CALHOUN COUNTY & BATTLE CREEK AREA

Stormwater Management Program:

Technical Reference Manual

September 2019

CALHOUN COUNTY & BATTLE CREEK AREA

Stormwater Management

Technical Reference Manual (TRM)

NOTE:

This document, which was developed by the City of Battle Creek with assistance from Calhoun County stakeholders, was made possible by a grant through the State of Michigan's Stormwater, Asset Management, and Wastewater (SAW) Program. The Stormwater Management Technical Reference Manual (TRM) is intended to be available for use by all cities, townships, and villages within Calhoun County, including the Calhoun County Water Resources Commissioner.

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2019 Stormwater Technical Reference Manual (TRM)

SECTION I Introduction

Overview

This Technical Reference Manual (TRM) is intended to be used by the communities in Calhoun County to protect surface water and groundwater, with an increased emphasis on water quality and environmental sustainability. These rules focus on specific controls which first provide filtration and/or infiltration of stormwater events up to the 2-year / 24-hour storm, then address flood control with detention basins. This level of control not only allows the reviewing agency to meet its permit obligations with the Michigan Department of Environment, Great Lakes, and Energy (EGLE), but will also have a positive impact on the quality of surface waters by controlling runoff volumes and pollutant concentrations, and protecting streambanks from excessive erosion. For managing the impacts of stormwater runoff, infiltration basins are considered most preferable, followed by flood control basins, e.g. detention basins, and, lastly, retention basins.

Regulated by the United States Environmental Protection Agency (US EPA), stormwater serves as a major contributor of non-point source pollution to receiving waters (e.g. rivers, lakes, groundwater). In Calhoun County, new- and re-development of properties increases volumes of stormwater runoff and pollutant loadings. In order to preserve the quality of receiving waters, development and implementation of effective, straightforward rules for managing stormwater has become a priority. The rules discussed in this document are intended to address the quantity (peaks and volumes) of stormwater runoff from developments and the quality (pollutant concentrations) associated with runoff. This document is intended to cover all watersheds and contributing subwatersheds within Calhoun County, including the Rice Creek, Battle Creek, Kalamazoo River, and St. Joseph River Watersheds. (Please see Appendix A for a map of these watersheds).

For all storm events, up to and including the 25-year storm, the intended management is to mimic pre-development hydrology so as to minimize the impact on downstream areas. The following discussion outlines basic ideas and principles of this management approach and provides a conceptual foundation for the design standards contained in this document. The Low Impact Development Manual for Michigan (Southeast Michigan Council of Governments, SEMCOG)[1] was used as the basis for many of the stormwater controls in this document. Best Management Practice (BMP) design requirements, calculations, and related figures are integrated throughout the document.

Framework for the Design of Stormwater Management Systems

Effective site planning can substantially reduce impacts associated with land development. To this end, communities, regulatory agencies, and designers must evaluate the impact of each individual development project over the long-term, and on a cumulative watershed scale. Such an approach requires consideration of BMPs that function together as a system to ensure the runoff volume, rate, timing and pollutant loads do not exceed the pre-development conditions. This can be achieved through a coordinated network of structural and non-structural methods designed to provide source and site

[1] Low Impact Development Manual for Michigan, 2008, http://www.semcog.org/reports/lid/index.html

controls (Figure 1). In such a system, the benefits of a single BMP unit may be minimal, however, as BMPs are combined, their cumulative effectiveness increases.

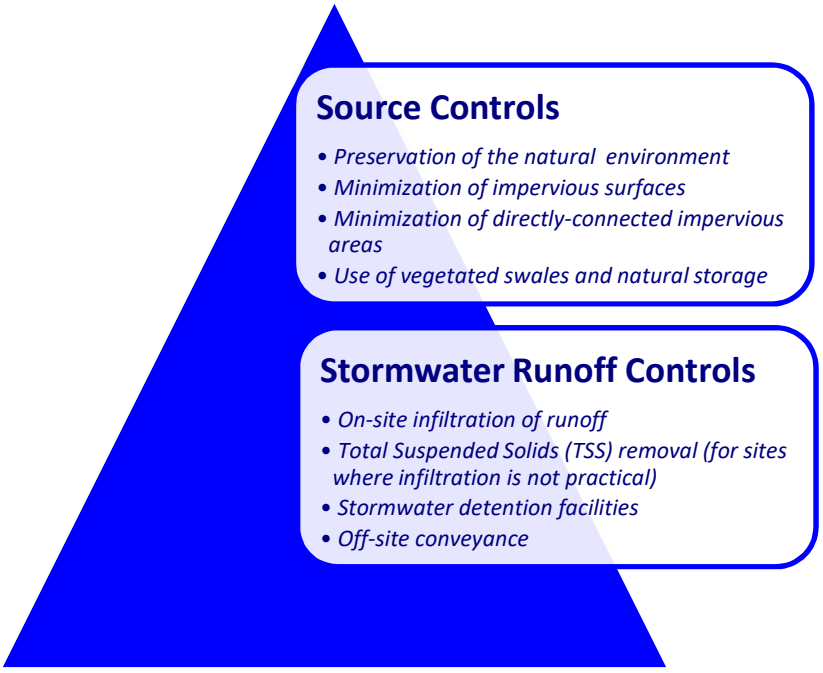

Figure 1: Hierarchy of Preferred Best Management Practices

Source Controls

Source controls reduce the volume of runoff generated on-site, encourage infiltration, and prevent pollutants from entering the drainage system. Source controls are the most effective options for controlling stormwater, and include the following key practices:

- Preservation of *existing natural features* that perform stormwater management functions. These include topographic depressions, wetlands, woodlands and vegetative buffers along streambanks.
- *Minimizing impervious surface area* using site planning to make efficient use of paved, developed areas and to maximize open space. Flexible street and parking standards and the use of alternative, permeable ground cover can also reduce impervious surfaces.
- *Minimizing direct connections to impervious surfaces* by conveying runoff from impervious areas to open vegetated areas, such as swales and lawns, rather than directly into the stormwater conveyance system. This includes practices such as directing roof downspouts to grassed areas, as opposed to driveways or streets.
- *Implementing proper erosion control measures* during the construction of the source control and performing rigorous maintenance throughout the construction period. Effective erosion control measures include *minimizing the area of site clearing* and grading, and the *immediate vegetative stabilization* of disturbed areas.
- The soil erosion and sedimentation control (SESC) construction sequence needs to *protect infiltration areas from sediment* and must include post-construction permeability testing and any necessary remediation prior to approval.

Site Controls

After the practical source controls have been identified, site controls are typically required to infiltrate, convey, pre-treat, and treat the additional stormwater runoff generated by land development. The range of engineering and design techniques available to achieve these objectives is dictated by site configuration, soil type, and the receiving waterway. For example, flat or extremely steep topography may preclude the use of grassed swales, which are otherwise preferable to curb and gutter systems. Likewise, sites that have a hydraulically-constrained outlet may require additional stormwater detention to limit peak flows to that which the receiving system can accommodate.

Preferred Hierarchy of Stormwater Runoff Controls

(Calculations and sizing methodologies included in Section IV)

1. In general, the most effective stormwater runoff control is infiltration, which reduces both the peak discharge and volume of runoff, and also reduces pollutant concentrations in stormwater runoff. Infiltration BMPs are most effective when distributed throughout a site, close to the sources of runoff, and upstream of conveyance systems. Large scale infiltration measures (i.e. tributary areas exceeding 2.5 acres of impervious surface), such as basins and trenches, receive more concentrated loading and are more likely to fail due to clogging. Therefore, an aggressive maintenance program and extensive upstream pre-treatment measures, such as oil/grit separators, sedimentation basins and vegetative filter strips, must be incorporated into any stormwater management system that employs these practices. Specific site conditions, including soil type and water table elevation, are key considerations. Infiltration is generally practical for most soil types; even many NRCS (SCS) Type C soils.
2. For development sites unable to satisfy the requirements for on-site infiltration, the use of flood control BMPs, such as detention basins, will still be required. Detention basins should be designed to provide extended detention of stormwater, to provide as much settling of particulate matter as possible, and, in developments where infiltration requirements have been waived, pre-treatment shall be used to remove a minimum of 80 mg/l of Total Suspended Solids (TSS) upstream of the detention basin.
3. Retention basins, previously popular in developments throughout Calhoun County, are now discouraged due to a history of observed problems with long-term performance. Although soils in Calhoun County are generally well-drained with reasonable infiltration rates, these basins frequently accumulate fine sediments and become clogged within several years of their construction, thereby failing to serve their design intent. ***These rules are intended to favor detention basins with a hydraulic outlet***. In cases where a proper site outlet is not immediately available, it is expected that the developer will provide the infrastructure necessary to accommodate a positive outlet.
4. Once all methods of reducing and treating stormwater on-site have been implemented, excess runoff can be discharged into downstream conveyance systems and carried off-site. Discharges must be at rates, velocities, and volumes that will not cause adverse downstream impacts to property or waterways.

Stormwater systems require regular maintenance in order to maintain proper performance. Depending on the specific BMP, maintenance must be performed at regular intervals, into perpetuity. This may include inspection, sediment removal, mulch removal/replacement, invasive species removal, maintenance of vegetation and structures, replacement of filters, and any other necessary measures to

maintain their basic function. A maintenance and budget plan must be developed concurrent with the system design, as outlined in Appendix C. To assist maintenance efforts, adequate access easements must be included in the design of all stormwater controls, including detention basins and decentralized infiltration BMPs. For small sites with simple stormwater controls (i.e. single BMP), the reviewing agency may reduce the detail necessary for the maintenance and budget plan. At a minimum, the plan shall specify the type and frequency of maintenance necessary to maintain BMP functionality.

The Role of the Reviewing Agency

The reviewing agency exercises authority over the design and construction of certain facilities that manage, convey and treat stormwater runoff. Throughout this document, the term 'reviewing agency' refers to the municipality (City, Village, or Township) in which the development will occur. During the review process, reviewing agencies may provide variance in requirements for appropriate situations. The Calhoun County Water Resource Commissioner (CCWRC) shall be the reviewing agency for any development which discharges to a County Drain, or any other development which falls under the jurisdiction of the CCWRC (see Section II).

This document governs the design of such management facilities with the following objectives:

- Control stormwater runoff and impacts through source control and infiltration
- Incorporate design standards that address water quantity and quality
- Encourage innovative stormwater management practices that meet the criteria contained within these rules
- Accommodate future maintenance of facilities by planning for it as part of system design
- Establish maintenance plans, procedures, and agreements to ensure effective long-term operation
- Make safety of facilities a priority
- Protect natural features
- Control soil erosion and sedimentation

Figure 2 is a flow chart that provides the step-by-step process that should be followed when evaluating, designing, and seeking approval for stormwater system design. In brief, sites located within wellhead protection areas will require attention from the reviewing agency prior to stormwater system design. Additionally, the developer may be required to obtain EGLE permits prior to local approval. It is the responsibility of the developer to determine if state regulations apply. Further detail is provided for each component of the flow chart in the paragraphs following Figure 2.

The Conceptual Plan Meeting (listed as the first step in Figure 2) is an optional but ***highly recommended*** step for the design and construction of all sites that are covered under these rules.

Exemption from TRM

Land development within the Columbia Avenue Business Improvement District (Columbia BID) in the City of Battle Creek shall be exempt from these rules, as the City of Battle Creek is in the process of planning and implementing specific stormwater BMPs to address flood control and water quality standards in this district. Any development within the Columbia BID shall be subject to a separate technical review by City of Battle Creek staff for conformance to the Columbia BID stormwater control plan (see Appendix A for BID figure).

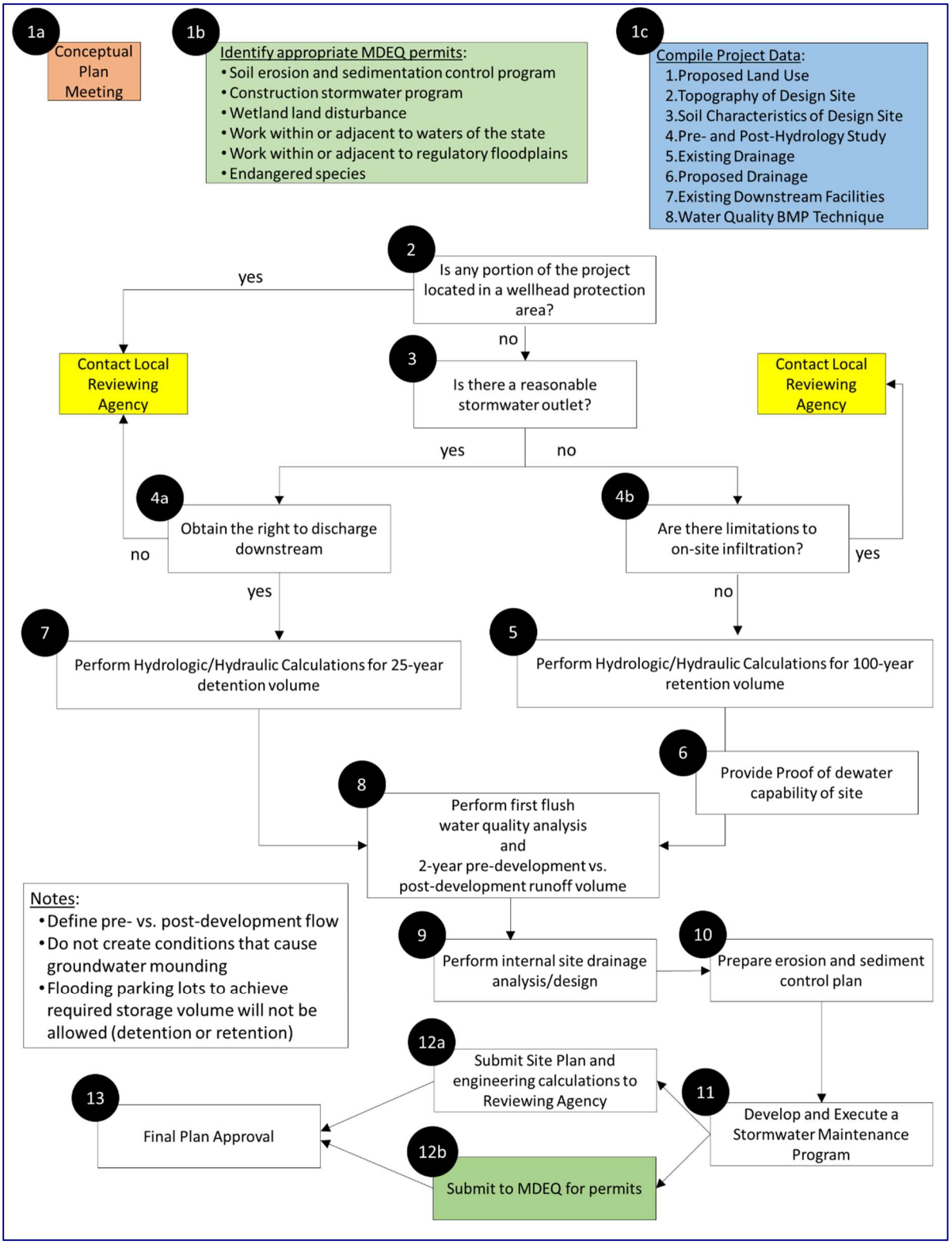

Figure 2: Step-by-step process for evaluation of BMPs for site development

Description of Process for Evaluation of BMPs for Site Development

1a Conceptual Plan Meeting: **Section II**

The Conceptual Plan Meeting is an optional but highly recommended step for the design and construction of all sites that are covered under these rules. The purpose of the meeting is to discuss the rule requirements, existing site characteristics, identifying existing in-situ soil conditions (which will determine whether infiltration will be required), Best Management Practices (BMPs) proposed for use on the site, long-term maintenance needs, and the capacity of the stormwater outlet. At this meeting, the reviewing agency staff will also confirm whether the development/redevelopment is within a drainage area that has a restricted outlet. This will determine the methodology that shall be used for determining the 25-year allowable peak discharge rate. This meeting may allow for a faster, more cost-effective site design by identifying the stormwater management issues early in the process.

The Conceptual Plan Meeting will also be used to discuss, if applicable, the No Outlet Certification.

1b Identify appropriate EGLE permits: **Section V**

Permits beyond those required by the reviewing agency may be required through the Calhoun County Road Commission (www.calhouncountyroads.com) or EGLE. It will be the developer's responsibility to secure necessary County, State, and/or Federal approvals prior to securing final approval by the local reviewing agency. A list of potential permits required by EGLE is provided below (additional permits may apply):

- Soil Erosion and Sedimentation Control Program: **(SESC) Part 91, Soil Erosion and Sedimentation Control, application available on the Calhoun County website,** https://www.calhouncountyroads.com/about/services/soil-erosion-sedimentation-control-permits/ (a Part 91 permit is generally required for any earth change activity which disturbs one or more acres of land or which is within 500 feet of a lake or stream)
- Construction Stormwater Program: **(NPDES), application available on the EGLE website** (a NPDES permit is required for any construction activities which disturb one or more acres of land and have a point source discharge of stormwater)
- Land disturbance within or adjacent to wetlands, including draining surface water to wetlands: **Part 303, EGLE / USACE Joint Permit Application, application available on the EGLE website**
- Work within or adjacent to Waters of the State, including culverts, bridges, utility crossings, stream bank protection, and similar work within open channels: **Part 301, Inland Lakes and Streams, EGLE / USACE Joint Permit Application, application available on the EGLE website**
- Work within or adjacent to regulatory floodplains: **Part 31, Water Resources Protection (PA 451), EGLE / USACE Joint Permit Application, application available on the EGLE website**
- Endangered species: **Application for a Threatened/Endangered Species Permit, application available on the MDNR website**

Any other permits deemed necessary during the land development process shall be provided to the reviewing agency. A list of the permits that will be submitted to EGLE for approval shall be included in the final submittal to the reviewing agency (Step 12).

1c Compiling Project Data: **Section II**

This step must comply with the Site Plan Ordinance requirements of the reviewing agency. The basic components of this data include, but are not limited to, the following:

- Proposed Land Use
- Topography
- Soils
- Pre- and Post-Hydrology study
- Existing drainage
- Proposed drainage
- Existing downstream facilities
- Water Quality BMPs/Green Infrastructure techniques highlighted

In general, project data should cover contributing drainage areas; or if adjacent property does not contribute, a minimum of 100 feet beyond project boundaries. Some flexibility may be afforded by the reviewing agency for smaller sites.

2 Is any portion of the project located in a wellhead protection area? **Section IV**

Determine if the property is located in a wellhead protection area. See Appendix D for an overview of wellhead protection area locations in Calhoun County. If a portion of the property is deemed to lie within a wellhead protection area, the developer must contact the reviewing agency to determine the appropriate next steps. If it is determined that the property does not lie within a wellhead protection area, the developer should proceed to Step 3.

A map of local wellhead protection areas in the City of Battle Creek can be found at: http://www.battlecreekmi.gov/DocumentCenter/View/174

Additional wellhead protection area maps can be found through EGLE's drinking water website at: https://www.michigan.gov/egle/0,9429,7-135-3313_3675_3695---,00.html

Developers should contact the local reviewing agency at the beginning of the project to receive the most up to date information regarding wellhead protection areas.

3 Is there a reasonable stormwater outlet? **Section II**

For sites possessing a positive outlet, the developer may proceed to Step 4a. If the site is deemed to have no practical positive outlet, Step 4b should be taken. ***In order to demonstrate that no positive outlet is available, the developer shall submit a No Outlet Certification (see Section II).***

4a Has the right-to-discharge downstream been obtained? **Section III**

To obtain this right to discharge to downstream private properties, a drainage easement or right-of-way must be established as a legally binding constraint on the appropriate downstream property. In addition, the reviewing agency will require a Drainage Acceptance Covenant (a standard form is provided in Appendix E), from the owner of the downstream property, but only for downstream properties that are privately owned. This form indicates full knowledge of the proposed alteration in

pre-existing drainage patterns and accepts responsibility to indemnify, defend and save harmless the reviewing agency from all liability due to the proposed alteration. Upon receiving the required right to discharge documents, the developer should proceed to Step 7. If the answer to this question is no, the developer must contact the reviewing agency to identify the appropriate next steps.

4b Can on-site retention handle total volume? **Section IV & Section V**

Limiting factors for infiltration will need to be determined, such as saturated soil conductivity and depth to the water table. If no limiting factors exist, proceed to Step 5. If limiting factors exist or if no complete onsite retention is being provided, the reviewing agency should be contacted.

5 Perform hydrologic and hydraulic calculations for no-outlet system: **Section IV**

For this case, complete retention of post development runoff for the 100-year, 24-hour storm event (5.2 inches) is required. No reduction in the required storage volume for infiltration during the storm is allowed.

If no positive outlet is available to dewater storage within 3 days, an evaluation of the in-situ saturated soil conductivity is required to verify that the storage volume can be recovered within 3 days. If the soil conductivity is inadequate, consult the proper reviewing agency. Generally, the soil conductivity will need to be at least 1 inch per hour for a retention basin to drain within 3 days, although the soil conductivity may need to be higher if the design high water level is more than 3 feet from the basin bottom.

6 Provide proof of dewater capability of site: **Section IV**

Certified soil boring and/or test pit results shall be provided which demonstrate any onsite infiltration capacity. Drawdown times for infiltration BMPs or storage areas shall be included. A factor of safety of 0.5 shall be applied to infiltration rates as determined by using soil borings. Test pits are the preferred method to test soil conductivity and require no factor of safety.

Section IV provides additional information on providing proof of dewatering capability

7 Perform hydrologic/hydraulic calculations with outlet: **Section IV**

For proposed post-development site runoff, the total runoff volume and peak flow rate shall be at or below existing levels for all storms up to the 2-year, 24-hour event. “Existing levels” means the runoff flow volume and rate for the existing land use at the time of the site plan application. Where more restrictive channel protection criteria already exist or are needed to meet the goals of reducing runoff volume and peak flows to less than existing levels on lands being developed or redeveloped, the use of more restrictive criteria may be required.

The outlet structure must also restrict the peak discharge rate for the 25-year / 24-hour storm (SCS Type II rainfall distribution). Adequate storage volume to achieve this peak flow control is required on the development site. An overland emergency flow relief path must be identified and designed for the 100-year / 24-hour peak flow resulting from proposed land use conditions.

8 First flush water quality: **Section IV**

Treatment of the first 1 inch of rainfall is required on all developments to satisfy water quality requirements per EGLE requirements.

9 Perform internal site drainage analysis/design: **Section IV & Section V**

Project specific drainage analysis and design evaluations must be performed. Flooding parking lots to achieve required storage volume will not be allowed for either retention or detention.

10 Prepare erosion and sediment control plan:

All sites within 500 feet of a lake, stream, or county drain; or disturbance of more than one acre of land, must have a Soil Erosion Sedimentation Control (SESC) permit prior to obtaining a building permit. An erosion and sediment control plan is required to obtain an SESC permit. The Calhoun County Road Department, located at 13300 Fifteen Mile Road, Marshall, Michigan, administers the SESC program for Calhoun County. The SESC permit is available online, at the Road Department's website. The SESC Permit should be completed by the developer and made available to the reviewing agency. http://www.calhouncountyroads.com/

11 Develop and Execute a Stormwater Maintenance Program: **Section V**

Performance of Stormwater control measures (SCMs) are dependent on their maintenance. A signed maintenance agreement may be required. Appendix C provides a standard form for completion of the stormwater maintenance management agreement.

