1) PDF file, and one (1) electronic DXF file.		
17.	Final Plat submitted for review.		
Prior to Final Plat Approval or Release of Surety			
18.	Evidence of municipal approval of Preliminary plat.		
19.	Recorded restrictive covenants or master deed.		
21.	Recorded maintenance agreement (if required).		
22.	Recorded 433 Agreement.		
23.	Route and course description.		
24.	Drainage District map and legal description.		
25.	Drain maintenance fee (per Section 433).		
26.	Drain Commissioner signs Final Plat (within 10 days).		
27.	Drain Commissioner accepts Construction Drawings (within 30 days).		
28.	Drain Commissioner returns remaining surety and review deposit (if any).		

SUBMITTAL CHECKLIST

(Private Development)

Development Name: _____ Date: _____

Location: _____ Reviewed By: _____

		Date Received	Date Accepted
Required for Site Plan Approval			
1.	Completed Site Plan Review Application form.		
2.	Preliminary site plan; or Construction drawings including calculation package – one (1) print, one (1) electronic PDF file, and one (1) electronic XLSX file of calculations (if		
3.	Restrictive covenant or master deed language, including certification of minimum floor and opening elevations by Design Engineer.		
4.	Recorded drainage easements.		
5.	Drain permit application (if required for maintenance to existing County Drains).		
6.	Review fees and deposit (if any).		
7.	Escrow account and financial guaranty (if required by municipality).		
Upon Completion of Construction	*Prior to Certificate of Occupancy, return of remaining escrow amount, and release of financial guaranty*		
8.	Recorded restrictive covenants or master deed.		
9.	Land survey elevation certificate for minimum building opening (if applicable).		
10.	Certification by registered Professional Engineer that stormwater management facilities and work on County Drains has been completed in accordance with approved construction drawings.		
11.	Construction record drawings ("As-builts") - one (1) print, one electronic (1) PDF file, and one (1) electronic DXF file.		

STORMWATER REVIEW CHECKLIST

Development Name: _____ Date: _____

Location: _____ Reviewed By: _____

CONCEPT REVIEW MEETING

The following information must be provided at a minimum:

		Provided/ Satisfactory	Comments
1.	Location map (include sections and watershed or Drainage District boundaries).	☐	_____
2.	Acreage of the total site and acreage of disturbed area, including proposed percent impervious.	☐	_____
3.	Description proposed development and location of proposed activities impacting stormwater and drainage both on and off the site.	☐	_____
4.	Conceptual layout of proposed stormwater management system, if known.	☐	_____

PRELIMINARY PLAT OR SITE PLAN DRAWINGS

The following information shall be included on all preliminary plats or site plans submitted for approval. Sheets shall be no larger than 24" x 36" at a scale no smaller than 1" = 100' and prepared by a Professional Engineer or Surveyor licensed in the State of Michigan.

		Provided/ Satisfactory	Comments
General			
1.	Development name/subdivision number.	☐	_____
2.	Name, address, and telephone number of Developer.	☐	_____
3.	Name, address, telephone number, email, signature, and seal of the Design Engineer (and/or Surveyor).	☐	_____
4.	Description of location (section and fractional portion thereof; town and range; township, city or village; county; state).	☐	_____
5.	Location map.	☐	_____
6.	North arrow, scale and legend.	☐	_____
Site Layout			
7.	Number of acres to be developed.	☐	_____

STORMWATER REVIEW CHECKLIST

8.	Development boundary with legal property description tied to government corners.	☐	_____
9.	Identification of all adjoining parcels (for subdivisions show address, lot number, subdivision name, liber, and page numbers; for metes and bounds parcels show address and permanent parcel number).	☐	_____
10.	Lot layout with dimensions and lot numbers.	☐	_____
11.	Building setback lines.	☐	_____
12.	Roadway layout (e.g. streets, alleys, non-motorized pathways).	☐	_____

Easements

13.	Utility easements with dimensions, type of utility, and recording liber and page.	☐	_____
14.	Existing drainage easements with name of grantee, dimensions, and recording liber and page.	☐	_____
15.	Proposed drainage easements with name of grantee and dimensions.	☐	_____

Soils

16.	Soil type(s) from County Soil Survey.	☐	_____
17.	Soil borings indicating ground elevation and water table elevations.	☐	_____
18.	Areas of known contamination.	☐	_____

Existing and Proposed Site Features

19.	Existing and proposed contours (no greater than 2' interval inside the plat; no greater than 10' interval outside the plat).	☐	_____
20.	Existing and proposed buildings (label those under construction with address).	☐	_____
21.	Existing and proposed roads with name, right-of-way width, and ownership (public or private).	☐	_____
22.	Location and description of any other on-site and adjacent offsite utilities or features that may be relevant to the site plan (e.g. railroads, high tension power lines, underground transmission lines, sanitary sewers, water mains, septic fields, wells, cemeteries and parks).	☐	_____

STORMWATER REVIEW CHECKLIST

Drainage

23.	Existing watercourses and waterbodies on or adjacent to the development.	☐	
24.	County, municipal, MDOT and private drains (permission required to connect).	☐	
25.	Limits and elevation of 100-year floodplain.	☐	
26.	Wetland boundaries with determination date and company.	☐	
27.	Riparian buffers, natural flow pathways, and other sensitive areas.	☐	
28.	Existing ditches, culverts, storm sewer, drainage structures and stormwater BMPs (with labeling as to type, size, rim and invert elevations).	☐	
29.	Proposed drainage system (clearly identify all open and enclose portions).	☐	
30.	Preliminary layout of proposed stormwater BMPs.	☐	
31.	Ownership of proposed drainage system.	☐	
32.	Stormwater runoff discharge location(s) from the site, including roof water.	☐	

CONSTRUCTION DRAWINGS

The following additional information shall be included on all construction drawings submitted for approval. 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. A final set of approved drawings, updated with date in revision block, must be received before written approval will be granted.

		Provided/ Satisfactory	Comments
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 stormwater BMPs.	☐	
3.	Details of storm sewer and culverts: numbering of manholes/catchbasins; invert and casting elevations; pipe length, diameter, material, slope, class or gauge, joints; special backfill and bedding; inlet/outlet protection; profile of the hydraulic grade line.	☐	
4.	Details of outlet control structures including a scaled detail with dimensions, elevations and hydraulic information matching calculations.	☐	

STORMWATER REVIEW CHECKLIST

		Provided/ Satisfactory	Comments
5.	Lot grading plan (detail, statement, or drainage arrows).	☐	
6.	Minimum opening and basement elevation for each lot.	☐	
7.	A soil erosion and sedimentation control plan with minimum measures and proposed staging.	☐	
8.	Protected sensitive areas, minimal disturbance areas and other "non-structural" BMPs.	☐	
9.	Location of all proposed drain fields. (Drain fields shall comply with isolation distance requirements.)	☐	
10.	Contaminated soil and groundwater procedures (if required).	☐	
11.	Recorded liber and page of easements obtained for the site development.	☐	

MAINTENANCE ASSURANCE

The Design Engineer shall incorporate considerations for access, operation and maintenance into the design of all stormwater BMPs to ensure the stormwater management system can be readily maintained. Specific minimum requirements are included on individual BMP design criteria sheets. The following information must be shown on the construction drawings, and clearly identified on Exhibit B of the maintenance plan (if one is required):

		Provided/ Satisfactory	Comments
1.	Identified access routes for trucks and maintenance equipment, including fences and gates.	☐	
2.	Proper siting, sizing and design of BMPs for accessibility (e.g. outlet control structure access during flood event, steps, turning room, cleanouts, etc.).	☐	
3.	Design of BMP elements to minimize amount of maintenance required (e.g. filters on small orifices, design of trash racks to facilitate debris removal, etc.).	☐	
4.	Design details to illustrate maintenance features (e.g. removable grates or rails, locks, access platforms, etc.).	☐	
5.	Identified areas for staging and temporary spoil disposal.	☐	

STORMWATER REVIEW CHECKLIST

DESIGN CALCULATIONS

Completed by a Professional Engineer licensed in the State of Michigan.

Submit initial design calculations with preliminary submittal (if any). A full set of design calculations shall be submitted with construction drawings. A final set of approved calculations, updated with date, must be received before written approval will be granted.