12a Submit results to reviewing agency: **Section V**

Results of the evaluations and design performed as outlined in the flow chart of Figure 2 should be compiled in a report and submitted to the reviewing agency for review and approval. A standard checklist form to be used by the Battle Creek Area Clean Water Partners when reviewing drainage and stormwater management features of site development projects is provided in Appendix F.

12b Submit for EGLE permits: **Section V**

At the time of plan submission to the reviewing agency, the developer should also submit for all necessary EGLE permits, as discussed in Step 1b.

13 Approval of Final Plans: **Section V**

If all items identified on the checklist form (Appendix F) are determined to be in compliance with requirements and the necessary EGLE permits are awarded, the project can be approved. If items are found to be missing, or are not in compliance with requirements, the checklist will be sent to the applicant to indicate the reason or reasons for disapproval.

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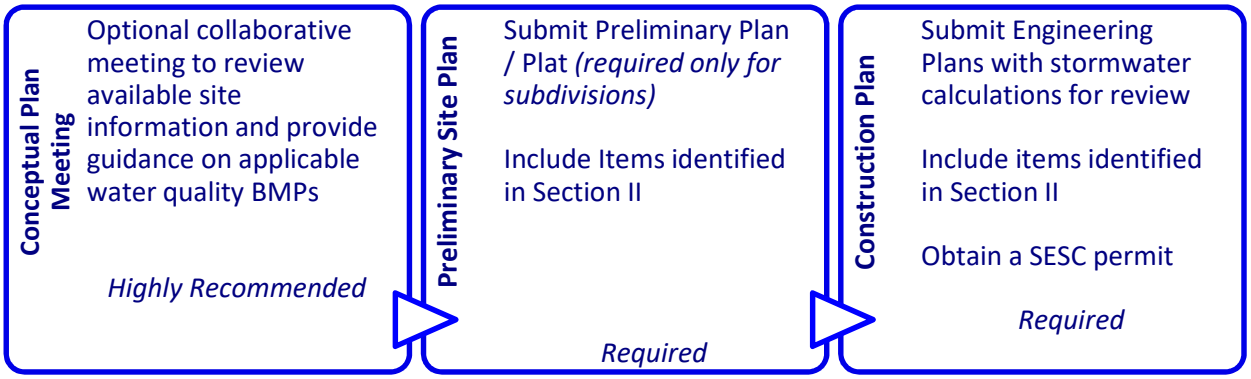
SECTION II Plat and Plan Submission Review Procedures

Part A: Purpose & Introduction

Each site proposed for development or redevelopment is unique due to soils, land cover, topography and location. Therefore, waivers or variances from certain provisions of these standards may be requested as outlined in depth in this section when it can be demonstrated that these standards cannot be feasibly accommodated. In these situations, alternatives consistent with the overall intent of these rules must be proposed for consideration and will be subject to the approval of the reviewing agency, i.e. the local unit of government.

1. The reviewing agency will require water quantity controls and reduction of pollutant loading to improve water quality in accordance with the stormwater permit to comply with the Clean Water Act and the Natural Resources Environmental Protection Act.
2. Under these rules, the reviewing agency will ensure that all stormwater facilities necessary for a proposed development or redevelopment have an appropriate governmental unit responsible in perpetuity for performing maintenance or for overseeing the performance of maintenance by a private entity, such as an individual property owner, Home Owners' Association, or similar entity. The appropriate Maintenance Agreement may be obtained from the reviewing agency office.
3. The general standards set forth herein will be applied in the review of the following:



Part B: Conceptual Plan Meeting

The Conceptual Plan Meeting is an optional but ***highly recommended*** step for the design and construction of all sites that are covered under these rules.

The Conceptual Plan Meeting will also be used to discuss, if applicable, the No Outlet Certification.

Part C: Preliminary Plan / Plat and Site Plan Submittal & Approval

These requirements have been developed in the context of preliminary plat submittal under the Michigan Land Division Act. Submission of the site plan should be in compliance with the local reviewing agencies' submittal standards. The following information shall be considered a minimum for the review of Preliminary Plans or Plats under the standards of this TRM.

1. DRAINAGE INFORMATION REQUIREMENTS

    a. Calculations used in designing all components of stormwater management systems must be submitted to the reviewing agency along with plans.

        i. The Stormwater Calculation Tool spreadsheet, available from Calhoun County and the City of Battle Creek, provides a simple approach to calculating required infiltration and detention volumes, as well as allowable peak flows. Using the output from this spreadsheet will expedite the review process. Using the spreadsheet is optional and does not relieve the designer from confirming and certifying the calculations.

    b. All preliminary plans/plats shall include, at a minimum, the following stormwater management information:

        i. The overall stormwater management system for the proposed development with structure rim and invert elevations, culvert and storm sewer lengths and sizes as well as all surface stormwater conveyance top of bank and centerline elevations at 100-foot intervals. The preliminary plan/plat must indicate how stormwater management will be provided and to where the drainage will outlet.

        ii. The location of any on-site and/or off-site stormwater management facilities and appropriate easements that will be dedicated to the entity responsible for future maintenance.

        iii. A description of the drainage course that will be utilized as the stormwater outlet and evidence that it is adequate for the proposed discharge. It is noted that controlling flow to a rate that is equal to or below the pre-development rate may not be considered to be evidence of adequacy. The Engineer's Certificate of Outlet, Appendix G, must be provided including the signature and seal of the Professional Engineer responsible for determining adequacy.

        iv. If no adequate watercourse exists to effectively handle the proposed discharge of stormwater (***No Outlet Scenario***), stormwater retention may be an option. Before receiving approval to construct a retention basin, a ***No Outlet Certification*** must be submitted for review:

            - A ***No Outlet Certification*** is a due diligence that demonstrates whether or not it is feasible to construct a drainage outlet where none currently exists. *In general, this certification will not be approved unless it can be clearly demonstrated that constructing a drainage outlet will be infeasible. Having to construct drainage facilities outside of the property boundary is not necessarily considered to be a trigger for infeasibility.* The ***No Outlet Certification*** must be included in the site plan if a *No Outlet Scenario* is proposed. This must include, at a minimum, the following information:

1. Location, condition, and size of the nearest available drainage outlet.
2. Schematic showing the necessary infrastructure required to connect the development to the nearest available drainage outlet, including any necessary easements.

- The reviewing agency will consider the ***No Outlet Certification*** and will provide one of the following responses:
    1. Denial of *No Outlet Scenario*, based on lack of evidence of infeasibility. In this case, the developer shall build the infrastructure necessary to connect to the identified outlet.
    2. Approval of *No Outlet Scenario*, based on sufficient evidence that providing a drainage outlet is not feasible.
    3. If a feasible outlet is possible at a lower flow rate, a restricted outlet (and corresponding flow rate) will be established. In this scenario, the site plan will include a 25-year detention basin design with a reduced peak flow rate.

v. A map showing the drainage boundary of the proposed development and its relationship with existing drainage patterns, including any drainage originating outside the development that limits flows onto or across the development. Such offsite drainage shall be quantified.

vi. Proposed topography for all areas, both off and onsite, to be disturbed by construction. The proposed topography will be provided in one-foot contour intervals. If off-site grading is required, provide evidence of appropriate easements.

vii. Any natural water courses and/or county drains passing through or adjacent to the proposed development, along with the following:

- Area of upstream watershed
- Preliminary calculations of runoff from the upstream area for both the 100-year and 2-year recurrence interval 24-hour design storms, for fully developed conditions according to the current land use plan for the area
- Normal surface water elevation
- 100-year recurrence interval water surface elevation

viii. Calculations determining required stormwater infiltration volume, if applicable

ix. Calculations determining first flush (1 inch of rainfall) and channel protection (2-year / 24-hour storm) volumes

c. The increased volume of water discharged due to the development of the site must not create adverse impacts to downstream property owners and water courses. Adverse impacts may include, but are not limited to flooding, excessive soil saturation, crop damage, erosion, and/or degradation in water quality or habitat.

d. The proposed drainage plan will, in every way feasible, respect and conform to the natural drainage patterns within the site and the watershed in which it is located.

Proposed drainage should be consistent with any local stormwater management plans that may exist and/or comply with any ordinance in effect in the municipality/ies where the proposed development is located.

Part D: Construction Plan Submittal & Approval

All final plans shall include all the required Conceptual Plan Information, Preliminary Plan Information and the other information as required by the reviewing agency.

Part E: Final Subdivision Plat Submission & Approval ***(Calhoun County WRC jurisdiction)***

Final subdivision plat review will be completed by the Calhoun County Water Resources Commissioner's office within 10 days of submission by the proprietor. If the plat is not acceptable, a written notice of rejection and the reasons there for will be given to the proprietor. If the Water Resources Commissioner approves the plat, s/he will affix his/her signature to it and the plat will be executed. As a condition of final plat approval, the Water Resources Commissioner will require the following:

1. The municipal governing body in which the proposed development is located must approve the preliminary plat. Evidence of this approval shall be submitted to the Water Resources Commissioner's office with the final plat.
2. Before approval of the final plat, it must be demonstrated that all necessary Wetland, Floodplain, Inland Lakes and Streams, Erosion Control or other needed state, federal or local permits are in place.
3. A satisfactory agreement that assures long-term maintenance of all drainage improvements will be in place before submission of the final plat. Documentation of maintenance agreement shall be supplied to the Water Resources Commissioner.
4. Complete subdivision agreement (including deed restrictions) must be submitted for the Water Resources Commissioner's review and approval prior to recording. These agreements must include the appropriate easement language for the development. See Appendix A, Typical Easement Language. If the drainage work involves crossing, tapping into, or other work within an existing county drain or its easement, a permit application (Appendix J) must be submitted and approved by the Office of the Water Resources Commissioner prior to construction. This permit application will be accompanied by any necessary release of rights-of-way in recordable form, executed by all owners of interest. Prior to constriction, copies of any required state, federal or local permits shall be submitted to the Water Resources Commissioner. A final plat, when submitted to the Water Resources Commissioner for signature, will include the Water Resources Commissioner's Certificate.

Part F: Mobile Home Preliminary Plan

The preliminary plan shall include the location, layout, general design and a general description of the project. The information submitted for review should satisfy the requirements set by the reviewing agency.

Part G: Drains Under the Jurisdiction of the Water Resources Commissioner

1. Drainage districts will not be altered when designing development drainage, except as provided under Sections 425 and 433 of Act 40, Public Act 1956 as amended.

2. Existing county drain easements will be indicated on plans and final plats and will be designated as "_____" (County Name) Drain. In addition, the liber and page shall be provided for any existing drainage easements on the parcel(s) being developed. County drain easements prior to 1956 were not required by statute to be recorded immediately; therefore, it may be necessary to check the permanent records of the Water Resources Commissioner's Office to see if a drain easement is in existence on the subject property.
3. Proposed modifications to county drains will require a permit application to the Office of the Water Resources Commissioner. State, federal and local permits may also be necessary.
4. A permit will be obtained from the Water Resources Commissioner prior to any work that affects a county drain, including tapping into or crossing. The permit must be obtained prior to construction plan approval.
    a. Detailed construction plans along with the appropriate review fees shall be submitted for review with the permit application. These shall be prepared in accordance with Section II, Part D.
    b. Payment of all fees is prerequisite to permit approval.
    c. Upon receipt of an approved permit, the permittee must contact the Water Resources Commissioner 72 hours prior to the start of construction.
    d. All work shall be completed in accordance with the plans and specifications approved by the Water Resources Commissioner.
    e. A cash deposit in an amount satisfactory to the Water Resources Commissioner to cover inspection services shall be deposited to insure satisfactory completion of the project in accordance with the approved plans. The permittee shall contact the Water Resources Commissioner to perform an inspection of the permitted activity.
    f. The Water Resources Commissioner shall be notified in writing within 10 days of completion of an approved project.
    g. Authority granted by a permit from the Water Resources Commissioner does not convey, provide, or otherwise imply approval of any other governing act, ordinance, or regulation, nor does it waive the permittee's obligation to acquire any federal, state, county, or local approval or authorization necessary to conduct the activity.

Part H: Appeal Procedure

1. If the proprietor wishes to appeal a decision made by the reviewing agency, a written appeal may be filed within 14 calendar days of that decision. If an appeal is filed with the reviewing agency, an informal hearing will be scheduled within 21 calendar days from the date of the filing.
2. The informal hearing will allow the proprietor an opportunity to submit additional information or re-emphasize previously submitted data. The reviewing agency will then review the information and make a final decision, within 21 days of the informal hearing, and forward this final decision to the proprietor by first class mail.

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SECTION III Permit Requirements Review Fees

Part A: Permits with Calhoun County Resource Commissioner

A permit will be required for all activities crossing, modifying, discharging to a county drain, or any work within a county drain easement. Submittals shall include all the following information:

1. A fully completed permit application, including appropriate signatures.
2. Permit, review, and inspection fees as specified in Table 1 below.
3. A drawing including the following information at a minimum:
    a. Location of county drain easements on the property
    b. Descriptions of all construction activity within drain easement
    c. Dimensions and elevations of all facilities being proposed for construction within the drain easement
    d. Type of material used for construction of facilities within the drain easement
    e. Soil erosion and sedimentation control measures.

Certain construction activities require that the County Water Resources Commissioner be assured of appropriate and timely completion of the permitted activity. In such cases, security in the form of cash or a letter of credit will be deposited with the Water Resources Commissioner prior to a permit being issued. These activities and minimum amount of security required are defined in Table 1 below. Developers should contact their local reviewing agency to obtain the most up to date fees for permit review.

Table 1: Permit Requirement Costs

Permit Type	Permit Fee	Initial Review Fee $105/hour	Initial Inspection Fee $105/hour	Minimum Security Required
Minor Residential Permit	$60	One Hour	One Hour	None
Tap-In Permit Open Drain	$60	One Hour	One Hour	None
Tap-In Permit Enclosed Drain	$60	Two Hours	Two Hours	$1,000
Culvert Installation	$60	One Hour	One Hour	$500
Bored Crossing	$60	Two Hours	One Hour	$500
Open Cut Crossing	$60	Two Hours	Four Hours	$5,000
Bridge Crossing	$60	Four Hours	Four Hours	$2,000
Drain Clean Out	$60	Two Hours	Four Hours	$5,000
Construction Easement	$60	Two Hours	Two Hours	None

Part B: Fees

1. All site plan review fees are charged at varying rates, based on acreage and the reviewing agency. For the City of Battle Creek, current site plan review fees are $150 for sites under 5

acres and $250 for sites greater than 5 acres. Reviewing fees for other entities within Calhoun County can be obtained by contacting the appropriate agency (Table 2). A review of plans received will not be scheduled or completed until the appropriate fee has been submitted. The initial review fee for all site plans or platted subdivisions is based on the acreage of the development and is outlined in Table 2. If the review fee initially submitted is not sufficient to complete the necessary reviews, additional fees will be invoiced. Additional reviews will not be completed until the additional invoiced amount is submitted. Review time will be billed for all work necessary to complete the review process including but not limited to plan review, file research, meetings, predevelopment site inspections, telephone calls, etc.

Table 2: Contact information for reviewing agencies within Calhoun County

Calhoun County Water Resource Commissioner	(269) 781-0790
City of Battle Creek	(269) 966-3320

Townships within Calhoun County:

Albion Township	(517) 629-2289	**Homer Township**	(517) 568-4786
Athens township	(269) 729-5305	**Lee Township**	(269) 749-9292
Bedford Charter Township	(269) 968-6917	**Leroy Township**	(269) 979-9421
Burlington Township	(517) 765-2323	**Marengo Township**	(269) 781-8422
Clarence Township	(517) 857-2288	**Marshall Township**	(269) 781-7976
Clarendon Township	(517) 767-4416	**Newton Township**	(269) 979-3212
Convis Township	(269) 789-0654	**Pennfield Charter Township**	(269) 968-8549
Eckford Township	(269) 781-9222	**Sheridan Township**	(517) 629-2604
Emmet chart Township	(269) 968-0241	**Tekonsha Township**	(517) 767-3366
Fredonia Township	(269) 781-8115		

2. Inspection Fees for WRC only: Inspection fees are charged at an hourly rate. Inspections will not be performed until the appropriate fee has been submitted. The initial inspection fees will be 10% of the approved design engineer's construction cost estimate. In instances where representatives of the local municipality will complete the inspection on behalf of the WRC this initial fee will be reduced to 5%. Once the initial inspection fee has been depleted, additional inspection time will be billed to the developer. Additional inspections will not be completed until the invoiced amount is submitted. Inspection time will be billed for all work necessary to complete the inspection including inspection time, travel time, mileage costs, as built plan review, meetings, telephone calls, etc. Any unused inspection fees will be returned upon completion of the required inspections.

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SECTION IV Computation Requirements for Stormwater Management Systems

Part A: Purpose & Introduction

This section sets forth specific design standards and calculation methodologies that will be used in review of proposed stormwater management systems in accordance with the objectives of managing both the quantity (volume and rate) and quality of stormwater runoff. A *Glossary of Terms* used throughout this section is provided in Appendix A.

The flood control design requirements address the capture and peak flow mitigation for the less frequent, severe runoff events. Infiltration requirements address more frequent events, including the channel protection (2-year / 24-hour rainfall) and first flush (1-inch rainfall) events. These rules require that the runoff from the channel protection and first flush events be captured and, where possible, infiltrated.

Any proposed development or redevelopment that has a total impervious area greater than ½ acre shall meet the infiltration requirements for the *larger* volume resulting from the two calculations below:

1. Runoff volume resulting from 1 inch of rainfall over the developed site; calculated using the composite runoff coefficient for developed conditions, or;
2. The increased runoff volume from the 2-year/24-hour rainfall, as measured by subtracting the runoff volume from pre-development conditions from the runoff volume from post-development conditions. Where pre-development assumes the last approved site plan conditions within 5 years of the current development.

Infiltration requirements address water quality in two important ways.

- First, eroded soil and other pollutants that accumulate on impervious surfaces, such as heavy metals, fertilizers, pesticides, oils and grease, are flushed off by the early stage of runoff, which then carries elevated concentrations of these pollutants into receiving waterways. By infiltrating the runoff from the first inch of rain, pollutants that are normally washed off of the site can be intercepted and prevented from being transported downstream.
- Second, the increase in frequency and duration of bankfull flow conditions resulting from development exacerbates channel and bank erosion and destroys aquatic habitats. Infiltration allows for a developed site to more closely mimic the natural hydrology of the same site prior to development. BMPs that can accomplish this goal include:
    - Surface Infiltration Basins
    - Subsurface Infiltration Beds
    - Bioretention Areas
    - Rain Gardens
    - Pervious Asphalt, Concrete or Pavers
    - Infiltration Trenches

- Naturalized areas (undisturbed areas of site, such as woodlands, prairie, meadow)
- Other BMPs that provide infiltration (vegetated filter strips, bioswales, or dry wells)
- Wet Retention/Detention

Each site proposed for development is unique due to soils, land cover, topography and location. Therefore, waivers or variances from certain provisions of these standards may be requested when it can be demonstrated that these standards cannot be feasibly accommodated. In these situations, alternatives consistent with the overall intent of these rules must be proposed for consideration and will be subject to the approval of the reviewing authority.

1. STORMWATER MANAGEMENT REQUIREMENTS

Infiltration Requirements

To manage water quality, infiltration will be required for the greater of the two following volume calculations:

- First flush volume; the runoff from one inch of rain over the entire developed site as determined using the composite runoff coefficient for developed conditions.
- Channel Protection Volume; The difference between the pre-development 2-year/24-hour and post development 2-year/24-hour runoff volumes. Pre-development is the existing condition of the site as of the date of the site plan submittal. If the existing site is partially- or fully-developed, then that level of development shall be considered the pre-developed condition. If recent changes to the use have occurred "pre-development" will refer to the site conditions prior to these changes (i.e. recent farming of a meadow will not be allowed as a pre-development condition). The runoff volume for the 2-year/24-hour storm event shall be determined by using NRCS Curve Number methodology.

Note to designers: *the calculations for the volumes listed above can be made using the Calhoun County Stormwater TRM Calculation Spreadsheet, available from the websites of the City of Battle Creek or the Calhoun County Water Resources Commissioner. This spreadsheet simplifies and standardizes the calculation process and will likely expedite the site plan review process.* ***Using the spreadsheet is optional and does not relieve the designer from confirming and certifying the calculations.***

Soil borings and/or soil test pits will be required at each infiltration/BMP site to determine the feasibility of infiltration. The developer/applicant must submit a soil boring and/or test pit infiltration report certified by a Professional Engineer licensed in the State of Michigan. The infiltration rate shall be measured at the proposed subgrade for any BMP. The subgrade refers to the bottom of the BMP excavation, which is coincidental with the bottom of proposed engineered soil mix (for bioretention) or bottom of open-graded stone base for pervious pavement. Generally, this is at least 3-4 feet below existing grade. Factors of safety applied to observed infiltration rates (a/k/a saturated soil conductivity, or K_{sat}) shall be as follows:

- On-site test pits: Design K_{sat} = Observed K_{sat} x 1.0
- Soil boring-derived infiltration rate: Design K_{sat} = Observed K_{sat} x 0.5

The additional factor of safety used for the soil boring-derived infiltration is based on local experience that indicates that infiltration rates determined from soil borings tend to overestimate the actual (in-situ) infiltration rates.

Infiltration BMPs must be engineered to dewater within 48 hours of the end of the storm event. Full dewatering is defined as having no standing water within the BMP. The following infiltration (K_{sat}) values shall be used to determine the appropriate design methods for infiltration BMPs:

- $K_{sat} \geq 0.4$ inches/hour: Infiltration BMPs shall be constructed to provide the infiltration volume as calculated using the above requirements. No underdrain shall be permitted for infiltration BMPs in areas where $K_{sat} \geq 0.4$ inches/hour.
- $K_{sat} < 0.4$ inches/hour and $K_{sat} \geq 0.1$ inches/hour: Use underdrains for infiltration BMPs to assist in dewatering should the underlying soils fail to provide adequate drawdown/dewatering time. This design scenario provides both filtration and infiltration, which will achieve the water quality standards and, with time and plant growth, the infiltration rate should improve and potentially result in infiltration being the dominant outlet mechanism.
- $K_{sat} < 0.1$ inches/hour: ***The infiltration volume requirement shall be waived***. However, the first flush volume shall be intercepted and treated to meet the specifications listed below:
    - The methods selected to treat the first flush volume shall be designed on a site-specific basis to achieve a discharge concentration of TSS that does not exceed 80 mg/L. BMPs may be used individually, or in combination, to achieve the required first flush volume and TSS removal for the site.
- In cases where the infiltration rate varies across the development, the developer shall attempt to maximize the use of infiltration BMPs within areas of favorable ($K_{sat} \geq 0.4$ inches/hour) soils. If a subset of a development drains to an area where infiltration cannot be accommodated due to low K_{sat} values (< 0.1 inches/hour), that portion of the development can designed without infiltration BMPs, although all other stormwater management requirements will still apply to that area.

Other site conditions that can result in the waiver of infiltration volume requirements include:

- High Risk Zoning Districts, as defined in the City of Battle Creek Performance Standards for Groundwater Protection, within a 1-year Wellhead Protection (WHP) Area. Restricted zones include the Pennfield, Verona, and Columbia WHP Areas. This shall apply to any Calhoun County municipality that has defined wellhead protection areas (See Appendix D)
- Prevailing water table within two (2) vertical feet of the subgrade elevation of the proposed BMP, confirmed by test pits or soil borings.
- Evidence of contaminated soils on or immediately adjacent to the development (evidence must be provided with the site plan submittal).
- *In any of the above cases, the first flush volume shall still be treated to the 80 mg/l standard.*

An infiltration system may be a centralized, integrated part of the required flood control basin or it may be a separate system(s) dispersed (decentralized) throughout the development that will provide for the required infiltration volume. An infiltration BMP shall have the following maximum tributary areas without requiring pre-treatment:

- 5 acres of residential land use (maximum impervious percentage of 50%)
- 2.5 acres of impervious surface (commercial/industrial areas or high-density multi-family areas)

Centralized infiltration BMPs with tributary areas exceeding the above limits shall require pre-treatment, focusing on a maximum TSS concentration of 80 mg/l prior to discharge into the infiltration BMP. Pre-treatment may consist of mechanical separator (e.g. swirl concentrator) or other filtration methods as approved by the reviewing authority.

For sites where infiltration has been waived by the reviewing authority, the developer/applicant will still need to meet the 1-inch (first flush) water quality requirements and must therefore provide a NJDEP[2]-certified mechanical separator and/or other appropriate BMPs to provide treatment to meet the first flush TSS removal requirements. In this scenario, the detention basin outlet structure shall be designed with a multiple stage discharge structure that includes a control to limit the post-development 2-year peak flow to the pre-development level, in addition to required controls for the 25-year storm.

Flood Control Requirements

Flood control shall be established by one of the following criteria:

1. Default: post-development peak flows for the 25-year storm event shall not exceed the peak flows for the same events under pre-developed conditions, as demonstrated using NRCS Curve Number methodology.
2. In cases where the development discharges to a facility (pipe or open channel) that has been designed for a 100-year peak flow (and/or where a regulated floodplain exists), the reviewing authority reserves the right to require the flood control be designed for the 100-year storm. In this scenario, the peak flow from the developed site shall be equal to or less than the existing 100-year peak flow (unless a more restrictive flow rate has been established by the reviewing authority).
3. Downstream Restriction Scenario: If the reviewing authority has established the presence of a hydraulically-constrained outlet, then the peak flow shall be limited as prescribed by the reviewing authority. The developer/applicant may, at the reviewer's discretion, increase the outlet capacity through capital improvements to the downstream drainage system(s) at the developer's expense to establish a higher allowable discharge rate.
4. The flood control requirement may be waived if the development is part of a regionally-planned development that includes offsite regional flood storage that meets the current requirements of this TRM. This waiver is dependent on the regional flood storage being fully constructed and operational prior to the development under consideration for site plan approval.

Under the default criteria (post-development peak shall not exceed pre-development peak), the flood control basin design shall capture and detain the 25-year storm volume as determined by the NRCS Curve Number methodology. The storage volume required is the difference between the pre-development 25-year storm runoff volume and the post-development 25-year storm runoff volume. Pre-development conditions shall be calculated based on the existing condition of the site as of the date of the site plan submittal. The storage volume provided in the infiltration BMPs will be credited toward the total storage volume required for the 25-year storm.

In cases where it is deemed necessary to control peak flows for the 100-year storm, the developer shall also demonstrate that the 25-year peak flow does not exceed that under existing conditions.

[2] New Jersey Department of Environmental Protection (NJDEP; link below contains a thorough database of approved technologies and vendors related to TSS removal efficiencies)
http://www.nj.gov/dep/stormwater/treatment.html

All detention basins shall include an emergency overflow that can accommodate the 100-year peak detention basin ***inflow*** rate (i.e. 100-year peak flow calculated for developed conditions without detention). An adequate flow path (including easements, if deemed necessary by the reviewing agency) shall be identified in the site plan.

When calculating the pre-development peak flow rates, any existing detention storage, whether naturally-occurring (e.g. wetlands, depression areas) or constructed (e.g. detention basins) must be used in the peak flow calculations. In this scenario, the existing peak flow rate will be reduced by virtue of existing flood storage volume. This reduced peak flow shall establish the allowable discharge rate for the site, provided the Downstream Restriction Scenario does not apply.

Flood control using a retention basin (in conditions where no outlet is available) is discouraged and is generally not permitted unless the applicant can demonstrate there is no viable outlet and that an outlet cannot be provided through site improvements (see the ***No Outlet Certification*** in **Section II, Part C(1)(b)(iv)**). In rare cases in which retention is permitted, the retention basin shall include the following design provisions:

- Provide retention volume for a 100-year, 24-hour duration storm event (full event runoff volume with no credit for infiltration). Retention basin must be completely drained within 72 hours after attaining peak storage volume.
- Provide an emergency overflow outlet (overland flow path) to accommodate a flow rate equal to the 100-year peak flow under developed conditions. The reviewing agency may exercise discretion on the extent to which easements will be required.
- Provide water quality treatment upstream of the retention basin via the infiltration requirements in this chapter. This may include either decentralized BMPs (i.e. bioretention) or a centralized system (i.e. swirl concentrator / mechanical separator) upstream of the retention basin.

The selection of the design storm for the sizing of any component of the stormwater system should consider the existence and adequacy of an emergency overland flow path and the risks to public safety and property should a storm event of greater magnitude occur. If the emergency overland flow path is inadequate, nonexistent, or the risks to public safety and property resulting from the emergency overflow cannot be adequately defined, then the design engineer should consider a more appropriate and conservative design storm than the minimum storms suggested in this TRM. Design storms to be used for new stormwater facilities shall be as follows:

Table 3: Design Storm Events for New Stormwater Facilities

Type of Facility	Design Storm (Exceedance Probability)	Method of Calculation	
Temporary construction drainage channel	5-year	Rational Method or approved equal	**Peak Flow**
Minor System* (draining less than 100 acres)	10-year	Rational Method or approved equal	
Major System* (draining more than 100 acres)	25-year to 100-year	Rational Method or approved equal	
Detention Basin	25-year (100-year if an adequate downstream floodway does not exist)	24-hour rainfall, NRCS Curve Number method or approved equal (can use the TRM Calculation Spreadsheet)	**Volume**
Retention Basin (only with approved *No Outlet Certification*)	100-year	24-hour rainfall, NRCS Curve Number method or approved equal (can use the TRM Calculation Spreadsheet)	
** Reviewing agency will have discretion on interpreting whether a system shall be characterized as Minor or Major, depending on local risk factors, local drainage needs, anticipated project phasing, and history of flooding within the immediate area.*			

BMP Considerations

Extensive literature is available on specific design concepts and alternatives, and selected references are available from the Low Impact Development Manual of Michigan:

http://www.semcog.org/reports/lid/files/assets/basic-html/page-1.html#

Diagrams and details for structural BMPs, such as bioretention systems, rain gardens, pervious pavement, dry wells, green roofs, and water reuse are contained within Section V: Design Requirements for Stormwater Management Systems. Several other non-structural Best Management Practices (BMPs) are referenced within Section IV: Part D: Sizing Requirements for Non-Structural Credits.

2. STORMWATER MANAGEMENT FOR REDEVELOPED SITES

If redevelopment for any existing site proposes greater than ½ acre of new or replaced impervious area or more than 1 acre of total disturbed area, the stormwater management system performance must be brought up to the current infiltration requirements for stormwater quality.

The portion of the redeveloped area that shall meet the requirements in this section is that portion of a property that is disturbed and improved. For example, if a site plan for an existing 10-acre industrial facility calls for the replacement of its 4-acre parking lot (without changes to the building footprint), only the 4-acre area shall be considered when computing runoff volumes and infiltration volume requirements.

To manage water quality on redevelopment sites, infiltration will be required as detailed in Part A.1 of this Section. Pre-development conditions are the conditions of the site at the time of the site plan submittal.

Note for designers*: In cases where an existing commercial site is redeveloped without a substantial increase in impervious area, it is likely that the first flush volume (1-inch storm) will determine the required infiltration volume, as there will be a negligible increase in bankfull (i.e. channel protection) volume.*

The method to calculate required storage volume for flood control (25-year storm) is as detailed in Part A.1 of this Section. Pre-development conditions are the conditions of the site at the time of the site plan submittal.

Note for designers*: In cases where an existing commercial site is redeveloped without a substantial increase in impervious area, it is possible that the flood control volume may be achieved using the water quality volume. In these cases, it may not be necessary to have a secondary detention basin.*

3. STORMWATER DISCHARGE REQUIREMENTS

In no event will the maximum design peak rate of runoff exceed the maximum flow capacity of the downstream land, channel, pipe, or watercourse. It is the developer's obligation to meet this standard. Should a stormwater system, as constructed, fail to comply with this standard, the developer, at their own expense, shall be responsible for designing and constructing, or having constructed, any necessary additional and/or alternative stormwater management facilities. Such additional facilities will be subject to review and approval.

The allowable 25-year peak flow rate from the development shall be determined using the default or downstream restriction scenario options as outlined in Part A.1. of this Section. The allowable 10-year peak flow rate from the flood control storage basin shall not be greater than the 10-year pre-development peak flow rate as determined by the NRCS Curve Number Method.

A description of the drainage course that will be utilized as the stormwater outlet, along with evidence that the outlet is adequate for the proposed discharge, shall be provided. It is noted that controlling flow to a rate that is equal to or less than the pre-development rate may not be considered to be evidence of adequacy. The Engineer's Certificate of Outlet, Appendix G, must be provided, including the signature and seal of the Professional Engineer responsible for determining adequacy.

If no adequate watercourse exists to effectively receive a concentrated flow of runoff from the proposed development, additional measures must be taken. These measures may include volume control, acquisition of easements from downstream property owners, construction of off-site stormwater infrastructure, etc. If easements are required, it is the responsibility of the developer to secure any necessary easement(s) from downstream property owners. Typical easement language is provided in Appendix A.

Discharge should outlet within the watershed where flows originate, and generally may not be diverted to another watershed or subwatershed.

Part B: Sizing Requirements– Standard Method Computations

The following calculation method has been developed to simplify the design process and provide a quick and standardized way of determining key volumes used for stormwater controls. The optional Stormwater Design Spreadsheet tool (available from the City of Battle Creek or the Calhoun County Water Resources Commissioner) can be used to calculate volumes for required infiltration and flood control. Use of the spreadsheet is recommended, but not required, to ensure an expedited site plan review. The methods and equations that follow provide the technical methodology to calculate peak

flows and stormwater control volumes; they are duplicated in the Stormwater Design Spreadsheet. ***Using the spreadsheet does not relieve the designer from confirming and certifying the calculations.***

1. STANDARD METHOD OVERVIEW

When calculating runoff using the Standard Method, the following two-step approach will be used:

Step 1.

Determine the first flush (1-inch rainfall) runoff volume using the Rational Method. This method was chosen due to the underestimation of runoff volume that the NRCS Curve Number Method yields for rainfall of one inch or less.

Step 2.

Determine the bankfull (2-year), 10-year, 25-year, and, if required, 100-year runoff volumes using the NRCS Curve Number Method for both pre-development and developed conditions. All rainfall depths shall be based on NOAA Atlas 14 Point Precipitation Frequency Estimates (latest available version) and are subject to modification as NOAA updates the official rainfall statistics for the Michigan region. *References to previous rainfall statistics, including TP 40 and Bulletin 71, shall not be permitted, as these data sets are not based on recent climate data and are therefore considered obsolete.*

2. RUNOFF DETERMINATION – CURVE NUMBER METHOD

Introduction

The Curve Number Method is the standard methodology and must be used to determine bankfull, 10-year and 25-year runoff volumes for all developed sites. Runoff can be calculated using the curve number, rainfall, and time of concentration. Curve numbers are determined by land cover type, hydrologic condition, and hydrologic soil group (HSG), see Table 4. Antecedent Moisture Condition II (AMC II) is the default condition for the selection of all curve numbers.

Hydrologic Soil Groups

Soil properties influence the process of generating runoff from rainfall and must be considered in methods of runoff estimation. When runoff from individual storms is the major concern, the properties can be represented by a hydrologic parameter that reflects the minimum rate of infiltration obtained for a bare soil after prolonged wetting.

The hydrologic soil groups (types), as defined by the NRCS, are:

Type A

Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well- to excessively-drained sands or gravels. These soils have a high rate of water transmission. Generally, all Type A soils are good candidates for infiltration BMPs, provided the water table is at least 2 feet below the bottom of the BMP cross section.

Type B

Soils having moderate infiltration rates when thoroughly wetted and consisting of moderately deep to deep, moderately well- to well-drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission. Generally, most Type B soils are good candidates for infiltration BMPs, provided the water table is at least 2 feet below the bottom of the BMP cross section.

Type C

Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes the downward movement of water or soils with moderately fine to fine texture. These soils have a slow rate of water infiltration. Generally, some (but not all) Type C soils are good candidates for infiltration BMPs, provided the water table is at least 2 feet below the bottom of the BMP cross section.

Type D

These soils have very poor drainage and a high runoff potential. Generally, Type D soils preclude the use of infiltration BMPs for stormwater management. Given the high curve numbers associated with Type D soils, this soil classification is not considered valid for any pre-development peak flow rate calculation, as it sets an unreasonably-high peak flow rate for pre-development conditions. ***Where Type D soils are encountered using USDA soils data, Type C soils shall be assumed for design purposes.***

For a full description on soil types, see the EGLE document "Computing Flood Discharges for Small Ungaged Watersheds" by Richard Sorrell. For a list of acceptable curve numbers adapted from TR-55, see Table 4.

Land Cover Types

In the NRCS method of runoff estimation, the effects of the surface conditions of watershed are evaluated by means of land cover and land treatment classes. Land cover is the watershed cover and it includes every kind of vegetation, litter, mulch, and fallow (bare soil), as well as non-agricultural uses such as water surfaces (lakes, wetlands, etc.) and impervious surfaces, such as roads, roofs, etc.

Table 4: Commonly Used Curve Numbers (CNs) from TR-55 (AMC2)[3]

Cover Type and Hydrologic Condition	A	B	C
Fully developed urban areas (vegetation established) ***OR*** *Open space (lawns, parks, golf course, cemeteries, etc)*	39	61	74
Impervious areas: Paved parking lots, roofs, driveways, etc. (excluding right-of-ways)	98	98	98
Streets and Roads:			
Paved; curbs and storm sewers (excluding right-of-way)	98	98	98
Paved; open ditches (including right-of-way)	83	89	92
Gravel (including right-of-way)	76	85	89
Pasture, grassland or range - continuous forage for grazing	39	61	74
Meadow - continuous grass, protected from grazing and generally mowed for hay	30	58	71
Brush - brush-weed-grass mixture with brush the major element	30	48	65
Woods - grass combination (orchard or tree farm)	32	58	72
Woods	30	55	70
Farmsteads- buildings, lanes, driveways and surrounding lots	59	74	82

[3] This table has been modified to remove the Poor and Fair options for existing conditions

Land treatment applies mainly to agricultural land uses and includes mechanical practices such as contouring and terracing, as well as management practices like grazing control and crop rotation. The classes consist of cover and treatment combinations typically found on watersheds.

Runoff Calculations

The Runoff Curve Number Method, developed by the Natural Resources Conservation Service (NRCS), 1986, is one of the most commonly used methods for estimating peak flows and runoff volumes. In this method, runoff is calculated based on precipitation, curve number, watershed retention, and initial abstraction. When rainfall is greater than the initial abstraction, runoff is calculated by:

EQUATION

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$Q =$ runoff (in.)

$P =$ rainfall (in.)

$I_a =$ initial abstraction (in.)

$S =$ potential maximum retention after runoff begins (in.)

Initial abstraction (I_a) includes all losses before the start of surface runoff: depression storage, interception, evaporation, infiltration, etc. I_a can be highly variable, but NRCS has found that it can be empirically approximated by:

EQUATION

$$I_a = 0.2 * S$$

Therefore, the runoff equation becomes:

EQUATION

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

Finally, S is a function of the watershed soil and cover conditions as represented by the runoff curve number (CN).

EQUATION

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

Flood Control Detention Volume = 25-year Post-Development Runoff Volume – 25-year Pre-development Runoff Volume – Infiltration Requirement Volume

EQUATION

$$V_{detention} = V_{25yr\ Post} - V_{25yr\ \ Pre} - V_{inf}$$

Hydraulically constricted drains

For developments with hydraulically-constrained outlets, a modification to the NRCS method was created to incorporate the time of concentration for the 25-year storm event calculations, where time of concentration can be calculated by:

EQUATION

$$T_c = \frac{L}{V * 3600}$$

T_c= time of concentration (hr)

L= length of flow path (ft)

V= velocity (fps)

This method utilizes the EGLE unit peak flow rate calculation procedure described in the document, "Computing Flood Discharges for Small Ungaged Watersheds" by Richard Sorrell (2010). Equation 9.1

Velocity

$$V = K * S^{0.5}$$

Where:

K = Coefficient determined by type of Flow Path

S = Slope of Flow Path (%)

Peak Discharge

$$Q_p = q_u * A_m * Q * F_p$$

Where:

Q_p = Peak Discharge (cfs)

q_u = Unit Peak Discharge

A_m = Site Area (sq. mi.)

Q = Runoff (in)

F_p = Ponding Factor (assumed to be 1.0 – no ponding)

Unit Peak Discharge

$$Log(q_u) = C_0 + C_1 * \log(T_c) + C_2 * \left(Log(T_c)\right)^2$$

Where:

q_u = Unit Peak Discharge

C_0, C_1, and C_2 = Coefficients from Rainfall Table Type II, based on I_a/P ratio (equation obtained from *Appendix F* of *Urban Hydrology for Small Watersheds)*

T_c = Time of Concentration (hrs)

Delta

To simplify the NRCS method, the change (Δ) in flow (Q_p) is used to determine the final 25-yr storm detention requirement based on peak flow (PF) from the site in cubic feet per second where:

The change (Δ) in flow can be quantified with the Area (A) in acres expressed as:

EQUATION

$$\Delta = PF - Q_a * A$$

Where:

PF = Peak Flow (100-year pre-development peak discharge)

Q_a = Allowable Flow (as determined by the local reviewing agency)

A = Site Area (acres)

Detention Volume

The 25-yr detention volume (V_{det}) can then be determined via substitution of (V_p) into the following:

EQUATION

$$V_{det} = \left(\frac{\Delta}{Q_p}\right) * V_{25} - V_{inf}$$

3. RUNOFF DETERMINATION – COMPUTER BASED METHODS

More precise methodologies for predicting runoff, such as runoff hydrographs, are widely available, and may be required by the reviewing agency for sizing the drainage systems on large sites and/or smaller sites that are deemed potentially problematic. It is in the applicant's best interest to discuss acceptable alternatives for these or other unusual situations prior proceeding with site layout calculations. Acceptable alternative methods may include:

- U.S. Army Corps of Engineers HEC-HMS
- Natural Resources Conservation Service WinTR-20 and WinTR-55
- U.S. EPA's Stormwater Management Model (EPA SWMM, latest available version)

Unless a continuous simulation approach to drainage system hydrology is used, all design rainfall events will be based on the NRCS (formerly SCS) Type II 24-hour distribution, with an antecedent moisture condition 2 (AMC 2). Computer programs such as HEC-HMS, WinTR-20, WinTR-55, EPA SWMM, as well as EGLE permit applications and other relevant information can be downloaded free of charge from the respective agency websites.

Part C: Computational Requirements – BMP Sizing

The following structural BMPs can be utilized to reduce the amount of detention/retention volume required. Bioretention, rain gardens, porous pavement, infiltration basins, subsurface infiltration beds, infiltration trenches, vegetated swales, green roofs, and water reuse can all be used to meet some or all of the first flush/bankfull infiltration requirement for sites with adequate infiltration rates. See Chapter V: Design Requirements for Stormwater Management Systems and Section V: Part D: Item 2: Soil Infiltration Testing Guidelines. Peak flow rates and required storage volumes can be calculated using the Calhoun County TRM Calculation Spreadsheet, available from the websites of the City of Battle Creek or the Calhoun County Water Resources Commissioner.

For the purposes of site suitability, areas with tested soil infiltration rates as low as 0.1 inches per hour may be used for infiltration. To provide for adequate dewatering time, a perforated underdrain shall be provided for BMPs with in-situ infiltration rates between 0.1 and 0.4 inches per hour.

1. BIORETENTION/RAIN GARDENS

(Can be used to meet infiltration and storage requirements.)

Infiltration Area Calculation

The Infiltration Area is the average area of a Bioretention Basin or Rain Garden defined as:

$$BMP\ Area\ (Avg. Infiltration\ Area) = \frac{Area\ of\ Biorention\ at\ Ponding\ Depth\ (ft^2)\ + Area\ of\ Biorention\ at\ Bottom\ (ft^2)}{2}$$

*<u>Note to designers:</u> For bioretention areas, the BMP Area is typically about 5% of the tributary **impervious** area that drains to that BMP. Although this is only preliminary guidance on sizing BMPs, it should serve as a useful "first cut" at determining approximate BMP sizing. For sandy soils with high in-situ infiltration rates (i.e. > 1 inch/hour), the BMP Area will tend to be smaller than 5% of the tributary impervious area. For tighter soils with minimum in-situ infiltration values (i.e. ~ 0.1 – 0.2 inches/hour), the BMP Area will tend to be larger than 5% of the tributary impervious area.*

Volume Calculations

The storage volume of a Bioretention Basin or Rain Garden is defined as the sum total of the surface storage, subsurface void space within the engineered soil media, and the infiltration volume occurring during a six-hour period during the design storm. The infiltration volume is calculated using the in-situ infiltration rate of the underlying soils.

The volume of a Bioretention Basin or Rain Garden has three components:

1. $Surface\ Storage\ Volume\ (ft^3) = BMP\ Area\ (ft^2) * Maximum\ Design\ Water\ Depth\ (ft)$
2. $Soil\ Storage\ Volume\ (ft^3) = Length\ (ft) * Width\ (ft) * Depth\ (ft) * Void\ Ratio\ of\ Storage\ Material\ (\%)$
3. $Infiltration\ Volume\ (ft^3) = Infiltration\ Rate\ \left(\frac{in}{hr}\right) * 6\ hrs * BMP\ Area\ (ft^2) * \left(\frac{1\ ft}{12\ in}\right)$

Total Bioretention Basin or Rain Garden Volume (ft^3) =

Surface Storage Volume (ft^3) + Subsurface Storage (ft^3) + Infiltration Volume (ft^3)

Where:

Void Ratio of Storage Material (engineered soil backfill) = 0.30 (larger values may not be used)

2. INFILTRATION BASIN/TRENCH

(Can be used to meet infiltration volume requirements.)

Infiltration Area and Volume Calculations

Infiltration area and volume reduction calculations are the same as for bioretention BMPs.

3. POROUS PAVEMENT

(Can be used to meet infiltration volume requirements.)

Porous pavements are an effective BMP to reduce runoff volume and promote stormwater infiltration. Generally, porous pavements should be avoided in the following areas:

- On areas with compacted fill soils or with a robust tree canopy
- On sites with high pollutant loads, including sites that receive constant sediment, trash, or other debris, places where chemicals are stored or handled
- On sites where it will be difficult to access the entire porous pavement area (on a regular basis) for sweeping and/or vacuuming

Infiltration Area Calculations

The infiltration area shall be established as the minimum footprint of porous pavement required to meet the site infiltration volume requirement. This will depend on the cross section of porous pavement (i.e. total volume in the void space) and the in-situ infiltration rate.