		Provided/ Satisfactory	Comments
1.	Completed Stormwater Worksheet.	☐	
2.	A drainage map that clearly shows topography, subcatchment boundaries, acreages and flow paths of tributary areas to each point of discharge from the development, including tributary areas originating outside of the development. Also identify tributary areas to inlets, culverts, and other storm water BMPs.	☐	
3.	Calculations of peak discharge for a range of storms up to and including the 100-year storm for any natural water courses and/or County Drains passing through the proposed development, including area of upstream watershed.	☐	
4.	Normal, design and 100-year water elevations, including overland flow routes shown on the drainage map.	☐	
5.	Documentation and/or calculations required to demonstrate an adequate outlet, including the dimensions/sizes and locations of upstream and downstream drainage routes and infrastructure.	☐	
6.	Calculations of stormwater rates and volumes for each point of discharge or treatment train for pre-development and post-development conditions for the design storms.	☐	
7.	BMP design calculations.	☐	
8.	Groundwater mounding calculations (when required).	☐	
9.	Design summary report, including at a minimum: description of stormwater management plan for the site, identified contributing areas with land cover types, soils and runoff coefficients, times-of-concentration, runoff volumes, peak discharges, design high water levels, sewer hydraulic grade line, required storage volumes, and volumes provided.	☐	

CONSTRUCTION RECORD DRAWINGS

Sealed by a Professional Engineer licensed in the State of Michigan.

A final set of drawings, updated and marked "issued for construction record" with date in revision block, must be received before release of any security on deposit.

		Provided/ Satisfactory	Comments
1.	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.	☐	_____
2.	Final grading and volume of all detention/retention facilities and integrated BMPs with verification that they meet or exceed approved storage and infiltration capacities.	☐	_____
3.	Pipe inverts, length and slope, manhole and catch basin rims, top of berm, and spillway elevations.	☐	_____
4.	Details of inlet structures (including opening areas and elevations.)	☐	_____

GIS DIGITAL SUBMISSION REQUIREMENTS

Required for final plats and construction record drawings.

1. All files must be submitted in Drawing Exchange Format (DXF).
2. All submitted files must be zipped to ensure they arrive intact.
3. Email or compact disc are acceptable ways to receive files.

Technical Requirements:

1. All lines must be snapped closed (no dangles, overstrikes, or understrikes).
2. Layers must have a reasonable label of what can be found on each layer.
3. The following separate layers must be included:
    a. Lot Numbers.
    b. Lot Lines.
    c. Lot Dimensions.
    d. Right-of-Way Dimensions.
    e. Right-of-Way Names.
    f. Subdivision Boundaries.
    g. Water/Storm/Hydrants/Sewer Lines/Culverts.
    h. Easements.
    i. Easement Dimensions.
    j. Contours.
    k. Any other features of value in determining overall drainage requirements.
4. Lot and right-of-way dimension layers must have nothing more than leaderlines.
5. Hatching must be on one layer with no other items.
6. Layout design and any tables must be in one layer.

STORMWATER WORKSHEET

Project Name:_____ Location: _____

Developer/Owner:_____ Engineering Firm: _____

By (Design Engineer):_____ Date: _____

Sensitive Areas

Indicate on site plan and check below.

(Check all that apply)

☐ Waterbodies	☐ Rivers and Streams	☐ Floodplains
☐ Riparian Areas	☐ Wetlands	☐ Woodlands
☐ Sand Dunes	☐ Natural Drainage Ways	☐ Steep/Erodible/Karst
☐ Susceptible Groundwater	☐ Threatened & Endangered	☐ Other:_____

Special Site Considerations

(Check all that apply)

☐ Coldwater Stream Name:_____	☐ Hot Spot/Brownfield Activity:_____	☐ Policy Watershed Name: _____

Water Quality

Required for all sites.

Channel Protection

Required for surface water discharges.

(Check all that apply)

- ☐ Not required.
- ☐ On-site Retention (must be considered first and foremost).

If site conditions preclude on-site

- ☐ retention: Off-site Mitigation.
- ☐ Payment-in-lieu (subject to availability).
- ☐ Alternative Approach using Extended Detention (submit Engineer's Certification).

Flood Control

Required for all sites.

(Check all that apply)

- ☐ Standard release rate (0.13 cfs/acre).
- ☐ Alternate release rate allowed (describe): _____
- ☐ Floodplain required in lieu of detention.