Volume Calculations

$$Runoff\ Volume\ (ft^3) = Depth\ (ft) * Area\ (ft^2) * Void\ Space$$

$$Infiltration\ Volume\ (ft^3) = Infiltration\ Rate\ \left(\frac{in}{hr}\right) * 6\ hrs * Bed\ Bottom\ Area\ (ft^2) * \left(\frac{1\ ft}{12\ in}\right)$$

Where:

Depth = Depth of water stored in the reservoir layer of the pavement cross section during a storm event. The reservoir layer is the layer of open-graded stone beneath the pavement layer. The pavement layer shall ***not*** be considered part of the reservoir layer.

Void Ratio of Storage Material = 0.30 Maximum

4. DRY WELLS

Dry wells are discouraged for infiltration design, as their effectiveness as a stormwater BMP is questionable for the following reasons:

- Small footprint results in insignificant storage volumes and infiltration capacity
- Solids accumulation in dry wells will generally render them ineffective without either pre-treatment or regular removal/replacement of dry well material, both of which are generally cost-ineffective.

5. BIOSWALE

(Can be used to meet infiltration requirements.)

Volume Calculations

If check dams are utilized within the Bioswale, the volume behind each check dam can be estimated from the following:

$$Storage\ Volume\ (ft^3) = 0.5 * Length\ of\ Swale\ Impoundment\ Area\ per\ Check\ Dam\ (ft) * Depth\ of\ Check\ Dam\ (ft) * \frac{Top\ Width\ of\ Check\ Dam\ (ft) + Bottom\ Width\ of\ Check\ Dam\ (ft)}{2}$$

$$Infiltration\ Volume\ (ft^3) = Infiltration\ Rate\ \left(\frac{in}{hr}\right) * 6\ hrs * Bed\ Bottom\ Area\ (ft^2) * \left(\frac{1\ ft}{12\ in}\right)$$

6. GREEN ROOFS

(Can be used to meet infiltration and storage requirements.)

Volume Calculations

Green roof covers may have both retention and detention volume components. The effectiveness of green roof covers will vary according to the design and the regional pattern of rainfall and will require local weather data for calculations. The green roof runoff credit will be determined by subtracting the difference between a standard roof and the proposed green roof runoff volumes.

Peak Rate Mitigation

Green roof covers have a significant influence on runoff peak rates derived from roofs. Green roofs will reduce the composite curve number for a development by changing the rooftop area from impervious to pervious. These changes can be accounted for in the post-development runoff volume calculations, which will tend to reduce the required flood control storage volume and infiltration storage volume.

7. WATER REUSE

(Can be used to meet infiltration and storage requirements.)

Water reuse consists of storage vessels, such as rain barrels or cisterns, which store a specified volume of stormwater runoff and release (reuse) the runoff volume for onsite irrigation. The applicant shall provide a dewatering strategy for such storage vessels that specifies the timing and method(s) of dewatering. To qualify as meeting the infiltration volume requirement, all storage vessels shall be completely dewatered within 72 hours of a rainfall event, and all vessels shall discharge only to pervious surfaces.

Volume Calculations

The total aggregate storage volume shall be equal to the total storage volume of all storage vessels identified in the site plan.

Part D: Credits for Natural Area Preservation and Non-Structural BMPs

The use of Non-Structural BMPs is an important part of project's stormwater management system and deserves to be properly credited in the calculation process. However, these Non-Structural BMPs must be correctly implemented to be effective. The use of these calculation credits for Non-Structural BMPs must be documented fully.

The following Non-Structural BMPs are "self-crediting" in that the use of these BMPs automatically provides a reduction in impervious area and/or stormwater runoff (e.g., smaller curve number) and a corresponding reduction in the stormwater management requirements set forth by these Rules. When "self-crediting" BMPs are applied on a site, the land cover area may, in some cases, be excluded from the calculations as a runoff contributor, therefore reducing the required amount of infiltration and/or storage. Additionally, the use of these BMPs may be affected by other regulations/guidance (Master Plans, zoning, subdivision, etc.).

These non-structural BMPs are strongly encouraged:

- Protect Natural/Special Value Features
- Protect/Conserve/Enhance Riparian Areas
- Protect/Utilize Natural Flow Pathways

- Preserve Open Space (e.g. clustering)
- Reduce Street Width/Area
- Reduce Parking Width/Area
- Minimize Disturbed Area
- Protection of Existing Trees (part of minimizing disturbance)
- Re-Vegetate and Re-Forest Disturbed Areas
- Rooftop Runoff (downspout) Disconnection
- Disconnection of Impervious Areas (Non-Roof)

Table 5 lists key site design features (including both structural and non-structural BMPs) that can be used by developers to reduce the impact of development on stormwater runoff:

Table 5: Green Infrastructure Techniques – Hydrologic Impacts

	Green Infrastructure Component (BMP)													
Hydrologic Characteristic	Flatten Slope	Maximize/protect natural flow path	Increase surface roughness	Minimize disturbed area (preserve open space)	Preserve woodland areas	Install bioswales / infiltration swales	Install vegetative filter strips	Install bioretention / rain gardens	Install in-line pipe/sewer restriction	Install pervious pavement	Reduce street width / parking width	Install rain barrels / cisterns	Install green roofs	Disconnect impervious surfaces
Minimize impervious area (reduced runoff coefficient, c)				X	X					X	X		X	X
Increase time of concentration, T_c	X	X	X		X		X	X			X		X	X
Control/reduce runoff volume				X	X	X		X		X	X	X	X	X
Control/reduce peak flows	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Although these BMPs are self-crediting and are not further elaborated in these recommended procedures, the applicant may use these BMPs to impact the runoff curve numbers, times of concentration, and contributing drainage areas used to establish the design volumes for flood control, infiltration, and water quality as detailed in these Rules.

Any naturalized area that is proposed to be protected from disturbance/development must be clearly indicated on the site plan and noted by land area.

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2019 Stormwater Technical Reference Manual (TRM)

SECTION V Design Requirements and Guidelines for Stormwater Management Systems

Part A: Purpose & Introduction

Both onsite water quantity and quality must be managed in order to control flooding, reduce downstream erosion, and protect water quality. To manage the portion of runoff that is not managed through infiltration BMPs or treatment devices, detention basins must be designed to control the peak flows up to a 25-year / 24-hour storm event. Retention basins with no outlet shall be capable of storing the runoff generated from a 100-year / 24-hour duration storm.

In developments that have county drainage districts and established drains, the maintenance of standard stormwater infrastructure and stormwater BMPs is the responsibility of the property owner or governing association (i.e. Home Owners Association, or HOA) of the development. In the event that the owner or governing association does not complete the required maintenance, the local agency with jurisdiction will complete maintenance that is deemed necessary to assure appropriate operation of the stormwater system and assess/charge the property owner(s) for the work. Maintenance that is required solely for aesthetic purposes will not be completed by the local government jurisdiction (review agency). For developments which require stormwater structures to cross or parallel County drains, the permit provided in Appendix J must be completed.

1. EASEMENTS
   Wording relative to easements will be specifically required by the reviewing agency. If a county drain is to be established under the Michigan Drain Code, related easement language will be depicted on final plats and condominium drawings (in pdf format) as follows: " __ foot wide private easement to Calhoun County Water Resources Commissioner and the ____ Homeowner's (or Condominium) Association for drainage."

   The typical easement language specified in Appendix AH will be included in the subdivision deed restrictions or condominium master deed. The location and purpose of drainage easements should be clearly described in subdivision deed restriction or condominium master deeds. Language will be included within the subdivision deed restriction or condominium master deed that clearly notifies property owners of the presence of stormwater management facilities and accompanying easements, as well as restrictions on the use or modification of these areas.

   Easement widths will be determined by the Water Resources Commissioner and be situated in such a way as to allow maximum maintenance access, for example, offsetting them from the centerline. In general, easement widths will conform to the following:

   a. Open channels and watercourses: A minimum of 50 feet total width. Additional width may be required in some cases, including but not limited to: watercourse with floodplains delineated by FEMA; sandy soils, steep slopes, at access points from road crossings.

   b. Open swales (cross lot drainage): minimum of 30 feet total width.

   c. Enclosed storm drains: A minimum of 20 feet will be required, situated in such a way as to allow maximum maintenance access. Additional width will be required in some cases. These may

include but are not limited to, pipe depths exceeding 4 feet from the top of pipe, sandy soils and steep slopes.

d. Retention/detention basins or other stormwater management facilities will have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils, deposition and other activities identified in the development's stormwater management plan. Drain fields (septic areas) must not be located within drainage easements.

2. MAINTENANCE

Stormwater Management System Maintenance Plans

A Stormwater Management Maintenance Agreement (See Appendix C) will be submitted with all construction plans and included in the subdivision agreement or master deed documents of all subdivisions and site condominiums.

These plans must include the following information:

a. An annual maintenance budget itemized in detail by task. The financing mechanism must also be described.

b. A copy of the final approved drainage plan for the development that delineates the facilities and all easements, maintenance access, and buffer areas.

c. A listing of appropriate tasks defined for each component of the system, and a schedule for their implementation.

   The following areas will be covered:

   i. Maintenance of facilities such as pipes, channels, outflow control structures, infiltration devices and other structures.

   ii. Debris removal from catch basins, channels and basins.

   iii. Mulch removal and replacement within infiltration BMPs, if applicable.

   iv. Vegetation maintenance, including replanting, invasive species removal, etc.

   v. Dredging operations for both channels and basins to remove sediment accumulation.

d. The party responsible for performing each of the various maintenance activities described will be recorded with final approved plans and plats.

e. A detailed description of the procedure for both preventative and corrective maintenance activities. The preventative maintenance component will include:

   i. Periodic inspections (at least annually), adjustments and replacements.

   ii. Record-keeping of operations and expenditures.

f. Provision for the routine and non-routine inspection of all components within the system:

   i. Wet weather inspections of structural elements and inspection for sediment accumulation in detention basins must be conducted annually, with as-built plans in hand. Inspections should be carried out by the appropriate party reporting to the responsible agency or owner.

ii. Housekeeping inspections, such as checking for trash, should take place at least twice per year.

g. A description of ongoing landscape maintenance needs. Landscaping must consist of low maintenance and/ or native plant species. The developer/owner will monitor the viability of plantings for at least one year after establishment and plantings will be replaced as needed. Subsequent monitoring must be conducted by the landowner or development association. The local government jurisdiction (review agency) is not responsible for landscape maintenance.

h. Provision for the maintenance of vegetative buffers by landowner, development associations, conservation groups or public agencies. Buffers must be inspected annually for evidence of erosion or concentrated flows through or around the buffer.

i. A sample maintenance plan is illustrated in Appendix K.

Maintenance Responsibility

a. Property deed restrictions or condominium master deed documents will specify the entities responsible for inspection and maintenance of the stormwater management facilities and the timeframe for these activities. Primary responsibility will fall upon the property owner, Homeowners Association or Condominium Association, with the reviewing agency having responsibility only for inspection of the facilities to verify functionality and upkeep. The restrictions or documents will also specify that the governmental entity (i.e. reviewing agency) may perform inspections and complete maintenance in lieu of the primary when it is found to be necessary and assess costs associated with these activities against the property owners within the subdivision or condominium and other entities as determined appropriate.

   i. Routine maintenance of stormwater management facilities will be completed per the schedule submitted with the construction plans or within 30 days of receipt of written notification by the responsible governmental entity that action is required, unless other acceptable arrangements are made with the supervising governmental entity.

   ii. Emergency maintenance will be completed within 36 hours of written notification unless threat to public health, safety and welfare requires immediate action.

b. For systems with multiple individual users, such as site condominiums or subdivisions, the developer may fulfill the obligation to ensure that a governmental entity will be responsible for drainage system maintenance by establishing a county drainage district, or any other similar mechanism approved by the Water Resources Commissioner, to provide for the permanent maintenance of stormwater management facilities and necessary funding.

   If a county drain is not established, the developer will submit evidence of a legally binding agreement with another governmental agency responsible for maintenance oversight (see Appendix C).

c. A legally binding maintenance agreement will be executed before final project approval is granted. The agreement must be included in the property deed restrictions or condominium master deed documents so that it is binding on all subsequent property owners.

Part B: Design Requirements – Natural Wetlands & Floodplains

1. WETLANDS

   This section governs natural wetlands (differing from stormwater wetland systems that are constructed expressly for stormwater management purposes), when a natural wetland is incorporated in an overall stormwater management scheme.

   a. Wetlands will be protected from damaging modification and adverse changes in runoff quality and quantity associated with land developments. Approval of the final plan will be contingent upon securing all necessary wetland permits from EGLE and local governments.

   b. Direct discharge of untreated stormwater to a natural wetland is prohibited. All runoff from the development will be pre-treated to remove sediment and other pollutants prior to discharge to a wetland. Such treatment facilities will be constructed before property grading begins, and proved to be fully functional prior to acceptance.

   c. Site drainage patterns will not be altered in ways that will modify existing water levels in protected wetlands without proof that all applicable permits from EGLE and/or local government agencies have been obtained.

   d. A qualified professional with specific wetland expertise will oversee wetland construction, re-construction, and/or modification, and provide professional certification of construction in accordance with the approved plans.

   e. A fifteen (15) foot permanent buffer strip, vegetated with non-woody plant species, will be maintained or restored around the periphery of wet basins, or wetlands. Dry basins will not require the buffer strip. See the most recent LID Manual for Michigan, section "Recommended Plant Lists for Best Management Practices" for a guide on Native Plant Species to begin development of wetland buffer planting plans.

   f. Wetlands shall be protected during construction by appropriate soil erosion and sediment control measures.

2. FLOODPLAINS

   a. All necessary floodplain permits from EGLE and local governments must be in place prior to final plan approval.

   b. It is the responsibility of the developer to demonstrate that any activity proposed within a 100-year floodplain will not diminish flood storage capacity.

   c. In certain instances, such as areas without detailed floodplain mapping, an analysis to determine the 100-year floodplain may be required. Where available, the local community Flood Insurance Study (latest edition) shall be used.

   d. Compensatory storage will be required for all lost floodplain storage.

   e. The placement of storage facilities or infiltration BMPs within the 100-year floodplain is generally discouraged but may be allowed if the developer can demonstrate the functionality of BMPs through modeling. BMPs in the floodplain are considered more practical when the drainage area of the floodplain in question is so large relative to the development that the probability of coincidental peak flows is very low (e.g., a 20-acre development discharges to a stream that has a 100-square mile drainage area).

Part C: Design Requirements – Storage Facilities

1. GENERAL REQUIREMENTS
   All runoff generated by proposed development surfaces must be conveyed into stormwater treatment/infiltration areas (per Section IV) and then to a flood control retention/detention facility prior to being discharged from the site. The following criteria will apply to the design of all stormwater BMPs, retention and detention facilities.

   a. Stormwater must be pre-treated as discussed in Section IV prior to entering into retention/detention facilities.

   b. Use of decentralized Low Impact Development Stormwater BMPs, green roofs, bioretention, or water reuse cisterns are preferred options for controlling runoff volume and water quality treatment.

   c. Utilization of centralized infiltration BMPs (as defined in Section IV) will require that stormwater be pre-treated by passage through a mechanical swirl separator or other approved BMP prior to entering the infiltration BMP facility. Mechanical swirl separators function to reduce incoming water velocity, and to trap sediments making their removal easier during maintenance.

   d. Public safety is paramount when considering stormwater system and retention/detention facility design. Providing a safe design for stormwater storage is the developer's responsibility. Retention/detention facility designs will incorporate gradual side slopes, vegetative and barrier plantings, and safety shelves. Where further safety measures are required, the developer is expected to include them within the proposed development plans.

   e. BMPs and retention/detention facilities must be located on common-owned property in multi-ownership developments such as subdivisions and site condominiums, and not on private lots or condominium units. The BMPs must be fully-accessible for inspection and regular maintenance.

   f. For land divisions, the retention/detention system must be located in a drain easement.

   g. Where finished grades indicate a substantial amount of drainage across adjoining lots, a drainage swale of sufficient width, depth and slope shall be provided on the lot line to intercept this drainage. To ensure that property owners do not alter or fill drainage swales, easements will be required over areas deemed necessary by the reviewing agency, as stipulated in 0 of these standards. Areas within open drain easements that have been cleaned, reshaped or distributed in any manner will be stabilized with appropriate protection and vegetation measures immediately.

2. PROHIBITIONS

   a. Stormwater management systems incorporating pumps are not permitted.

   b. In-line detention basins are strongly discouraged in all circumstances, and are prohibited on watercourses greater than 2 square miles upstream or on a county drain. In-line basins are also prohibited if the waterway to be impounded traverses any area outside of the proposed development.

   c. The placement of retention/detention basins within a 100- year floodplain is generally discouraged but may be allowed if the developer can demonstrate the functionality of the basins through modeling. Detention and retention basins in the floodplain are considered more practical when the drainage area of the floodplain in question is so large relative to the

development that the probability of coincidental peak flows is very low (e.g., a 20-acre development discharges to a stream that has a 100-square mile drainage area).

d. Storage within regulated local, state or federal wetlands is prohibited.

3. TESTING REQUIREMENTS – INFILTRATION
   See Section IV for soil testing parameters.

4. BASIN INLET/OUTLET DESIGN REQUIREMENTS

   a. Outlets must be designed for the protection of the receiving waterway.

   b. Velocity dissipation measures shall be incorporated into basin designs to minimize erosion at inlets and outlets, and to minimize the resuspension of pollutants. Additional calculations may be required to demonstrate the effectiveness of the dissipation measure(s).

   c. The distance between detention basin inlets and outlets shall be maximized. The length and depth of the flow path across basins and marsh systems can be maximized by:

      i. Increasing the length to width ratio of the basin.

      ii. Increasing the dry weather flow path within the system to attain maximum sinuosity. Inlets and outlets should be offset at opposite longitudinal ends of the basin.

   d. It is required to use an outlet control structure with appropriate hydraulic controls (pipes, orifices, weirs) sized to assure an appropriate detention time.

   e. When a pipe outlet or orifice plate is used to control discharge, it shall have a minimum diameter of 4 inches. If this minimum orifice size permits release rates greater than those specified in these rules, an alternative outlet design that incorporates self-cleaning flow restrictors is required. Examples include perforated risers and “V” notch orifice plates that provide the required release rate. Calculations verifying this rate will be submitted to the reviewing agency for approval.

   f. Any backwater effects on the outlet structure caused by the downstream drainage system shall be evaluated when designing the outlet. This may require additional modeling and may be requested by the reviewing agency.

Outlet Control Structure Design

a. Inlet and outlet barrels and risers will be constructed of materials approved by the reviewing agency; reinforced concrete is the preferred material. The minimum diameter for riser pipes is 48 inches.

b. The outlet control structure must be set into a cast-in-place concrete base or properly grouted to a pre-cast concrete base. All riser pipes constructed of material other than concrete must be set into a cast-in-place base.

c. The outlet control structure shall be designed to overflow for storm events greater than the 25-year recurrence interval and shall be able to pass the 25-year peak flow rate from the incoming storm sewer. All orifice configurations must be sized to restrict to the allowable peak flow. When the infiltration requirement is waived, a 2-year orifice will also be required to control the 2-year peak flow to that of pre-development conditions.

d. The outlet control structure must be placed within the embankment and the emergency spillway to provide an overflow for the basin and for maintenance access.

e. An end section grate must be installed on inlet/outlet pipes to prevent clogging. Grate openings must be a maximum of three inches to center. End section grates must be installed on all outlet pipes of 24 inches and greater to prevent entrance by children.

f. All outlets will be designed to be easily accessible by heavy equipment required for maintenance purposes.

Piping Requirements

a. Anti-seep collars should be installed on any piping passing through the sides or bottom of the basin to prevent leakage through the embankment.

b. Pipe inverts will be such that all sections will drain completely during dry weather.

5. STORAGE FACILITY COMPONENTS

Spillway

All basins shall have provisions for a defined emergency spillway, routed such that it will flow unobstructed to the main outflow channel.

a. The emergency spillway elevation shall be set at the elevation of the maximum retention/detention facility design volume.

b. The spillway shall be sized to pass the 100-year peak flow tributary to the retention/detention facility under developed conditions.

Slopes

For safety purposes and to minimize erosion, basin side slopes shall not be steeper than one-foot vertical to five feet horizontal (5:1). In general, the side slopes must not be flatter than one-foot vertical to 20 feet horizontal (20:1). The reviewing agency may consider slopes steeper than one-foot vertical to 3 feet horizontal (3:1), but only when additional safety features are added, such as a safety shelf and/or perimeter fencing. It is the responsibility of the local reviewing agency to recommend perimeter fencing, on a case by case basis, based on site characteristics and public safety.

A minimum of one foot of freeboard shall be required above the 25-year recurrence interval stormwater elevation on all detention/retention facilities.

A minimum of one foot of freeboard shall be required above the 100-year recurrence interval peak water elevation on all ***retention*** facilities

Wet Detention Facility

Note: due to the requirements in this TRM pertaining to infiltration, the total runoff volume entering detention facilities is expected to be very low relative to past practices. As such, the practicality of wet detention facilities may be in question due to the lack of available inflow. It is most likely that wet detention facilities may only be practical for large drainage areas and/or for spring-fed ponds lined with impermeable soils.

Storage volume on a gravity outflow wet basin is defined as the volume of detention provided above the invert of the outflow device. Any volume provided below the invert of the outflow device will not be considered as detention. At a minimum, the volume of the permanent pool should be at least 2.5 times the water quality volume from the area tributary to the basin.

Volume of Permanent Pool (ft^3) = 2.5 x Water Quality Volume (ft^3)

The Water Quality Volume is equal to the runoff volume resulting from 1 inch of rainfall

Wet detention facility configuration will be as follows:

i. Surface area to volume ratio must be maximized to the extent feasible.

ii. In general, depths of the permanent pool must be varied and average a minimum of four (4) feet.

iii. A minimum length to width ratio of 3:1 is preferred unless structural measures are used to extend the flow path.

iv. Wedge-shaped retention/detention facilities that are narrower at the inlet, wider at the outlet and with irregular shorelines are preferred.

v. A flat safety shelf, a minimum of 4 feet wide at a depth of one foot, shall surround the interior of the perimeter to provide suitable conditions for the establishment of aquatic vegetation, and to reduce the potential safety hazard to the public.

vi. To avoid drawdown, a reliable supply of baseflow and/or groundwater will be required.

6. VEGETATIVE PLANTINGS ASSOCIATED WITH RETENTION/DETENTION FACILITIES

Basin designs shall be accompanied by a landscaping plan that incorporates plant species native to the local region and indicates how aquatic and terrestrial areas will be vegetated, stabilized and maintained.

Native wetland plants shall be used in the retention/detention facility design, either along the aquatic bench, fringe wetlands, safety shelf and side slopes, or within the shallow areas of the pools.

A permanent buffer strip of natural vegetation extending at least 15 feet in width beyond the freeboard elevation will be maintained or restored around the perimeter of all wet stormwater storage facilities. No lawn care chemicals may be applied within the buffer area. This requirement is to be cited in the subdivision restrictions of master deed documents.

7. EASEMENTS

Retention/detention basins or other stormwater management facilities will have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils, deposition and other activities identified in the development's stormwater management plan.

8. MAINTENANCE

Maintenance Access

Adequate maintenance access from a public or private right of-way to the stormwater storage basin will be provided. 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 the forebay, control structure, and the outlet.