(Check one)

- ☐ Emergency Overflow Routes available and identified on site plan.
- ☐ No acceptable Emergency Overflow Routes: *buildings protected with redundant storm sewer sized for 100-year storm; detention/retention sized at two (2) times the flood control volume.*

Appendix B – 433 Agreement and Release of Right of Way

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 **Jim Dull, Barry County Drain Commissioner**, hereinafter referred to as "Drain Commissioner" on behalf of the proposed (insert proposed drain name) Drain Drainage District; and (insert Landowner/Developer's name) , a Michigan (insert type of Business) , as owner(s) of the 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 Barry 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 cost 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 (insert drain name) Drain and that the land to be drained will be known and constituted as the (insert drain name) Drain Drainage District and will be subject to assessments, for cost of future operation, inspection, maintenance and improvement; and,

Whereas, Landowner has agreed to assume and pay all cost 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 hereto agree as follows:

1. Landowner agrees to construct and/or has constructed, at its expense, the Drain in accordance with plans and specifications approved by the Drain Commissioner.

2. The Landowner agrees to pay the cost of construction of said Drain and drainage facilities, including the acquisition of the necessary rights of way or easements, engineering, surveying, inspection, legal and administrative cost. In addition, the Landowner has deposited with the Drain Commissioner an amount of money equivalent to five (5%) percent of the cost of construction of the drainage facilities, 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 "(insert drain name) Drain Maintenance Fund."

3. That the Landowner shall secure at its own expense, all easements or rights of way necessary for the construction of the Drain over and across the properties owned by Landowner and across such other lands as necessary for the construction of the Drain from the point of beginning at the outlet of the point of ending. Said easements or rights of way shall be secured in writing and in a form acceptable to the Drain Commissioner. The Landowner shall be responsible for all cost for the recording of said easements, as directed by the Drain Commissioner.

4. 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.

5. The (insert drain name) Drain Maintenance Fund is agreed and understood as being for the sole benefit of the (insert drain name) 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.

6. Landowner agrees to indemnify and hold harmless the Drain Commissioner and the (insert drain name) Drain District for all claims, damages, lawsuits, cost, 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 environment laws and regulations, including all future amendments to such laws or regulations and the administrative and judicial interpretation thereof, except for liability arising out of the gross negligence or intentional wrongful conduct of the Drain Commissioner or its agents.

7. 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 by the duly authorized officers as of the day and year first above written.

In the Presence Of:

(insert drain name) Drain Drainage District

_____

Printed name:_____

Jim Dull
Barry County Drain Commissioner

_____

Printed name:_____

In the Presence Of:

(insert Landowner name)

_____

Printed name:_____

By: _____

_____

Its: _____

_____

Printed name:_____

STATE OF MICHIGAN)
) SS.
COUNTY OF BARRY)

On this_____day of_____, 20___, before me, a Notary Public in and for said County, personally appeared (current drain commissioner), Barry County Drain Commissioner, and (Landowner signatory name) to me 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
Barry County, Michigan
My Commission Expires:_____

STATE OF MICHIGAN)
) SS.
COUNTY OF BARRY)

On this_____day of_____, 20___, before me, a Notary Public in and for said County, personally appeared (insert signatory name), to me 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
Barry County, Michigan
My Commission Expires: _____

Instrument Drafted by:
(insert draftee name)

When recorded return to:
The Barry County Drain Commissioner

EXHIBIT "A"

Legal description of the Drainage District for the (insert drain name) Drain.

Legal description of the route and course for the (insert drain name) Drain:

EXHIBIT "B"

I, (insert engineer name), a Registered Professional Engineer in the State of Michigan, do hereby certify to the following for the (insert drain name, use development name), Drain Drainage District in Section (insert section number) of (insert Township name):

1. The above-mentioned lands to be developed naturally drain into the area served by the existing drains and that the existing drains are the only reasonable available outlet for the drainage from the lands to be developed.

2. To my knowledge, there is existing capacity in the existing drains to serve the lands to be developed without detriment to or diminution of the drainage service provided or to be provided in the foreseeable future in the existing district.

3. This statement is made with reliance upon consultation with the Barry County Drain Commissioner and upon review and approval of the construction plans by that office.

_____
(type Engineer name and number)

Date: _____

RELEASE OF RIGHT OF WAY

Section 74, Chapter IV and Section 127, Chapter VI, Act No. 40, P.A. of 1956, As Amended

For and in consideration of prospective benefits to be derived by reason of the locating, establishing, constructing and maintaining of a certain Drain under the supervision of the County Drain Commissioner of the County of Barry and State of Michigan, as hereinafter described.

I/We, **(Insert name and address)** (_____)
Marital Status

Do hereby release to the **(insert name of drain)** Drainage District, the Right of Way for a certain Drain, hereinafter more particularly designated and described, over and across the following lands owned by me (us) and situated in the Township of **(insert name of Township/City/Village)**, County and State aforesaid, which lands are described as:

INSERT TAX ID NUMBER

INSERT LEGAL DESCRIPTION OF PARCEL

The Right of Way or Easement conveyed is described as:

INSERT LEGAL DESCRIPTION OF EASEMENT

The Right of Way hereby conveyed and released is for the sole and only purpose of locating, establishing, constructing and maintaining over and across said premises of a certain Drain, petition for which in writing was made on **(insert date of petition)** the necessity for which has been determined by a Board of Determination bearing the date **(insert date of necessity)**.

The Route and Course of said Drain is described as follows:

INSERT LEGAL DESCRIPTION OF DRAIN ROUTE AND COURSE

This conveyance shall be deemed a sufficient conveyance to vest in the Drainage District an easement in said lands 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 lands, as may be necessary or useful for the construction, maintenance, cleaning out and repair of such Drain.

WITNESS: Our hand(s) and seal(s) dated _____

WITNESS: (TWO REQUIRED - please type or print names under signatures)

_____ _____
INSERT NAME OF PROPERTY OWNER

_____

STATE OF MICHIGAN)
) SS.
COUNTY OF BARRY)

On this_____day of_____, 20___, before me, a Notary Public in and for said County, personally appeared (insert signatory name), to me 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
Barry County, Michigan
My Commission Expires: _____

Instrument Drafted by:
(insert draftee name)

When recorded return to:
The Barry County Drain Commissioner

PLEASE TYPE OR PRINT NAMES UNDER ALL SIGNATURES

APPENDIX C – Irrevocable Letter of Credit (Sample)

(Date)
Barry County Drain Commissioner
220 W State Street
HASTINGS MI 49058

IRREVOCABLE LETTER OF CREDIT No.

RE: (insert name of entity letter is from)

PROJECT: (insert project/drain name)

To Whom It May Concern:

At the request of the Barry County Drain Commissioner we hereby establish our Irrevocable Letter of Credit in your favor and authorize you to draw on us to an aggregate, the amount of (amount written out) U.S. dollars 00/100 ($____) and we engage with that all drafts at sight drawn under and in compliance with the terms of this credit will be fully honored by us if presented a this office on or before (date), 20____or any extended date, provided:

Any draft(s) drawn by you under this Letter Of Credit shall be accompanied by a letter executed by an authorized official (or one describing himself or herself therein as an authorized official) of the Office of Barry County Drain Commissioner stating as follows:

1. "Claims have been submitted or may be submitted to the Barry County Drain Commissioner which remain unfulfilled by the (Sub)Contractor, and the funds represented by the attached in compliance with our contract with (Sub)Contractor."

2. Drafts presented must bear on their face the clause "drawn under (bank name and address) Letter of Credit No.____dated_____.

3. Drafts presented no later than_____, 20___,_____p.m. local time after which time this Letter of Credit shall be null and void.

We hereby agree that any draft drawn and presented in conformity with the terms of this Letter of Credit will be duly honored if presented to us on or before the time of expiration set forth herein.

Very truly yours,

APPENDIX D – Site Plan Review Application

SITE PLAN REVIEW APPLICATION

Barry County Drain Commissioner
220 W. State St.
Hastings, MI, 49058
(269) 945-1385 Fax: (269) 948-4884

PROJECT NAME:_____
PROJECT LOCATION:_____
TOWNSHIP/CITY:_____
SECTION:__ **QUARTER SECTION:**__ **PARCEL NO.:**_____
PROJECT ADDRESS:_____
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 **REVIEW TYPE:**_____PRELIMINARY
_____433 AGREEMENT _____CONSTUCTION

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 OR PLAN REVIEW
Submittal Fee: $_____
_____Request for Review Agreement (Check if included)
(Required for all Site Plan Reviews)

ESTABLISHMENT OF SECTION 433 DRAINAGE DISTRICTS
Deposit: $_____

APPENDIX E – Request for Review Agreement

REQUEST FOR REVIEW AGREEMENT

Barry County Drain
Commissioner 220 W. State St.
Hastings, MI,
49058
(269) 945-1385 Fax: (269) 948-
4884

The Barry County Drain Commissioner may, at their discretion hire an outside consultant for review of the stormwater management plan. Outside consultant services will be based on their current hourly billing rates for actual time and reimbursable expenses to perform review and inspections. This form must be signed and submitted to the Barry County Drain Commissioner along with the submittal fee and application for the plan review application to be considered complete.