Part D: Design Requirements – Infiltration BMPs

The phrase "infiltration BMPs" describes a wide range of stormwater management practices aimed at infiltrating some fraction of stormwater runoff from developed surfaces into the soil horizon. Infiltration BMPs include several types, based on construction and performance similarities.

- Surface Infiltration Basins

- Subsurface Infiltration Beds
- Bioretention Areas
- Rain Gardens
- Pervious Asphalt, Concrete or Pavers
- Infiltration Trenches
- Other BMPs that provide infiltration: vegetated filter strips, bioswales and dry wells

Additional information regarding infiltration BMPs can be found in the latest edition of the LID Manual for Michigan (SEMCOG).

http://www.semcog.org/reports/lid/files/assets/basic-html/page-1.html#

Refer to the Soil Infiltration Testing Guidelines below to determine if a site is adequate for infiltration BMPs.

1. ROLE OF INFILTRATION BMPs

   Infiltration BMPs replicate the natural hydrologic regime. During periods of rainfall, infiltration BMPs reduce the volume of runoff and help to mitigate potential flooding events. Infiltration BMPs are known to reduce non-point source pollutants from runoff through a complex mix of physical, chemical, and biological processes.

   Infiltration also includes environmental benefits, such as:

   a. Promotes maintenance of the natural temperature regimes of stream systems (cooler in summer, warmer in winter) which can be critical to the aquatic ecology

   b. Reduces the volume of runoff, which reduces erosive “bankfull” conditions and downstream erosion channel morphology changes

   c. Continual infiltration throughout varying sizes of storm events allows for a large percentage of infiltration during small storm events, and lesser infiltration during large storm events. Because most of the local rainfall occurs in small (less than 1-inch) events, the annual benefits of an infiltration system are significant.

2. SOIL INFILTRATION TESTING GUIDELINES (See Section IV for additional testing guidelines)

   Site design must first include use of all feasible areas for infiltration until the infiltration requirement is met. Prior to the optional Conceptual Plan Meeting with the reviewing agency, USDA-NRCS soil data (available online) should be collected as a “first cut” in determining potential soil characteristics. This will help in determining whether the site is a good candidate for infiltration.

   Prior to continuing with the design (before the first site plan submittal), the developer shall perform on-site soil tests, as described in Section IV, to demonstrate actual infiltration capacity. The purpose of the soil infiltration testing is to:

   - Determine which infiltration BMPs are suitable at the site and at what locations
   - Determine where, if at all, underdrains need to be used
   - Determine whether soil infiltration rates are low enough to waive the infiltration requirements
   - Obtain the required data for infiltration BMP design
   - Determine whether groundwater elevations are high enough to waive the infiltration requirements

Soil Testing must be conducted early in the conceptual design of the project so that information developed in the testing process can be used to direct the design. There should be a preliminary understanding of potential BMP locations prior to testing, and adjustments can be made as necessary based upon test results.

The soil investigation and evaluation may be conducted by geotechnical engineers, soils scientists, design engineers, licensed geologists, and other qualified professionals and technicians. If the design engineer is not experienced in soils, a professional experienced in observing and evaluating soils conditions, such as a professional soils scientist, can provide a reliable analysis of the soil conditions. The developer/applicant must submit a soil boring and/or test pit infiltration report certified by a Professional Engineer licensed in the State of Michigan.

Soil infiltration testing is a process to obtain the necessary data for the design of the stormwater quality facilities. The requirements for soil testing are:

Step 1. Background Evaluation

Prior to performing field testing and compiling a site plan, an inventory and review of the property must occur and include, but not be limited to the following, which shall be presented at the conceptual design meeting by the applicant:

- Existing mapped soils and U.S. Department of Agriculture NRCS Hydrologic Soil Group Classifications
- Existing geology (general description)
- Existing streams, water bodies, wetlands, hydric soils, floodplains, alluvial soils, stream classifications, headwaters and first order streams
- Existing topography, slope, drainage patterns and watershed boundaries
- Existing land cover/use boundaries
- Other natural or man-made features or conditions that may impact the design, such as historic uses or existing buildings
- Potential locations for infiltration BMPs
- Site environmental history (i.e., Phase I ESA) where required by the reviewing agency

Step 2. Test Pits

Test pits or deep holes are the preferred method to establish existing conditions, as they allow visual observation of the soil horizons and conditions both horizontally and vertically. The use of soil borings as a substitute for test pits is allowed, although a factor of safety of 0.5 shall be applied to any infiltration rate measured using soils extracted from a soil boring.

The test pit or deep hole will be a backhoe-excavated trench to a depth that is at least two vertical feet below the bottom of a proposed infiltration BMP (typically ranging between 72 and 90 inches below the ground surface elevation). The following conditions shall be noted and described:

- Soil horizons (measured from ground surface)
- Soil texture and color for each horizon
- USDA soil terminology to describe soil characteristics
- Color patterns
- Observance of pores or roots
- Estimated type and percent coarse fragments
- Observance of hardpan or limiting layers
- Depth to water table (measured from ground surface)

- Depth to bedrock (measured from ground surface)

Following all testing, the test pits must be filled with the excavated soil and the topsoil replaced. At no time should the test pit be accessed if there is a presence of unstable material or if site constraints preclude entry.

The test pit must provide information related to the conditions at the bottom of the proposed infiltration BMP. If the proposed BMP will be greater than 90 inches below the existing grade, deeper test pit excavation may be required. General test pit guidelines are as follows:

- For single-family residential subdivisions with on-lot infiltration BMPs, one test pit or soil boring per lot is necessary within 100 feet of the proposed BMP area. At the optional Conceptual Plan Meeting, the suitability of test pits can be determined.
- For multi-family and high-density residential developments, one test pit per infiltration BMP area or acre is necessary.
- For large infiltration areas, such as basins, commercial, institutional and industrial, multiple test pits or soil borings must be evenly distributed at the rate of 3-4 pits/borings per acre of BMP area, based on discussions during the pre-application meeting.

Additional soil test pits may be necessary due to subsurface variability, water table depth or topography. The reviewing agency will determine if more or fewer test pits will be required.

Step 3. Field Infiltration Testing

Field infiltration tests must not be conducted in the rain or within 24 hours of significant rainfall events (>0.5 inches), or when the temperature is below freezing. At least one test should be conducted at the proposed bottom elevation of an infiltration BMP, and a minimum of two tests per test pit are required. The methodologies for the tests include:

- Double-ring Infiltrometer test – estimate for vertical movement of water through the bottom of the test area
- Percolation tests – estimate for vertical movement of water through the bottom and sides of the test area
- Encased falling head permeability test – estimate for vertical movement of water through the bottom of the test area

Other acceptable test methods that are available:

- Constant head double-ring infiltrometer
- ASTM 2003 Volume 4.08, Soil and Rock (I): Designation D 3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using a Double-Ring Infiltrometer
- ASTM 2002 Volume 4.09, Soil and Rock (II): Designation D 5093-90, Standard Method of Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring
- Guelph permeameter
- Constant head permeameter (Amoozemeter)

3. CONSIDERATION OF INFILTRATION RATE IN DESIGN AND MODELING APPLICATION

See Section IV for ranges of measured infiltration rates, factors of safety, and their impact on BMP sizing and design.

4. INFILTRATION BMP GUIDELINES

The purpose of these guidelines is to provide designers, reviewers, and other interested parties with specific instructions for the successful construction and long-term performance of infiltration BMPs. These guidelines fall into three categories:

- Site conditions and constraints
- Design considerations
- Construction requirements

a. Site Conditions and Constraints

i. It is necessary to maintain at least a 2-foot clearance above the seasonally high water table for most BMPs (e.g., basins serving large areas). This reduces the likelihood that temporary groundwater mounding will affect the system, and allows sufficient distance of water movement through the soil to assure adequate pollutant removal.

ii. Soils underlying infiltration devices should have infiltration rates between 0.1 and 10 inches per hour, which in most developments should result in reasonably sized infiltration systems. Where soil permeability is extremely low, infiltration may still be possible but the surface area required could be large, and other volume reduction methods may be warranted. Undisturbed Hydrologic Soil Groups A, B, and C often fall within the acceptable range and cover most of the state.

iii. Infiltration BMPs must be sited to minimize any risk to groundwater quality, at least 50 horizontal feet from individual water supply wells, 75 horizontal feet from community or municipal Type IIb and III water supply wells and 200 horizontal feet from community or municipal Type I or IIa water supply wells. Horizontal separation distances or buffers may also be appropriate from special geologic features, such as fractures, traces and faults, depending on water supply sources.

iv. Infiltration BMPs should be sited so that they present no threat to sub-surface structures, typically at least 10 feet down gradient or 100 feet up gradient from building basement foundations (see specific BMP for applicable setbacks) and 100 feet from septic system drain fields unless specific circumstances allow for reduced separation distances.

v. In general, soils of Hydrologic Soil Group D will not be suitable for infiltration. Similarly, areas of floodplains and areas in close proximity to wetlands and streams will generally not be suitable for infiltration (due to high water table and/or low permeability).

b. Design Considerations

i. Infiltration facilities may not be placed on compacted fill. Infiltration in native soil without prior fill or disturbance is preferred but not always possible. Areas that have experienced historic disturbance or fill are suitable for infiltration provided sufficient time has elapsed and the soil testing indicates the infiltration is feasible. In disturbed areas it may be necessary to infiltrate at a depth that is beneath soils that have previously been compacted by construction methods or long periods of mowing. Such areas must be tilled to 18 inches or more.

ii. A level infiltration area is preferred. Bed bottoms should always be graded into the existing soil mantle, with terracing as required to construct flat structures. Sloped

bottoms tend to pool and concentrate water in small areas, reducing the overall rate of infiltration and longevity of the BMP. Infiltration areas should be flat or nearly so.

Note: Bioswales proposed with flat bottoms and grass vegetation do not work and will not be approved.

iii. The soil mantle should be preserved to the maximum extent possible, and excavation should be minimized. Those soils that do not need to be disturbed for development should be left undisturbed. Maximizing the soil mantle also increases the pollutant removal capacity and reduces concerns about groundwater mounding. Therefore, excessive excavation for the construction of infiltration systems is strongly discouraged.

iv. Contaminated areas: stormwater infiltration will be waived in areas of known soil contamination. The developer shall provide evidence of the contamination through an Environmental Site Assessment.

v. In retention basins, the depth of water may be required to be limited. The total effective depth of water should generally not be greater than three (3) feet. The design of any infiltration system must avoid any excessive pressure and potential sealing of the bed bottom.

vi. Drawdown time must be considered. In general, infiltration BMPs should be designed so that they completely empty within 48 hours. Retention basins shall dewater within 72 hours.

vii. All infiltration BMPs should be designed with a positive overflow that discharges excess volume in a non-erosive manner, and allows for controlled discharge during extreme rainfall events or frozen bed conditions. Infiltration BMPs should never be closed systems dependent entirely upon infiltration in all situations. Discharge must be directed in a manner to avoid property damage and have an unimpeded route to a receiving channel or outlet.

viii. Geotextiles should be incorporated into the design as necessary in certain infiltration BMPs. Infiltration BMPs that are subject to soil movement and deposition must be constructed with suitably permeable nonwoven geotextiles to prevent movement of fines and sediment into the infiltration system. The designer is encouraged to err on the side of caution and use geotextiles as necessary at the soil/BMP interface.

c. Construction Requirements

i. Do not compact soil infiltration beds during construction. Prohibit all heavy equipment from the infiltration area and minimize all other traffic. Equipment should be limited to vehicles that will cause the least compaction, such as low ground pressure (maximum 4 pounds per square inch) tracked vehicles.

ii. Protect the infiltration area from sediment until the surrounding site is completely stabilized. Methods to prevent sediment from washing into BMPs should be clearly shown on plans. Runoff from construction areas should be prevented from draining to infiltration BMPs, with techniques such as diversion berms, and immediate vegetative stabilization.

iii. Where vegetation is a component of an infiltration BMP, it must be established prior to putting the device into use.

iv. All infiltration areas shall be tested for permeability after construction, and must perform to design permeability.

Note: For all construction steps, erosion and sediment control methods must adhere to latest requirements of the EGLE Soil Erosion and Sedimentation Control Program
https://www.michigan.gov/egle/0,9429,7-135-3311_4113---,00.html

For additional information see the latest version of the SEMCOG LID Manual for Michigan.

http://www.semcog.org/reports/lid/files/assets/basic-html/page-1.html#

Part E: Design Requirements – Bioretention Basins

1. GENERAL REQUIREMENTS

Bioretention systems are flexible in design and can vary in complexity according to site conditions and runoff volume requirements. Bioretention areas are not to be confused with constructed wetlands or wet retention/detention facilities, which permanently pond water. They can increase time of concentration and store additional volume below grade. Typically, bioretention systems have planted native vegetation beds atop 3(+/-) feet of amended soils. See Figure 3 and Figure 4 for more detail on bioretention systems.

Deeper-rooted plants perform best, but any native vegetation is acceptable – grass, annuals, grasses, shrubs, or a combination of these.

Bioretention basins generally require maintenance on an annual basis to replace the mulch layer and to prevent the proliferation of noxious weeds and invasive species. This can include hand weeding, burns, herbicide or mowing. Planning tools shall be included to provide management that ensures their long-term functionality (deed restrictions, covenants, easements, budget, etc.). A maintenance plan is required (see the SEMCOG Low Impact Development Manual for Michigan for guidance).

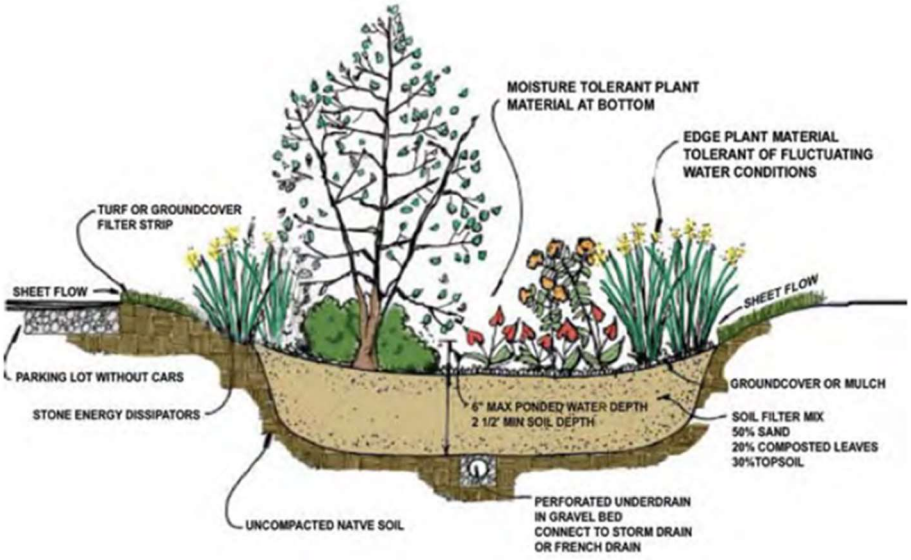


Figure 3: Schematic of a small bioretention area[4]

[4] Source: LID Manual for Michigan - Chapter 7, pg. 134, adopted from the Prince George's County Bioretention Manual with modifications from Cahill Associates, 2004

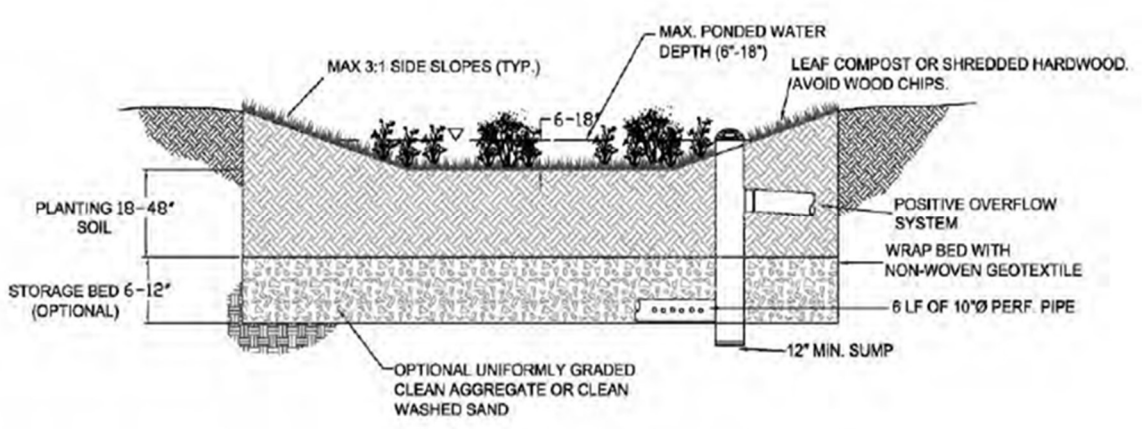


Figure 4: Schematic of an engineered bioretention area[5]

2. PROHIBITIONS

   Bioretention will be waived under specific circumstances, such as high groundwater, impermeable soils, and contaminated soils as listed in Section IV.

3. SETBACKS

Table 6: Setback Distances for Bioretention

Setback from	Minimum Distance (feet)
Property Line	10
Building Foundation/Basement*	15
Private Well	10
Public Water Supply Well	10
Septic System Drainfield (primary & reserve)	50
*minimum with slopes directed away from building	

4. TESTING REQUIREMENTS

   a. See Section IV for details.
   b. The overall site shall be evaluated for potential infiltration systems early in the design process.

5. BASIN COMPONENTS/CONFIGURATION

   The primary components (and subcomponents) of a bioretention system are:

   Flow Entrance (how stormwater enters the BMP)

   - An inlet (e.g. flared end section with level spreader; a sump at this location helps to trap sediments in a single location)
   - Sheet flow into the facility over grassed areas
   - Curb cuts with grading for sheet flow entrance
   - Roof leaders with direct surface connection
   - Trench drain
   - Pipe

[5] Source: LID Manual for Michigan - Chapter 7, pg. 134, adopted from the Prince George's County Bioretention Manual with modifications from Cahill Associates, 2004

In all cases, entering velocities must be non-erosive and may require energy dissipation.

Positive Overflow

- Will discharge runoff during large storm events when the subsurface/surface storage capacity is exceeded or when the ground is frozen. Discharge must be directed in a manner to avoid property damage and have an unimpeded route to a receiving channel or outlet.
- Examples include beehive yard basin, curb inlet, catch basin, weir, etc.

Bioretention Facility Area

- Maximum depth of ponding is 12 inches. Additional depth may be permissible in cases where soil infiltration capacities are higher (i.e. 2.0 in/hr or higher), but never more than 18 inches.
- An overflow must be provided and must be directed in a manner to avoid property damage and have an unimpeded route to a receiving channel or outlet.
- Plants must be salt tolerant if in a location that would receive snowmelt chemicals

Planting

Proper plant selection is essential for bioretention areas to be effective. Typically, native floodplain or wet meadow plant species are best suited to the variable environmental conditions encountered in a bioretention system. Live perennial plant material in plug or gallon-potted form should be utilized and installed on 1'-2' centers. Seed is not an acceptable method for plant establishment below the storage elevation unless a method of germination and stabilization is provided. Planting with seed has highly unreliable results due to water flows displacing seed. If proposed, the application method and seed mix must be submitted for approval. Upon installation, vegetative establishment must be documented and approved as per the soil erosion and sedimentation control permit. Perennials, grasses, shrubs and trees are acceptable plantings, however, trees are prohibited in any BMPs where an underdrain is used.

6. EASEMENTS

Bioretention systems shall have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils deposition, and other activities identified in the development's stormwater system maintenance plan.

7. CALCULATIONS

See Section IV for bioretention sizing guidelines.

8. CONSTRUCTION

The following is a typical construction sequence; alterations will be necessary depending on design variations. For additional details, see *Michigan LID Manual*, Chapter 7 pg. 144.

Note for all construction steps: Erosion and sediment control methods must adhere to the latest requirements of the EGLE Soil Erosion and Sedimentation Control Program.

a. Install temporary sediment control BMPs as shown on the plans.

b. Complete site grading, minimizing compaction as much as possible. If applicable, construct curb cuts or other inflow entrances but provide protection so that drainage is prohibited from entering the bioretention system construction area.

c. Excavate the bioretention system to the proposed invert depth and scarify the existing soil surfaces. Do not compact in-situ soils.

d. When soil conditions warrant an underdrain will be installed.

e. Backfill the bioretention system with amended soil as shown on plans and specifications. Overfilling is recommended to account for settlement. Light hand tamping is acceptable if necessary.

d. Presoak the planting soil prior to planting vegetation to aid in settlement.

e. Complete final grading to achieve proposed design elevations, leaving space for upper layer of compost, mulch or topsoil as specified on plans.

f. Mulch and install erosion protection at surface flow entrances where necessary.

g. Plant vegetation according to planting plan.

h. Once the drainage area is completely and permanently stabilized, the bioretention system should be brought online.

i. Removal of weeds and unwanted species is usually needed in the first 1-3 years following installation.

j. Post-construction permeability shall be verified following complete installation of soil media and vegetation.

9. MAINTENANCE

Properly designed and installed bioretention systems require regular maintenance.

a. While vegetation is being established, hand weeding or other weed control methods will be required. Thereafter, twice annual weeding is typical. Invasive plants should be controlled early in their establishment before they spread.

b. Fall and spring cleanup must be performed including cutting down dead perennials, removal of weeds and removal or mulching of leaves and stems.

c. Mulch must be re-spread when erosion is evident and be replenished annually. Once every 2 to 3 years the entire area may require mulch replacement.

d. Bioretention systems must be inspected at least two times per year for sediment buildup, erosion, vegetative conditions, etc. Sediment must be removed from forebay and riprap/stone protected areas at least twice per year. Sediment should be removed before its accumulation negatively impacts the performance of the pretreatment device.

e. During periods of extreme drought, bioretention systems may require watering.

f. Bioretention systems must not be regularly mowed.

g. Trees and shrubs must be inspected twice per year to evaluate health.

h. Invasive species must be removed on an annual basis and disposed of in compliance with local, state and federal regulations.

Part F: Design Guidelines – Rain Gardens

For the purposes of this TRM, Rain Gardens are considered to be equivalent to bioretention basins.