The applicant grants Barry County Drain Commissioner authority to utilize outside consultants and to invoice the applicant/owner for the services provided. Invoices shall be paid within 15 days of receipt of the invoice.

SITE INFORMATION	BILLING INFORMATION
Parcel No:	Project Name:
Property Owner/Business Name:	Name:
Address:	Address:
Telephone:	Telephone:

I declare under penalty of perjury that I am the property owner or that I am authorized to enter into this fee agreement on his/her behalf. I have read the conditions concerning Barry County Drain Commissioner outside consultant fees and I understand that in the event that the billing party I have indicated does not pay required fees, I will be responsible for payment.

_____ *Dated:* _____

Signature & Title

_____ *Telephone #:* _____

Printed Name

APPENDIX F - Glossary

As-Built Plans - Drawings prepared by an Engineer or Surveyor that represent conditions as they were constructed.

ASTM – American Society for Testing and Materials

Bass Flow - The portion of stream flow that is not due to runoff from precipitation, usually supported by water seepage from natural ground water.

Basin - A surface water runoff storage area.

Best Management Practice (BMP) - Structural, vegetative, or managerial practices used to protect and improve our surface waters and groundwater's. The most cost-effective management practice that achieves the design goal.

Borings - Cylindrical samples of soil profile used to determine soil types, ground water level(s), and infiltration capacity. Backhoe cuts are acceptable and in many cases are a preferred alternative. USDA terminology is to be used when identifying soils.

Buffer Strip - A zone where plantings capable of filtering stormwater are established or preserved and where construction, paving and chemical applications are prohibited.

Check Dam - An earthen, rock or log structure used in grass swales to reduce water velocities, promote sediment deposition, and enhance infiltration.

CN – Curve Number

Contractor - Any person(s) or company that constructs the development.

County Drain - An open or enclosed stormwater conveyance system that is under the legal jurisdiction of the Drain Commissioner for construction, operation, and maintenance.

Culvert - A conduit used for the passage of surface water under a road or other embankment.

Design Engineer – The licensed Professional Engineer retained by the Proprietor to design the site plan for a plat or any other land development, including stormwater management and drainage.

Design Flow - Projected flow through a watercourse, which will recur with a stated frequency. The projected flow for a given frequency is calculated using statistical analysis of peak flow data or using hydrologic analysis techniques.

Detention - Practices which store stormwater for some period before releasing it to a surface waterbody. See also retention.

Developer - Anyone who organizes the actual development of land and may or may not be the landowner.

Development - Modifications to a property to enhance a new usage. Infrastructure construction such as roads and storm sewer are typical of a development.

Discharge - Volume of water moving out of a basin, structure, or pipe per unit time.

Easement (also known as a "Right-of-way") - A legal right granted by a property owner to another entity giving that entity limited use of the property involved for a specific purpose. The Drain Commissioner secures temporary and permanent easement adjacent to stormwater facilities for the purpose of construction and maintenance access.

EGLE - Michigan Department of Environment, Great Lakes and Energy

Erosion - The wearing away of the land surface by wind, water, ice, and gravity dislodging of soil particles. Evidence of erosion are gullies, rills, sediment, plumes, etc.

First Flush - The delivery of a highly concentrated pollutant loading during the early stages of a storm due to the washing effect of runoff on pollutants that have accumulated on the land.

Flood Plain - For a given flood event that area of land adjoining a continuous watercourse that has been covered temporarily by water.

Flood Routing - The planning of what runoff water will do if it exceeds the capacity of a conveyance system or storage basin. This answers the question "what would happen if an event that exceeded the design event happened?"

Forebay – A separate storage area near the inlet to a storage basin, used to trap and settle incoming sediments before they can be delivered to the basin.

Freeboard - The space from the top of an embankment to the highest water elevation expected for the largest design storm to be stored. The space is required as a safety margin in a pond or basin.

Gabion - A rectangular box of heavy gage wire mesh that holds cobble size rock.