Part G: Design Guidelines – Pervious Pavement

1. GENERAL REQUIREMENTS

Pervious pavement is an infiltration technique that combines stormwater infiltration, storage, and structural pavement. It consists of permeable surface underlain by a storage reservoir. Pervious pavement is well suited for parking lots, walking paths, sidewalks, playgrounds, plazas, athletic courts, and other similar uses. It has also been successful on roadways. Variations on the surface material include: Porous Asphalt, Pervious Concrete, Permeable Paver Blocks, or Reinforced Turf (see Figure 5 and Figure 6).

a. Pervious pavement and infiltration beds must not be placed on areas of recent fill or compacted fill. Any grade adjustments requiring fill must be done using the stone sub-base material. Areas of historical fill (>5 years) may be considered for pervious pavement.

b. The bed bottom is not compacted. However, the stone sub-base is placed in lifts and lightly rolled according to specifications.

c. Bed bottoms must be level or nearly level. Sloping bed bottoms will lead to areas of ponding and reduced stormwater distribution within the bed.

d. All systems must be designed with an overflow system. Water within the subsurface stone bed must never rise to the level of pavement surface. Inlets can be used for cost effective overflow structures. All beds must empty within 48 hours.

e. Infiltration beds must also be able to convey and mitigate the peak of less-frequent, more intense storms such as the 100-year recurrence interval. Control in beds is usually provided in the form of an outlet control structure. A modified inlet box with an internal weir and low-flow orifice is a common type of control structure. The specific design of these structures may vary, depending on factors such as allowable discharge rate and storage requirements, but it always must include positive overflow from the system.

f. The subsurface bed and overflow may be designed and evaluated in the same manner as a detention basin to demonstrate the mitigation of peak flow rates. In this manner, the need for a detention basin may be eliminated or the basin may be significantly reduced in size.

g. A weir plate or weir within an inlet or overflow control structure may be used to maximize the water level in the stone bed while providing sufficient cover for overflow pipes.

h. Perforated pipes may be used to evenly distribute runoff over the entire bed bottom. Continuously perforated pipes must connect structures (such as cleanouts and inlets). Pipes must lay flat and provide the uniform distribution of water. Depending on size, these pipes may provide additional storage volume.

i. Infiltration areas must be located within the immediate project area in order to control runoff at its source. Expected use and traffic demands must also be considered in pervious pavement placement.

j. An impervious water stop should be placed along infiltration bed edges where pervious pavement meets standard impervious pavements.

k. The underlying infiltration bed is typically 12 to 36 inches deep and comprised of clean, uniformly-graded aggregate. A maximum of 30% will be approved for void space when determining storage volumes. AASHTO No. 3, which ranges 1.5 – 2.5 inches in gradation, is often used. Depending on local aggregate availability, both larger and smaller sized aggregate have

been used. The critical requirements are that the aggregate be uniformly- graded, clean washed, and contain a significant void content. The depth of the bed is a function of stormwater storage requirements, frost depth considerations, site grading, and anticipated loading.

l. While most pervious pavement installations are underlain by an aggregate bed, alternative subsurface storage products may also be employed.

m. All pervious pavement installations must have a backup method for water to enter the stone storage bed in the event that the pavement fails or is altered. In uncurbed lots, this backup drainage may consist of an unpaved 2 feet wide stone edge drain connected directly to the bed. In curbed lots, inlets with sediment traps may be required at low spots. Backup drainage elements will ensure that functionality of the infiltration system if the pervious pavement is compromised.

n. In those areas where the threat of spills and groundwater contamination is likely, pretreatment systems may be required before any infiltration occurs. In any areas with contamination, such as truck stops and fueling stations, the appropriateness of pervious pavement must be carefully considered. A stone infiltration bed located beneath standard pavement, preceded by spill control and water quality treatment, may be more appropriate.

2. PROHIBITIONS

Pervious pavement will not be allowed in the following:

a. Areas with known pollution as identified by EGLE

b. Facilities containing a high potential for surface water contamination, such as gas stations, vehicle maintenance facilities, public works fleet facilities, and similar facilities.

c. Where the estimated high ground water elevation will be within 2 feet of the bottom of the facility

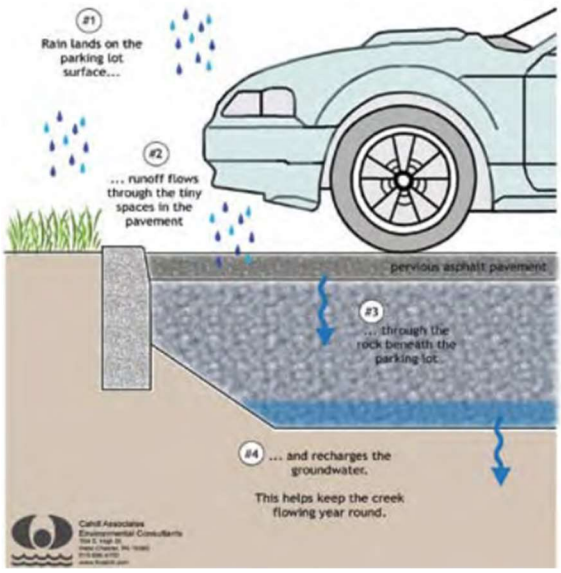


Figure 5: Pervious pavement with infiltration schematic[6]

[6] Source: LID Manual for Michigan - Chapter 7, pg. 241, adopted from Cahill Associates, 2004

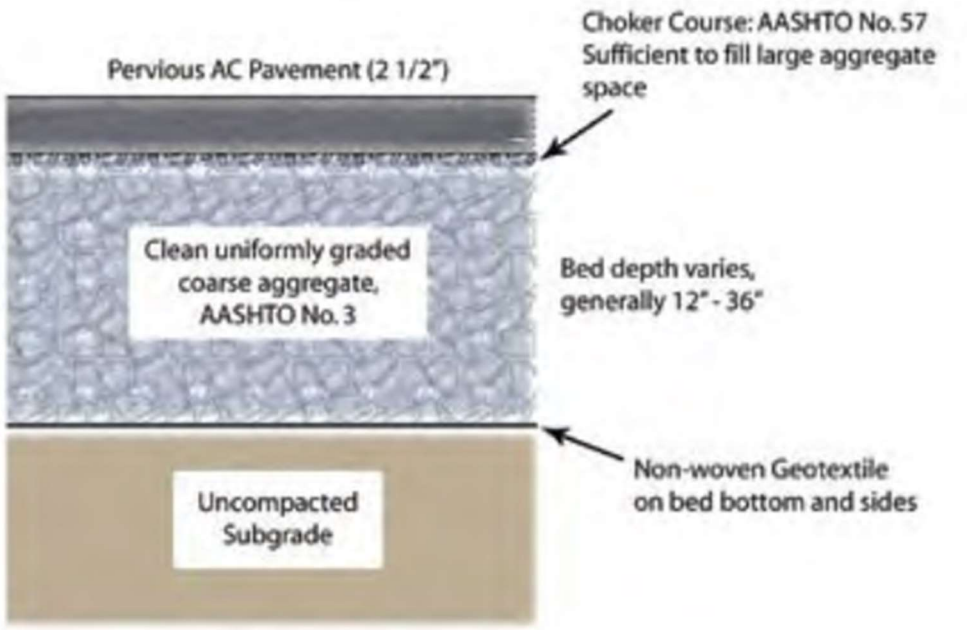


Figure 6: Pervious pavement example cross section.[7]

An experienced Professional Engineer shall design the cross-section and mix design based on site-specific conditions

3. SETBACKS

Table 7: Setback Details for Pervious Pavement

Setback from	Minimum distance (feet)
Property Line	10
Building Foundation/Basement*	15
Private Well	50
Type IIb and III Public Water Supply Well	75
Septic System Drainfield (primary & reserve)	100
Type I and IIa Public Water Supply Well	200

4. TESTING REQUIREMENTS

   a. See Section IV for details.
   b. The overall site must be evaluated for potential infiltration systems early in the design process.

5. CALCULATIONS

   See Section IV for bioretention sizing guidelines.

6. CONSTRUCTION

   The following is a typical construction sequence; however, alternations will be necessary depending on design variations.

   a. Due to the nature of construction sites, pervious pavement and other infiltration measures must be installed toward the end of the construction period. Once the site is stabilized and erosion

[7] Source: LID Manual for Michigan - Chapter 7, pg. 243, adopted from Cahill Associates, 2004

control is no longer required, the bed is excavated to its final grade and the pervious pavement system is installed.

b. The existing subgrade under the bed areas must NOT be compacted or subject to excessive construction equipment traffic prior to geotextile and stone bed placement. Completed subgrade must be approved by the jurisdiction having authority prior to geotechnical installation.

c. Where erosion of subgrade has caused accumulation of fine materials and/or surface ponding, this material must be removed with light equipment and the underlying soils scarified to a minimum depth of 6 inches with a York rake (or equivalent) and light tractor. All fine grading must be done by hand. All bed bottoms must be at level grade.

d. Earthen berms (if used) between infiltration beds must be left in place during excavation. These berms do not require compaction if proven stable during construction.

e. Geotextile bed aggregate must be placed immediately after approval of subgrade preparation. Geotextile is to be placed in accordance with manufacturer's standards and recommendations. Adjacent strips of geotextile must overlap a minimum of 18 inches. It must also be secured at least 4 feet outside of bed in order to prevent any runoff or sediment from entering the storage bed. This edge strip must remain in place until all bare soils contiguous to beds are stabilized and vegetated. As the site is fully stabilized, excess geotextile along bed edges can be cut back to bed edge.

f. Clean (washed) uniformly-graded aggregate is to be placed in the bed in 8-inch lifts. Each layer must be lightly compacted, with the construction equipment kept off the bed bottom. Once bed aggregate is installed to the desired grade, a +/- 1 in. layer of choker base course aggregate (AASHTO #57) must be installed uniformly over the surface in order to provide an even surface for paving.

g. After final pervious asphalt or concrete installation, no vehicular traffic of any kind must be permitted on the pavement surface until cooling and hardening or curing has taken place, and in no case within the first 72 hours.

h. The full permeability of the pavement surface must be tested by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution device. All applied water must infiltrate directly without puddle formation or surface runoff.

i. Control of sediment is critical. Rigorous installation and maintenance of erosion and sediment control measures is required to prevent sediment deposition on the pavement surface or within the stone bed. Non-woven geotextile may be folded over the edge of the pavement until the site is stabilized. The designer should consider the site placement of pervious pavement to reduce likelihood of sediment deposition. Surface sediment must be removed by a vacuum sweeper and must not be power-washed into the bed.

7. MAINTENANCE

a. Maintenance of pervious pavement will be the responsibility of the owner or governing association of the development and the deed restrictions and covenants for the development shall state such, including the annual testing and recording of permeability. The reviewing agency will not maintain nor accept easements over pervious pavement. In the event that pervious pavement is not maintained, the reviewing agency will take the appropriate legal action to enforce the deed and covenants.

b. Prevent Clogging of Pavement Surface with Sediment
   i. Vacuum pavement twice per year
   ii. Maintain planted areas adjacent to pavement
   iii. Immediately clean any soil deposited on pavement
   iv. Do not allow construction staging, soil/mulch storage, etc. on unprotected pavement surface
   v. Clean inlets draining to the subsurface bed twice per year

c. Snow/Ice Removal
   i. Do not apply abrasives such as sand or cinders on or adjacent to pervious pavement
   ii. Snow plowing is fine but should be done carefully (i.e. set the blade slightly higher than usual)
   iii. Salt application is acceptable, although more environmentally –benign deicers are preferable. The need for application of salt and other deicers should be minimal, as water does not pond and freeze on top of properly operating pervious pavement.

d. Repairs
   i. Surface shall never be seal-coated
   ii. Damaged areas less than 50 sq. ft. can be patched with pervious or standard pavement
   iii. Larger areas should be patched with an approved pervious asphalt or pervious concrete, or as approved by the local reviewing agency
   iv. Pervious pavers must be repaired/replaced with similar pervious paver block material or turf reinforcement system
   v. Pervious pavers and gravel pavers may require the addition of aggregate on an annual basis or as needed, in order to replenish material used to fill in the open areas of the pavers. Turf pavers may require reseeding as needed if bare areas appear.

Part H: Design Guidelines – Infiltration Trenches

1. GENERAL GUIDELINES

a. Infiltration Trenches are sized to temporarily retain, infiltrate and convey stormwater runoff from areas no greater than five (5) acres. An Infiltration Trench is typically a linear trench with a rock storage bed below the surface (see Figure 7).

b. Infiltration Trenches must drain-down within 48 hours. Longer drain-down times reduce Infiltration Trench efficiency and can lead to anaerobic conditions, odor and other problems.

c. Infiltration Trenches are not recommended when their installation would create a significant risk for basement seepage or flooding. Fifteen feet of separation is required between Infiltration Trenches and building foundations.

d. The Infiltration Trench must be wrapped in non-woven geotextile filter fabric to prevent the migration of the subsoils into the stone voids.

e. The underlying infiltration bed is typically comprised of clean, uniformly-graded aggregate with approximately 30% void space. Typically, 40% void space is acceptable; however, a 25%

reduction was incorporated as a safety factor. AASHTO No.3, which ranges 1.5-2.5in in gradation, is often used. Depending on local aggregate availability, both larger and smaller size aggregate may be used. The critical requirements are that the aggregate be uniformly graded, clean washed, and contain a significant void content. The depth of the bed is a function of stormwater storage requirements, frost depth considerations, site grading, and anticipated loading. Infiltration Trenches are typically sized to mitigate the increased runoff volume from a 2-yr design storm.

f. A water quality inlet or catch basin with sump is required for all surface inlets to avoid standing water for periods greater than 48 hours.

g. Perforated pipes along the bottom of the bed may be used to evenly distribute runoff over the entire bed bottom. Continuously perforated pipes must connect structures (such as cleanouts and inlets). Pipes must lay flat along the bed bottom and provide for uniform distribution of water. Depending on size, these pipes may provide additional storage volume.

h. Adequate inspection and maintenance accesses or cleanouts to the Subsurface Infiltration Bed will be provided.

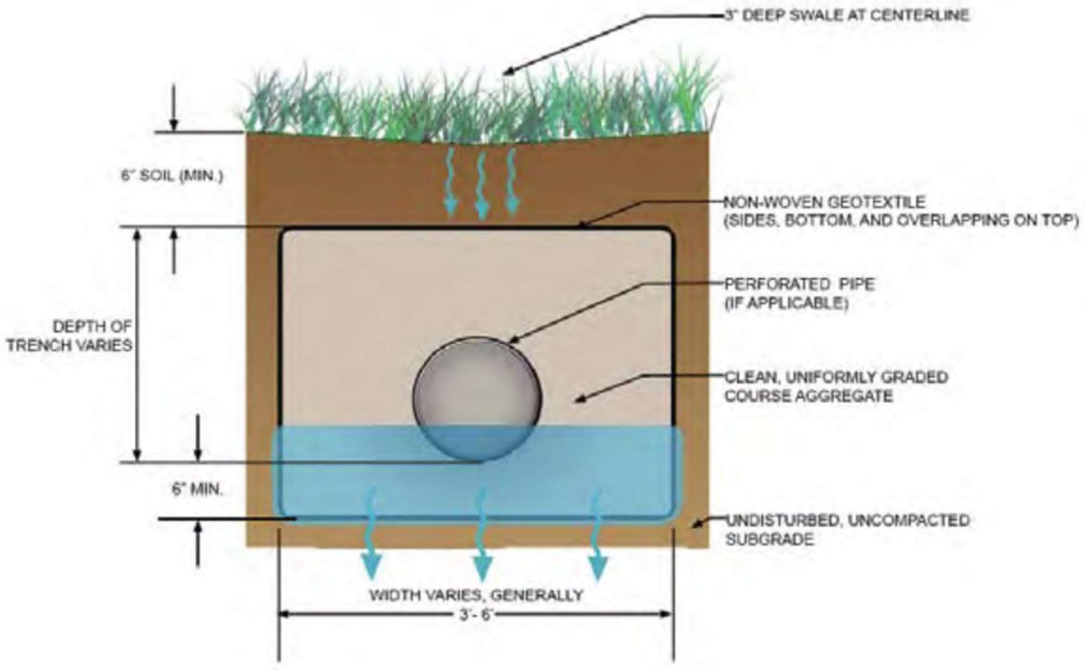


Figure 7: Infiltration Trench Cross Section[8]

2. PROHIBITIONS

Infiltration facilities will not be allowed in the areas that follow:

a. Areas with known pollution as identified by EGLE

b. Where the estimated high ground water elevation will be within 2 feet of the bottom of the facility.

[8] Source: LID Manual for Michigan

As with other infiltration practices, Infiltration Trenches may not be appropriate for contaminated areas or other areas where high pollutant or sediment loading is expected without additional design considerations. Infiltration Trenches are not recommended within a specified distance to structures or subsurface sewage disposal systems. (See Infiltration System Guidelines)

3. SETBACKS

Table 8: Setback Details for Infiltration Trenches

Setback from	Minimum distance (feet)
Property Line	10
Building Foundation/Basement*	15
Private Well	50
Type IIb and III Public Water Supply Well	75
Septic System Drainfield (primary & reserve)**	100
Type I and IIa Public Water Supply Well	200
*minimum with slopes directed away from building **50 feet from septic systems with a design flow less than 1,000 gallons per day	

4. TESTING REQUIREMENTS

   a. See Section IV.

   b. The overall site shall be evaluated for potential infiltration systems early in the design process.

5. INLET/OUTLET DESIGN

   An Infiltration Trench is a subsurface storage facility that temporarily stores, infiltrates and conveys stormwater runoff from nearby impervious areas. Inlets and catch basins with sumps connect directly to the Infiltration Trench.

   All Infiltration Trenches must be able to convey system overflows to downstream drainage systems. System overflows can be incorporated either through surcharge (or overflow) pipes or via connections to more substantial infiltration areas.

6. COMPONENTS/CONFIGURATION

   Infiltration Trenches typically consists of clean washed, uniformly graded aggregate with 30% void capacity (AASHTO No.3, or similar). Infiltration Trench aggregate is wrapped in a non-woven geotextile, which provides separation between the aggregate and the surrounding soil. Typically, Infiltration Trenches will be covered in at least 12-inches of soil or 6-inches of gravel or river stone. An alternative form of Infiltration Trench is a subsurface, prefabricated perforated pipe chamber. A variety of prefabricated perforated pipes are currently available on the market for Infiltration Trench applications.

7. EASEMENTS

   Infiltration Trenches will have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment spoils deposition, and other activities identified in the development's stormwater system maintenance plan.

8. CALCULATIONS

   See Section IV for details.

9. CONSTRUCTION

The following is a typical construction sequence; however, alterations will be necessary depending on design variations.

a. The infiltration area must be protected from compaction prior to installation.

b. Infiltration Trenches must not be placed on areas of recent fill or compacted fill. Any grade adjustments requiring fill must be done using the stone sub-base material. Areas of historical fill (>5 years) may be considered for Infiltration Trenches.

c. Install Infiltration Trenches during later phases of site construction to prevent sedimentation and/or damage from construction activity.

d. Installation and maintenance of proper Erosion and Sediment Control Measures must be followed during construction.

e. Excavate Infiltration Trench bottom to a uniform, level uncompacted subgrade free from rocks and debris. Do NOT compact subgrade. To the greatest extent possible, excavation should be performed with the lightest practical equipment. Excavation equipment should be placed outside the limits of the Subsurface Infiltration Bed.

f. Completely wrap Infiltration Trench with non-woven geotextile. (If sediment and/or debris have accumulated in Infiltration Trench bottom, remove prior to geotextile placement.) Geotextile rolls must overlap by a minimum of 24 inches within the trench. Fold back and secure excess geotextile during stone placement.

g. Install continuously perforated pipe, observation wells, and all other Infiltration Trench structures. Connect inlets and catch basins to trench as indicated on approved plans.

h. Clean-washed, uniformly grated aggregate is to be placed in 8-inch lifts. Each layer must be lightly compacted with the construction equipment kept off the bed bottom.

i. Backfill perforated pipe with clean-washed uniformly grated aggregate in 8-inch lifts, lightly compacted between lifts.

j. Fold and secure non-woven geotextile over trench with a minimum overlap of 16-inches.

k. Place a 6-inch lift of approved topsoil over trench, as indicated on approved plans.

l. Topsoil stabilization and seed must be applied to the disturbed area.

m. Do not remove Erosion and Sediment Control measures until site is fully stabilized.

10. MAINTENANCE

As with all infiltration practices, Infiltration Trenches require regular and effective maintenance to ensure prolonged functioning. The following represent minimum maintenance requirements for Infiltration Trenches.

a. Inspect Infiltration Trenches at least four times per year, as well as after every storm exceeding one inch.

b. Dispose of sediment, debris/trash, and any other waste material removed from an Infiltration Trench at suitable disposal/recycling sites and in compliance with local, state, and federal waste regulations.

c. Evaluate the drain-down time of the Infiltration Trench to ensure the maximum time of 48 hours is not being exceeded. If drain-down times are exceeding the maximum, drain the Infiltration Trench via pumping and clean out perforated piping, if included. If slow drainage persists, the system may need replacing.

d. Regularly clean out inlets, catch basins and gutter and ensure proper connections to facilitate the effectiveness of the Infiltration Trench.

e. Replace filter screen that intercepts roof runoff as necessary.

f. If an intermediate sump box exists, clean it out at least once per year.

Part I: Design Guidelines – Vegetated Filter Strips

1. GENERAL GUIDELINES

Vegetated Filter Strips are planted permanent linear features meant to slow and infiltrate overland runoff as well as filter out sediments. To be effective, stormwater entering the Vegetated Filter Strip must be sheet flow. Typically, this type of BMP is used with other BMPs such as a level spreader to increase the stormwater mitigation potential.

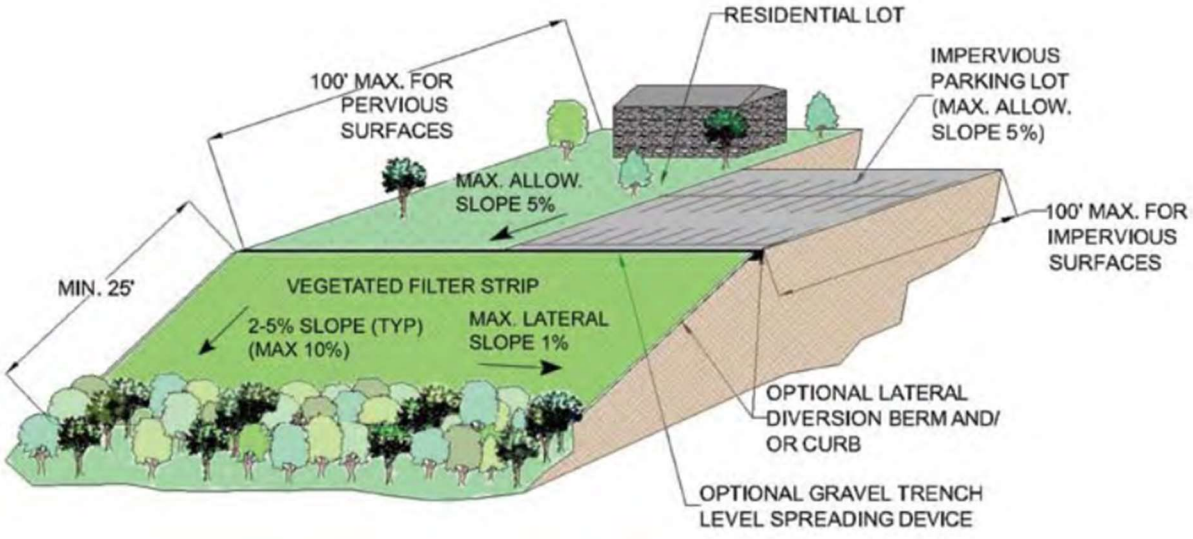


Figure 8: Vegetated Filter Strip Diagram[9]

2. PROHIBITIONS

Infiltration facilities will not be allowed in the areas that follow:

a. Areas with known pollution as identified by EGLE

b. Where the estimated high ground water elevation will be within 3 feet of the bottom of the facility.

3. SETBACKS

Setback Distances - N/A

[9] Source: LID Manual for Michigan

4. TESTING REQUIREMENTS

    a. See Section IV.
    b. The overall site shall be evaluated for potential infiltration systems early in the design process.

5. VEGETATED FILTER STRIP COMPONENTS/CONFIGURATION

    Proper plant selection is essential for Vegetated Filter Strip areas to be effective. Native, salt-tolerant, drought tolerant and erosion resistant plant species are suited to the variable environmental conditions encountered in a Vegetated Filter Strip. See the Low Impact Development Manual for Michigan for a comprehensive list of acceptable Vegetated Filter Strip plants.

    Planting periods will vary, but in general vegetation should be planted from mid-March through early June, or mid-September through mid-November.

    Planting soil must be a loam soil capable of supporting healthy vegetative cover. A recommended soil blend is 20-30% organic material (compost), 20-30% sand, and 20-30% topsoil. Planting soil must be 4 inches deeper than the bottom of the largest root ball, or native soils in-situ at a depth of eight (8) inches.

    Soils must have clay content less than 10% (a small amount of clay is beneficial to absorb pollutants and retain water), and be free of toxic substances and unwanted plant material. (Tests should be conducted to determine volume storage capacity of amended soils.)

6. EASEMENTS

    Vegetated Filter Strips will have sufficient easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils deposition and other activities identified in the development's stormwater maintenance plan.

7. CALCULATIONS

    Volume Reduction Calculation

    Typically, Vegetated Filter Strips do not have significant volume reducing capacity. However, it is entirely possible for infiltration and evapotranspiration to occur during a storm event. To account for the volume reduction, it is recommended that the post-development Curve Number be adjusted downward to accommodate the portion of the drainage area consisting of the Vegetated Filter Strip. The filter strip area should be considered a "Naturalized Pervious Area" which has a lower Curve Number than manicured grassed areas.

    The cover type of the Vegetated Filter Strip must be considered in the volume reduction calculation. Areas with turf grass should not be used in the volume reduction calculation for a Vegetated Filter Strip.

    Sizing Criteria

    a. **Surface area** is dependent upon storage volume requirements but should generally not exceed a maximum lading ratio of 6:1 (impervious drainage area to infiltration area; see Design Requirements for Infiltration Systems for additional guidance on loading rates.)

    b. **Surface Side slopes** must be gradual. The maximum allowable slope for Vegetated Filter Strips is 5:1.

c. **Planting soil depth** must be at least eight inches where only herbaceous plant species will be utilized. If trees and woody shrubs will be used, soil media depth may be increased depending on plant species.

8. CONSTRUCTION

The following is a typical construction sequence; however, alterations will be necessary depending on design variations. Note for all construction steps: Erosion and sediment control methods must adhere to the latest requirements of the EGLE Soil Erosion and Sedimentation Control Program.

a. Install temporary sediment control BMPs as shown on the plans.

b. Begin construction of the Vegetated Filter Strip only when the upper gradient has been significantly stabilized.

c. Complete site grading, minimizing compaction as much as possible. If applicable, construct curb cuts or other inflow entrances but provide protection so that drainage is prohibited from entering the Vegetated Filter Strip construction area.

d. Grade the Vegetated Filter Strip as proposed on approved plans and scarify the existing soil surfaces. Do not compact in-situ soils.

e. Do not compact the subgrade of gravel trenches.

f. Presoak the planting soil prior to planting vegetation to aid in settlement.

g. If used, sod must be staggered and placed tightly to avoid gaps and channelization. A roller must be used on the sod to remove and prevent any air pockets.

h. Seeded Vegetated Filter Strips must be stabilized with mulch blankets and staked to prevent erosion.

i. Install erosion protection at surface flow entrances where necessary.

j. Erosion control must be present until the site is fully stabilized.

k. Once drainage area and Vegetated Filter Strip are completely and permanently stabilized after one full grow year, the Vegetated Filter Strip should be brought online (opened for use).

9. MAINTENANCE

Properly designed and installed Vegetated Filter Strips require regular maintenance.

a. Removal of weeds and unwanted species is usually needed within the first 1-3 years following installation.

b. If a sediment control device, such as a stone trench or level spreader is installed, it shall be inspected quarterly for the first two years following construction and then twice a year thereafter.

c. Sediment and debris must be removed when build up exceeds two inches in depth in the Vegetated Filter Strip, level spreader or stone trench.

d. Disposal of sediment, debris/trash, and any other waste material shall be disposed/recycled at a suitable site, in compliance with local, state, and federal waste regulations.

e. Rills and gullies must be filled in with topsoil and stabilized with seed and mulch blankets.

f. Detritus (e.g. dead/decomposing leaves) may also need to be removed approximately twice per year. Perennial planting may be cut down at the end of the growing season, or beginning of the next.

g. Invasive species must be removed on an annual basis and disposed of in compliance with local, state, and federal regulations.

h. If used, grass cover must be maintained and mowed at a height of 4-6 inches.

Part J: Guidelines - Bioswales

1. GENERAL GUIDELINES

Bioswales are shallow densely planted channels meant to convey stormwater runoff as well as filter out other sediments. Check dams shall be installed per the *Low Impact Development Manual for Michigan* to improve sediment capture and increase the time of concentration. If appropriate, clean washed aggregate and perforated pipe can be introduced into the system to enhance the storage capacity of the bioswale. If an underdrain is used there will be no allowance for infiltration credits.

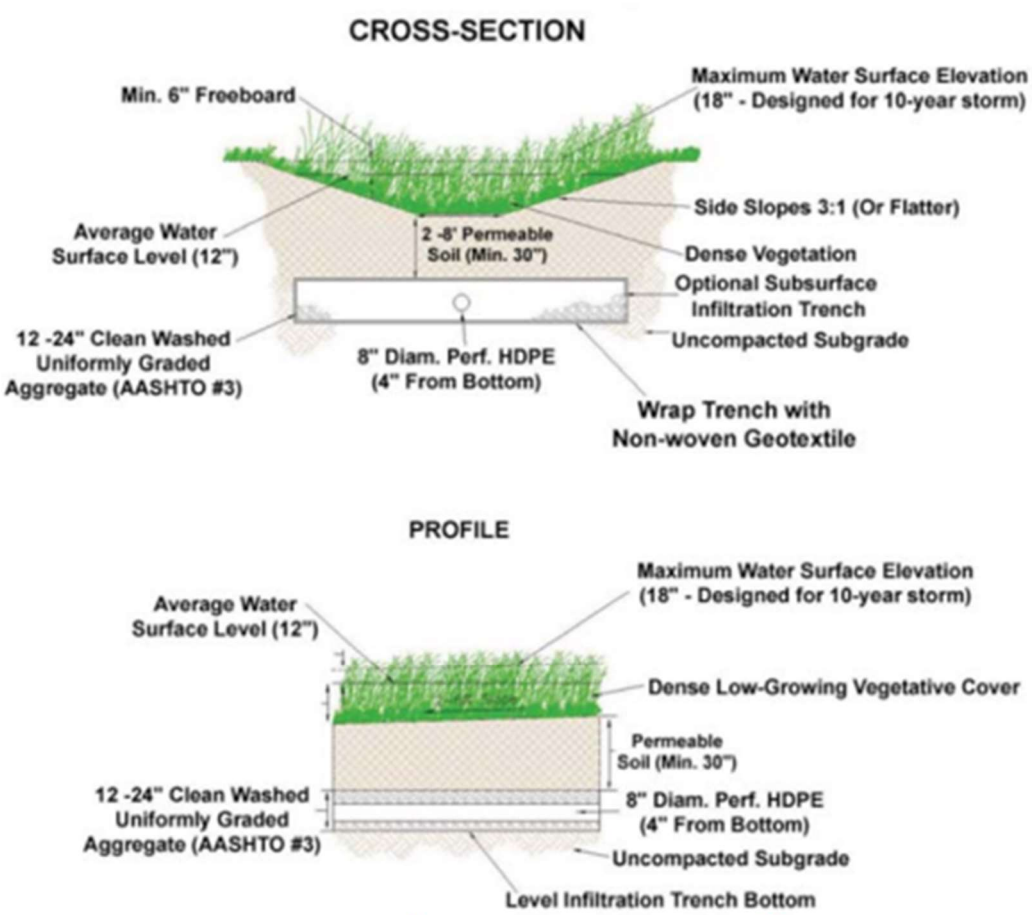


Figure 9: Bioswale cross section and profile

2. PROHIBITIONS

   Infiltration facilities will not be allowed in the areas that following;

   a. Areas with known pollution as identified by EGLE

3. SETBACKS

Table 9: Setback Details for Bioswales

Setback from	Minimum distance (feet)
Property Line	10
Building Foundation/Basement*	15
Private Well	50
Public Water Supply Well	75
Septic System Drainfield (primary & reserve)**	100
*minimum with slopes directed away from building	

4. TESTING REQUIREMENTS

   a. See Section IV.

   b. The overall site shall be evaluated for potential infiltration systems early in the design process.

5. BIOSWALE COMPONENTS/CONFIGURATION

   The primary components (and subcomponents) of a Bioswale are:

   Flow Entrance

   Water may enter via:

   - An inlet (e.g. flared end section)
   - Sheet flow into the facility over grassed areas
   - Curb cuts with grading for sheet flow entrance
   - Roof leaders with direct surface connection through a gravel trench
   - Pipe: in all cases entering velocities must be non-erosive sheet flow.

   Positive Overflow

   - Bioswales will discharge runoff to a suitable downstream conveyance or storage area.
   - Bioswales must be designed to include proper overflow paths for events above the 10-year recurrence interval.
   - Discharge must be directed in a manner to avoid property damage and have an unimpeded route to a receiving channel or outlet

Ponding Area (Water Surface Level/Elevation)

- Overflow must be provided over check dams
- Maximum ponding depth (water surface level) of 18 inches at the end of channel
- The use must be within banks

Plantings

Proper plant selection is essential for Bioswales to be effective. Native salt-tolerant, drought tolerant and erosion resistant plant species are suited to the variable environmental conditions encountered in a Bioswale. In addition, the use of trees is prohibited in any BMP where an underdrain is used. See the LID Manual for Michigan for more information.

Planting periods will vary, but in general vegetation should be planted from mid-March through early June, or mid-September through mid-November. Planting soil must be a loam soil capable of supporting healthy vegetative cover. A recommended soil blend is 20-30% organic material (compost), 20-30% sand, and 20-30% topsoil. Planting soil must be 8 inches deep along the bottom of the Bioswale. Soils must have clay content less than 10% (a small amount of clay is beneficial to absorb pollutants and retain water), be free of toxic substances, construction debris and unwanted plant material and have a 5-10% organic matter content. Additional organic matter can be added to the soil to increase water holding capacity. Tests should be conducted to determine volume storage capacity of amended soils. Establishment should include full erosion control blankets or the equivalent.

6. EASEMENTS

Bioswales will have sufficient Calhoun County Water Resource Commission easements for maintenance purposes. Easements will be sized and located to accommodate access and operation of equipment, spoils deposition and other activities identified in the development's stormwater system maintenance plan.

7. CALCULATIONS

Volume Reduction Calculations: See Section IV.

Sizing and Design Criteria

a. **Surface area** is dependent upon storage volume requirements (impervious drainage area to infiltration area; see Design Requirements for Infiltration Systems for additional guidance on loading rates.)

b. **Surface Side slopes** must be gradual. The maximum allowable slope for Bioswales is 3:1.

c. **Surface Ponding depth** must not exceed 12 inches throughout the Bioswale and 18 inches at the end point and will empty within 24 hours.

d. **Ponding area** must provide sufficient surface area to meet required storage volume without exceeding the design ponding depth. A subsurface storage/infiltration bed can be used to supplement surface storage where appropriate.

e. **Planting soil depth** must be at least eight inches where only herbaceous plant species will be utilized. If trees and woody shrubs will be used, soil media depth should be increased depending on plant species. Native soils can be used as planting soil or modified on many sites.

8. CONSTRUCTION

   The following is a typical construction sequence; however, alterations will be necessary depending on design variations.

   Note for all construction steps: Erosion and sediment control methods must adhere to the latest requirements of the Michigan DEQ's Soil Erosion and Sedimentation Control Program.

   a. Install temporary sediment control BMPs as shown on the plans.
   b. Begin construction on the Bioswale only when upper gradient has been significantly stabilized.
   c. Complete site grading, minimizing compaction as much as possible.
   d. Rough grade the Bioswale as proposed and scarify the existing soil surfaces. Deposit and spread planting soil. Do not compact in-situ soils.
   e. Presoak the planting soil prior to planting vegetation to aid in settlement.
   f. Install erosion protection.
   g. Erosion control must be present and maintained for the first 75 days following the first storm event of the season.

9. MAINTENANCE

   a. Properly designed and installed Bioswales require regular maintenance.
   b. Annually inspect the Bioswale for channel and slope uniformity.
   c. Inspect check dams annually and correct when signs of altered water flow are identified.
   d. Sediment and debris must be removed when build up exceeds 50% of ponding depth in the Bioswale.
   e. Dispose of sediment, debris/trash, and any other waste material removed from a Bioswale at a suitable disposal/ recycling site, in compliance with local, state, and federal waste regulations.
   f. Rills and gullies must be filled in with topsoil and stabilized with seed and mulch blankets.
   g. Detritus (e.g. dead/decomposing leaves) must be removed approximately twice per year. Perennial planting may be cut down at the end of the growing season, or early in the next growing season.
   h. Invasive species must be removed on an annual basis and disposed of in compliance with local, state, and federal regulations.

Part K: Design Requirements – Green Roofs

Green roofs are a complex BMP and individual applications are unique, based on structural limitations, building layout, and available materials. The reviewing agency will work with the developer to review the proposed green roof design and determine what credits would be appropriate for peak flow and volume control.

1. GENERAL REQUIREMENTS

   a. Vegetated roof covers intended to achieve water quality benefits shall not be fertilized

b. Temporary irrigation may be necessary to establish plants. Thereafter, irrigation is generally not required (or even desirable) for optimal stormwater management using vegetated covers

c. Internal building drainage, including provisions to cover and protect deck drain of scuppers, must anticipate the need to manage large rainfall events without inundating the cover.

d. The roof structure must be evaluated for compatibility with the maximum predicted dead and live loads and documented by a Professional Engineer on a sealed design.

e. Waterproofing underlying a green roof must be resistant to biological and root attack. In many instances a supplemental root fast layer is installed to protect the primary waterproofing membrane from plant roots. Root barriers must be thermoplastic membranes of at least 30 mils bonded by hot-air fusion.

2. CALCULATIONS

Volume Reduction Calculations

Volume reduction shall be determined on a case-by-case basis. Roof drainage systems that collect and store water (for later reuse) will achieve a larger volume reduction credit than roof systems that discharge to the stormwater system.

Peak Rate Mitigation

Vegetated roof covers can exert a significant influence on peak flow rates derived from roofs. An evaluation of peak runoff rates requires that the developer submit calculations based on the unique characteristics of the proposed green roof system.

3. CONSTRUCTION

The construction sequence shall be determined by the developer's engineer, based on the type of green roof system proposed.

4. MAINTENANCE

a. It will be the responsibility of the property owner or governing association of the development to maintain the green roof and deed restrictions and covenants for the development shall state such. The reviewing agency will not accept easements nor maintain green roofs. In the event that a green roof is not maintained, the local jurisdiction will take the appropriate legal action to enforce the deed and covenants.

b. Irrigation will be required as necessary to establish and/or maintain healthy vegetation for the entire green roof area. This irrigation will be temporary or permanent, depending on the design scenario and vegetation needs.

Part L: Design Requirements – Water Reuse

1. GENERAL REQUIREMENTS

a. Identify opportunities where water can be reused for irrigation or used for indoor greywater reuse. From this, calculate the water need for the intended uses. For example, if a 2,000 SF landscaped area requires irrigation for 4 months in the summer at a rate of 1" per week; the designer must determine how much water will be needed to achieve this goal, and how often the storage unit will be refilled via precipitation. The usage requirements and the expected rainfall volume and frequency must be determined.

b. Rain barrels and cisterns should be positioned to receive rooftop runoff.

c. Provide for the use or release of stored water between storm events in order for the necessary stormwater storage volume to be available.

d. If cisterns are used to supplement greywater needs, a parallel conveyance system must be installed to separate reused stormwater or greywater from other potable water piping systems. Do not connect to domestic or commercial potable water systems.

e. Household water demands must be considered when sizing a system to supplement residential greywater.

f. Pipes or storage units must be clearly marked “Caution: Reclaimed water, Do Not Drink”.

g. Screens must be used to filter debris from storage units.

h. Protect storage elements from direct sunlight by positioning and landscaping. Limit light into devices to minimize algae growth.

i. The proximity to building foundations must be considered from overflow conditions. Overflow discharge must be a minimum of 15’ from building foundation.

j. Climate is an important consideration. Capture/reuse systems must be disconnected and emptied during winter to prevent freezing.

k. Cisterns must be watertight (joints sealed with nontoxic waterproof material) with a smooth interior surface, and capable of receiving water from rainwater harvesting system.

l. Covers and lids must have a tight fit to keep out surface water, animals, dust and light.

m. Positive outlet for overflow must be provided a few inches from the top of the cistern.

n. Observation risers must be at least 6 inches above grade for buried cisterns.

o. Reuse may require pressurization. To add pressure, a pump, pressure tank and fine mesh filter can be used which adds to the cost of the system, but creates a more usable system.

p. Rain barrels require a release mechanism in order to drain empty between storm events. Connect a soaker hose to slowly release stored water to a landscaped area.

2. INLET/OUTLET DESIGN

Stormwater is conveyed to the rain barrel or cistern through a downspout. A small pump affixed to the structure will allow the stored stormwater to be removed and used. Positive outlet for overflow should be provided a few inches from the top of the cistern.

3. COMPONENTS/CONFIGURATION

Rain Barrels

Commonly, rooftop downspouts are connected to a Rain Barrel (container) that collects runoff and stores water until needed for a specific use. Rain Barrels are often used at individual homes where water is reused for garden irrigation, including landscaped beds, trees, or other vegetated surfaces. Other uses include commercial and institutional. See Figure 10 for more detail on Rain Barrels.

Cistern/Above Ground Tank

A Cistern or Above Ground Tank is a container or structure that has a greater capacity than a rain barrel. Cisterns and Above Ground Tanks may be comprised of fiberglass, concrete, plastic, brick or other materials and can be stored underground or on the surface. The storage size can range from

200 gallons to 12,000 gallons. See Figure 11 for more detail on Cisterns/ Above Ground Storage Tanks.

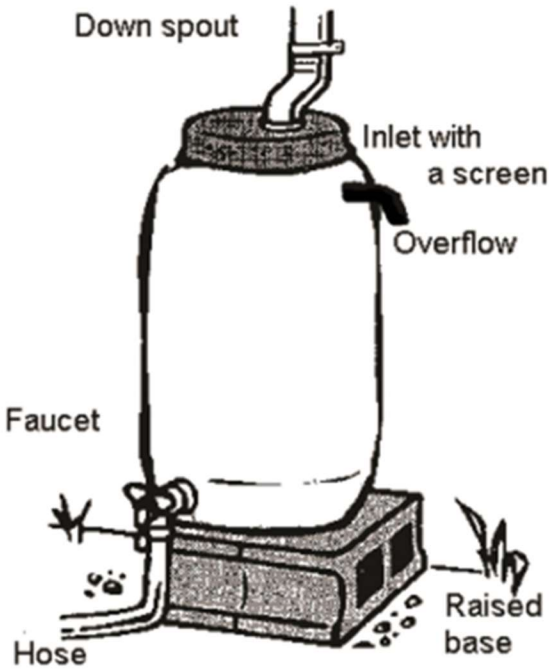


Figure 10: Rain Barrel

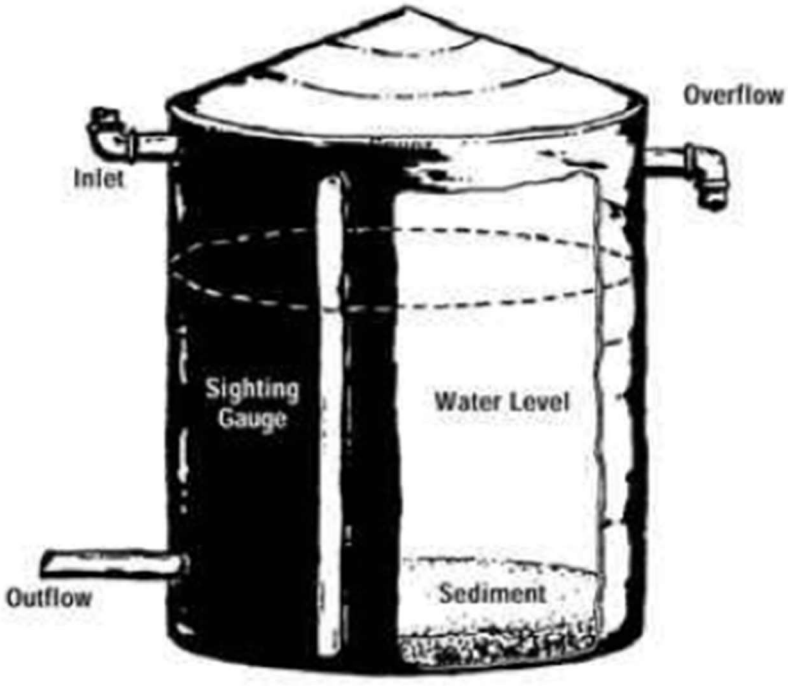


Figure 11: Cistern Detail

4. CALCULATIONS

Volume Reduction

The amount of water stored in the container is equal to the volume reduction.

Water Reuse Structure Capacity:

Rain Barrel 40-75 gallons

Cistern/Above Ground Tank 200-12,000 gallons

Peak Rate Mitigation

Overall, capture and reuse takes a volume of water out of site runoff and puts it back into the ground. This reduction in volume will translate to a lower overall peak rate for the site.

Water Quality

Pollutant removal takes place through filtration of recycled primary storage, and/or natural filtration through soil and vegetation for overflow discharge. Quantifying pollutant removal will depend on design. Sedimentation will depend on the area below outlet that is designed for sediment accumulation, time in storage, and maintenance frequency. Filtration through soil will depend on flow draining to an area of soil, the type of soil (infiltration capacity), and design specifics (stone bed, etc.).