Groundwater - (see also Seasonal High Groundwater Level)

Hydrograph – A graph, usually of discharge or stage versus time, at a given point along a drain.

Hydrology - The occurrence, distribution, and movement of water both on and under the earth's surface.

Impervious Surface - Means rooftops, road pavement, parking areas, and other surfaces which do not allow water to infiltrate into the ground.

Infiltration Capacity - Rate at which water can enter soil with excess water on the surface.

Invert - The lowest (elevation) point in a conveyance system cross section. The very bottom of the inside of a pipe is its invert. Sometime referred to as the flow line.

LID – Low Impact Development

Orifice – An opening in a wall or plate.

Outlet – The point, location, or structure where drainage discharges from a storage basin or conveyance system to a receiving system; also called an "outfall."

PA – Public Act

Peak Flow – Maximum flow through a watercourse which will recur with a stated frequency. The maximum flow for a given frequency may be based on measured data, calculated using statistical analysis of peak flow data, or calculated using hydrologic analysis techniques. Projected peak flows are used in the design of culverts, bridges, and dam spillways.

Permanent Soil Erosion and Sediment Control Measures - Means control measures installed or constructed to control erosion and sedimentation and maintained after project completion.

Precipitation - Water that falls to earth in the form of rain, snow, hail, or sleet.

Project Engineer - A Professional Engineer licensed in Michigan that performs the engineering design for the development.

Proprietor - Any person, firm, association, partnership, corporation, or any combination thereof that owns property proposed for development.

Rational Formula - A simple technique for estimating peak discharge rates for small developments based on the rainfall intensity, watershed time of concentration and runoff coefficient.

Retention - Practices which capture stormwater and release it slowly though infiltration into the ground. See also detention.

Review Engineer – The engineer appointed by the Drain Commissioner to review the stormwater management and drainage elements of a plat or any other land development.

Riprap - A combination of large stone, cobbles and boulders used to line channels, stabilize banks, reduce runoff velocities, or filter out sediment.

Runoff - Flow of water across the land surface. The volume is equal to the total rainfall minus the rainfall that is stored, infiltrates into soils, or is taken up by plants.

Runoff Coefficient - Ratio of runoff to precipitation.

Saturated Hydraulic Conductivity – The ability of water to pass through soils when completely saturated. This is the most accurate measure of infiltration.

Seasonal High Groundwater Level - The highest level of groundwater that occurs frequently enough for the water to stain the soils.

Sediment - Soil fragmental material that originates from weathering of rocks and is transported or deposited by air, water, or ice.

SEMCOG – Southeast Michigan Council of Governments

Sheet Flow – Runoff which flows over the ground surface as a thin even layer, not concentrated in a channel or pipe.

Spillway - A depression in the embankment of a pond or basin used to pass peak discharges more than the design storm.

Stream – By MDNR definition; "a river, creek, or surface waterway that may or may not be defined by Act 40, P.A. Of 1956: has definite banks, a bed, and visible evidence of continued flow or continued occurrence of water, including the connecting water of the Great Lakes."

Swale - A natural depression or wide shallow ditch used to temporarily convey, store, or filter runoff.

Temporary Soil Erosion and Sediment Control Measures - Means interim control measures which are installed or constructed to control soil erosion or sedimentation until permanent soil erosion control measures are established.

Time of Concentration - Time at which outflow from a basin is equal to inflow or time of equilibrium.

Tributary Area – The total surface area that contributes runoff to a point.

Unit Hydrograph - Graph of runoff vs. time produced by a unit rainfall over a given duration.

USDA - United States Department of Agriculture

Water Course - Means any natural or artificial water course including, but not limited to; streams, rivers, creeks, ditches, channels, canals, conduits, culverts, drains, gullies, ravines, or washes which has definite banks, a bed, and in which waters flow in a definite direction or course, either continuously or intermittently, and including any area adjacent thereto which is subject to inundation by reason of water flow or floodwater.

Weir – A device that has a crest and some side containment, and is used to measure, regulate, or restrict flow. The amount of flow that may pass over the weir is a function of the weir geometry and upstream height of water above the crest.

Wetland – An area that is regularly saturated by surface or ground water and subsequently is characterized by a prevalence of vegetation that is adopted for life in saturated soil conditions. Examples include swamps, bogs, fens, and marshes.