5. MAINTENANCE

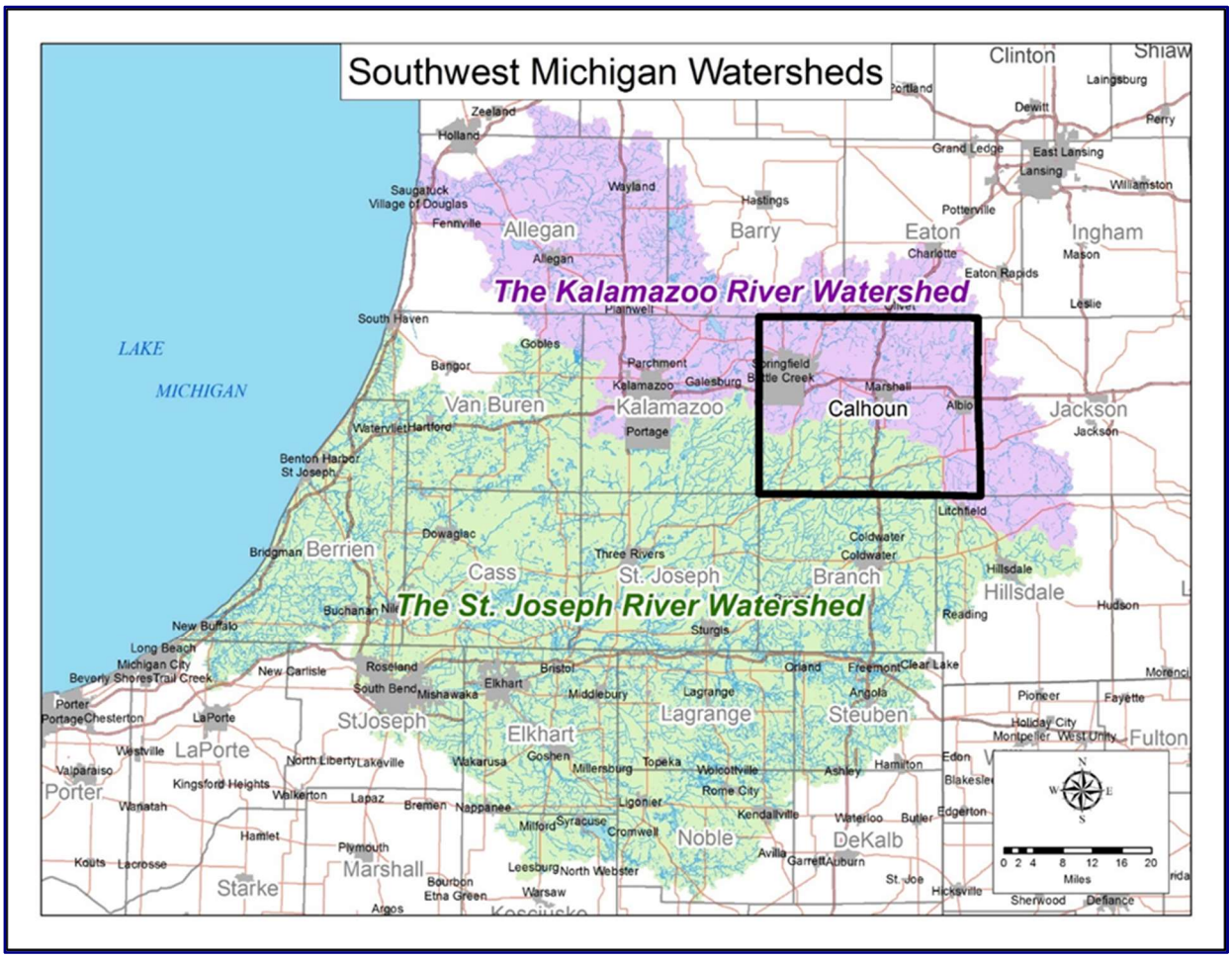
Rain Barrels

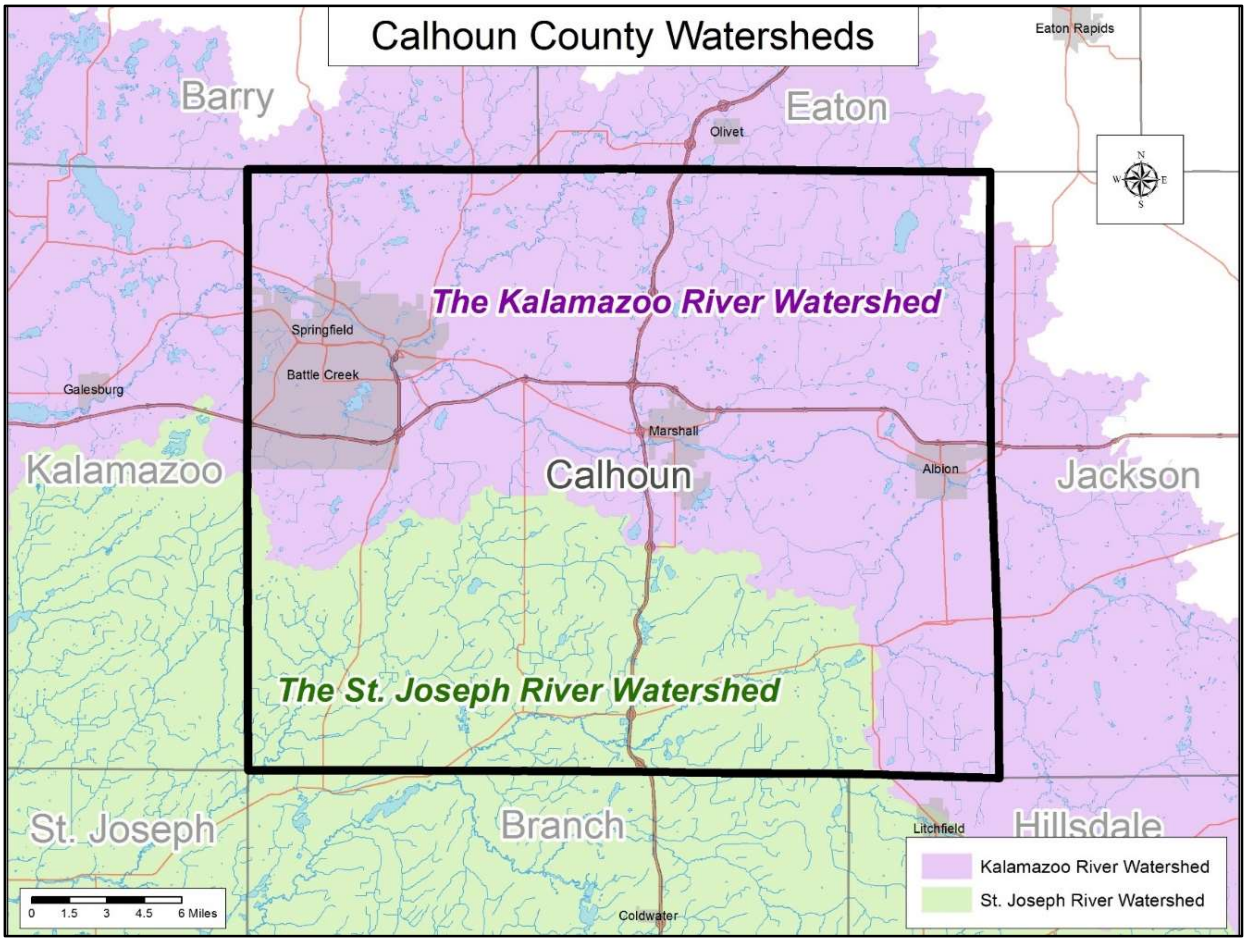
a. Inspect rain barrels four times per year, and after major storm events.
b. Remove debris from screen as needed.
c. Replace screens, spigots, downspouts and leaders as needed.
d. To avoid damage, drain container prior to winter, so that water is not allowed to freeze in the device.
e. It is the responsibility of the owner to maintain any pumps affixed to the rain barrel.

Cisterns

a. Flush cisterns to remove any sediment.
b. Brush the inside surfaces and thoroughly disinfect twice per year.
c. To avoid damage, drain container prior to winter, so that water is not allowed to freeze in the device.
d. It is the responsibility of the owner to maintain any pumps affixed to the cistern.

APPENDIX A Kalamazoo River and Calhoun County Watershed Map




Calhoun County Watersheds
Barry
Eaton
Eaton Rapids
Olivet
The Kalamazoo River Watershed
Springfield
Battle Creek
Galesburg
Marshall
Albion
Kalamazoo
Calhoun
Jackson
The St. Joseph River Watershed
St. Joseph
Branch
Litchfield
Hillsdale
Coldwater
0 1.5 3 4.5 6 Miles
Kalamazoo River Watershed
St. Joseph River Watershed

APPENDIX B Example Site Calculations

Example Problem 1: New development with outlet Overview:

A new hotel site is being constructed on a 5.7-acre parcel. The existing site is largely comprised of open grassy areas, with 0.25 acres of surface water. The construction of the hotel site will result in a 3.35-acre transformation of grassy areas to impervious area.

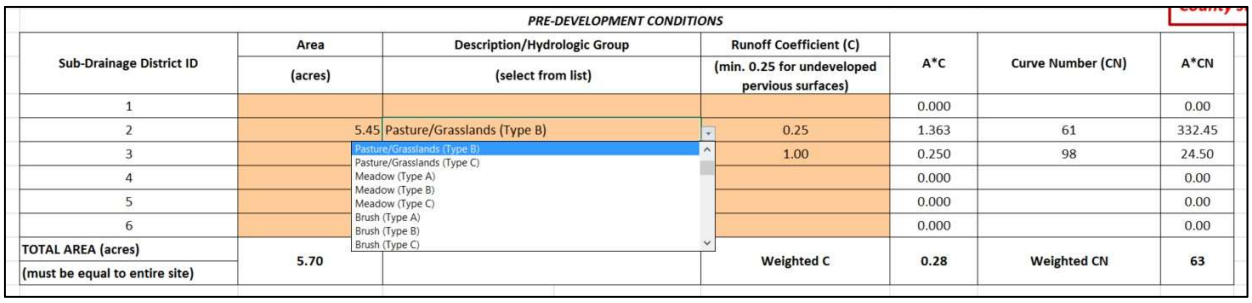
Design Process:

1. As a first step in the stormwater management process, the developer and local reviewing agency held a conceptual plan meeting. Since the site did not contain any portion of a wellhead protection area, the developer was able to proceed without special provisions from the reviewing agency. In addition, there was an existing drainage ditch approximately 300 feet from the site which provided a stormwater outlet. Soil testing found a well-distributed presence of high infiltration soils and a ground water elevation below all of the seven-foot test pits. Based on these findings, there were no limitations to on-site infiltration.
2. Next, the developer performed sizing calculations for an infiltration and detention basin on the existing and projected characteristics of the development site, using the *TRM Stormwater Calculation Tool* provided by the reviewing agency.
    a. The first step in this process was to define the pre-development and post-development site conditions, shown in Table 1.

Table 1

		Runoff Coefficient	Pre-Development	Post-Development
		(*C*)	Acres	Acres
Land Cover	Pasture / Grasslands	0.25	5.45	2.10
	Surface Water	1.00	0.25	0.25
	New Impervious	0.90		3.35
	Total Area		5.7	5.7
Weighted Curve Number (CN)			63	84
Time of Concentration (T_c) in hours			0.50	0.25

Site conditions were then entered in the *Input* tab of the *TRM Stormwater Calculation Tool* (Figure 1). Land cover was selected through the dropdown menu and the runoff characteristics were entered manually by the developer (Figure 1).



PRE-DEVELOPMENT CONDITIONS

Sub-Drainage District ID	Area (acres)	Description/Hydrologic Group (select from list)	Runoff Coefficient (C) (min. 0.25 for undeveloped pervious surfaces)	A*C	Curve Number (CN)	A*CN
1				0.000		0.00
2	5.45	Pasture/Grasslands (Type B)	0.25	1.363	61	332.45
3		Pasture/Grasslands (Type B)	1.00	0.250	98	24.50
4		Pasture/Grasslands (Type C)		0.000		0.00
5		Meadow (Type A)		0.000		0.00
6		Meadow (Type B)		0.000		0.00
TOTAL AREA (acres) (must be equal to entire site)	5.70	Meadow (Type C) Brush (Type A) Brush (Type B) Brush (Type C)	Weighted C	0.28	Weighted CN	63

Figure 1

b. Since the site's total impervious area was greater than 0.5 acres, the developer was obligated to satisfy the requirements set by the *Calhoun County & Battle Creek Area Stormwater Management Program*. To satisfy water quality requirements, infiltration was necessary for the greater of the first flush (1-inch) volume (Equation 1) or the difference between the pre- development and post-development 2-year/24-hour runoff volume, i.e. channel protection, (Equation 2). In addition, the infiltration basin was required to dewater (i.e. have no standing water) within 48 hours of the end of the storm event. The volume of the first flush and 2- year/24-hour storms were calculated within the *TRM Stormwater Calculation Tool*, through the following process:

Equation 1: First Flush Volume

$$V_{WQ} = \frac{1}{12} * A_m * C$$

Where:

V_{WQ} = Water Quality Volume (ft^3)

A_M = Total Site Area (ft^2)

C = Weighted Runoff Coefficient

Equation 2: Difference in Pre- vs. Post-Development runoff volume for 2-year/24-hour storm event

$$V_{difference} = V_{post} - V_{pre}$$

Where:

$V_{difference}$ = volume increase following development

V_{post} = volume runoff following development[1]

V_{pre} = volume runoff before development[1]

$$Volume_{runoff} = \sum_{land\ use} \frac{1}{12} * Area * \frac{P - (0.2 * S)^2}{P + 0.8 * S}$$

Where:

A = Area of land use (ft^2)

P = rainfall (in.)

S = function of the watershed soil and cover conditions, represented by the runoff curve number (CN)

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

Using Equations 1 and 2, the *TRM Stormwater Calculation Tool* found the 2-year/24-hour runoff volume to be greater than the first flush volume (Table 2), therefore, the 2-year/24-hour runoff volume governed the design.

Table 2

Event	Volume (ft^3)	Description
Water Quality (WQ) Volume	13,758	Runoff volume from 1 inch of Rainfall
Channel Protection (CP) Volume	24,195	Volume difference between pre- and post-development for the 2-yr, 24-hr storm

c. Soil test pits were performed at the proposed subgrade (i.e. bottom of the BMP excavation) of the infiltration basin. No ground water was encountered through the seven-foot test pits and sandy, loamy sandy soils were observed. The average infiltration rate (K_{sat}) acrossthe site was 1.15 inches/hour. Since the infiltration rate was greater than 0.4 inches/hour, the infiltration BMPs were sized for the required infiltration volume and underdrains were not permitted. Calculations were then performed to determine the infiltration area necessary to satisfy the 48-hour dewatering requirement for infiltration basins (Equation 3):

Equation 3: Time of Dewatering

$$Time_{dewatering} = \frac{Volume_{infiltrated}}{\frac{1}{12} * k * Area_{infiltraiton}}$$

Where:

$V_{infiltrated}$ = Required infiltration volume (ft^3) (first flush or 2-year/24-hour)
$A_{infiltration}$ = Bottom area of infiltration basin (ft^2)
k = designed infiltration rate (inches per hour)

An infiltration area of 6,209 ft^2 with an infiltration rate of 1.15 inches per hour was found to provide full dewatering of the 24,195 ft3 in 41 hours, which satisfied the maximum allowable time of 48 hours.

By incorporating infiltration into the design, the developer had a choice between de-centralized infiltration BMPs, where a single or multiple infiltration basins precede the detention basin, or centralized infiltration, where infiltration occurs at the bottom of the detention basin. The developer's preference was to utilize a centralized infiltration BMP. Since the site had more than 2.5 acres of impervious surface following the hotel construction, pre- treatment for reducing the maximum TSS concentration to 80mg/L was required prior to the infiltration basin. As a result, the developer chose to use mechanical swirl separators prior to the detention pond.

d. Flood control requirements were then considered by the developer. Since the site had an unrestricted hydraulic outlet, the 25-year storm e vent was used in designing the

centralized infiltration basin. As a result, the design focused on not increasing the peak runoff flow rate from pre-development to post-development.

As a first step in limiting the post-development peak runoff flowrate, the required storage volume, i.e. difference in pre-development and post-development runoff volume during the 25-year/24-hour storm event, was found. The same methodology as that used for the 2- year/24-hour volume difference (Equation 2) was applied. The *TRM Stormwater Calculation Tool* found the increase in runoff following the development of the site to be 37,802 ft^3 (Table 3).

Table 3

Flood Protection Volume: 25-yr

Site Name: Hotel Site
Total Site Area (acres): 5.70
25-Year, 24-Hour Rainfall: 4.33

Pre-development Conditions

Cover Type/Soil Type	Area (sf)	Area (ac)	CN	S	Q Runoff (in)	Runoff Volume (ft3)
Surface Water	10,890	0.25	100	0.0	4.33	3,929
Pasture/Grasslands (Type B)	237,402	5.45	61	6.4	0.99	19,502
0	0	0.00				0
0	0	0.00				0
0	0	0.00				0
0	0	0.00				0
TOTAL	**248,292**	**5.70**	**N/A**	**N/A**	**N/A**	**23,432**

Post-development Conditions

Cover Type/Soil Type	Area (sf)	Area (ac)	CN	S	Q Runoff (in)	Runoff Volume (ft^3)
Surface Water	10,890	0.25	100	0.0	4.33	3,929
Pasture/Grasslands (Type B)	91,476	2.10	61	6.4	0.99	7,515
Impervious Cover (Type B)	145,926	3.35	98	0.2	4.09	49,790
0	0	0.00				0
0	0	0.00				0
0	0	0.00				0
TOTAL	**248,292**	**5.70**	**N/A**	**N/A**	**N/A**	**61,234**

V_{25} Runoff Volume Increase (ft^3) =	**37,802**
25-year peak detention pond discharge (cfs) =	**4.32**

However, since the centralized infiltration basin was sized to handle the first 24,195 ft^3 of runoff volume, the detention basin only needed to handle the marginal volume beyond what could be infiltrated. In other words, the required volume detained during the 25-year/24-hour storm was that in excess to the volume initially treated by infiltration, or 37,802 – 24,195 = 13,607 ft^3 (Figure 2). This volume was determined in the *TRM Stormwater Calculation Tool*, as shown in Table 4.

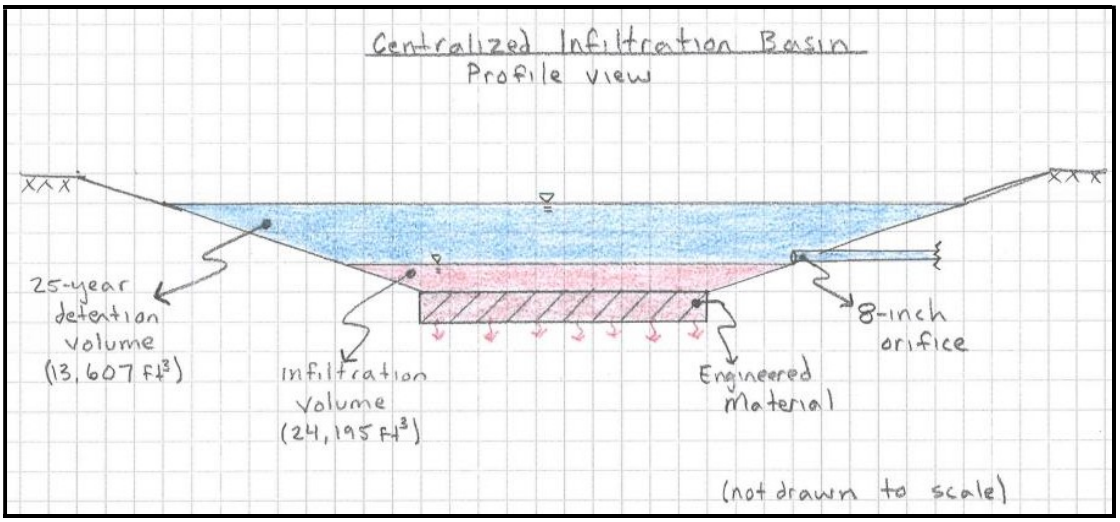


Figure 2

Table 4

	Contour Elevation (feet)	Contour Area (Sq. ft)	Storage Volume (Cu. ft.)	Total Volume (Cu. Ft.)
Lowest	893.0	8,273	0	0
	894.0	9,400	5,935	5,935
	895.0	10,600	6,714	12,649
Highest	896.0	11,871	7,540	14,254

1-Stage Outlet Design - INFILTRATION REQUIREMENT SATISFIED

25-Year Allowable Peak Discharge	4.32 cfs
25-Year Peak Storage Volume:	13,607 ft^3

Peak Storage Elevations

X_{bot} =	893.00 ft
X_{25} =	895.60 ft

25-Year Orifice and Peak Flow Calculations

25-Year Allowable Peak Discharge:		4.32	cfs
Chosen Orifice Size (25-Year Control):		10	in
Chosen Orifice Area:		0.55	ft^2
Number of Orifices (25-Year Control):		1	
Total Opening Area of 25-Year Control Orifice(s):		0.55	ft^2
25-year Peak Flow:	$0.62 * \#_{orif} * A_{orif}^{act} * \sqrt{2gh}$	4.01	ft^3
25-Year Peak Flow Requirement Met?	$Q_{25}^{act} < Q_{25}^{allow}$?	TRUE	

After determining the necessary detention volume, the detention outlet was sized to reduce the peak runoff flowrate to less than pre-development conditions. Using the *Pre vs Post Calculations* tab in the *TRM Stormwater Calculation Tool,* the 25-year/24-hour peak flow was determined with Equation 4:

Equation 4: Peak Discharge

$$Q_p = q_u * A_m * Q * F_p$$

Where:

Q_p = Peak Discharge (cfs)

q_u = Unit Peak Discharge

A_m = Site Area (sq. mi.)

Q = Runoff (in)

F_p = Ponding Factor (assumed to be 1.0 – no ponding)

Using Equation 4, the *Stormwater TRM Calculation Tool* found the pre-development peak flow (Table 5) during the 25-year storm event to be 4.32 cfs.

Table 5

Pre-Development					
Frequency	**q_u**	**A_m (sq. mi.)**	**Q**	**F_p**	**Q_p (cfs)**
2 yr, 24 hr	152.19	0.01	0.25	1.0	0.34
10 yr, 24 hr	408.30	0.01	0.68	1.0	2.46
100 yr, 24 hr	478.06	0.01	1.95	1.0	8.31
25 yr, 24 hr	449.24	0.01	1.09	1.0	4.34

The post-development peak runoff flowrate (Table 6) was also calculated using Equation 4 within the *Stormwater TRM Calculation Tool* and was 17.57 cfs for the 25-year storm event.

Table 6

Post-Development					
Frequency	**q_u**	**A_m (sq. mi.)**	**Q**	**F_p**	**Q_p (cfs)**
2 yr, 24 hr	612.91	0.01	1.18	1.0	6.42
10 yr, 24 hr	729.44	0.01	2.02	1.0	13.15
100 yr, 24 hr	731.33	0.01	3.97	1.0	25.88
25 yr, 24 hr	731.33	0.01	2.71	1.0	17.62

In sizing the detention basin's outlet, the *TRM Stormwater Calculation Tool* was used to determine the appropriate orifice size necessary for reducing the post-development peak flow (17.62 cfs) to less than the pre-development 25-year peak flow (4.34 cfs). A single 10-inch orifice placed at the bottom of the 25-year/24-hour detention volume was found to reduce the post-development peak runoff from 17.62 cfs to 4.01 cfs (Table 7), which satisfied flood control requirements.

Table 7

	Contour Elevation (feet)	Contour Area (Sq. ft)	Storage Volume (Cu. ft.)	Total Volume (Cu. Ft.)
Lowest	893.0	8,273	0	0
	894.0	9,400	5,935	5,935
	895.0	10,600	6,714	12,649
Highest	896.0	11,871	7,540	14,254

1-Stage Outlet Design - INFILTRATION REQUIREMENT SATISFIED

25-Year Allowable Peak Discharge	4.32 cfs
25-Year Peak Storage Volume:	13,607 ft^3

Peak Storage Elevations

X_{bot} =	893.00 ft
X_{25} =	895.60 ft

25-Year Orifice and Peak Flow Calculations

25-Year Allowable Peak Discharge:		4.32	cfs
Chosen Orifice Size (25-Year Control):		10	in
Chosen Orifice Area:		0.55	ft^2
Number of Orifices (25-Year Control):		1	
Total Opening Area of 25-Year Control Orifice(s):		0.55	ft^2
25-year Peak Flow:	$0.62 * \#_{orif} * A_{orif}^{act} * \sqrt{2gh}$	4.01	ft^3
25-Year Peak Flow Requirement Met?	$Q_{25}^{act} < Q_{25}^{allow}$?	TRUE	

Example Problem 2: new development with no outlet

Overview:

To demonstrate the additional resources associated with a no outlet BMP, Example Problem 1 is being reconsidered. In this scenario, the developer is considering the impacts of satisfying the stormwater requirements set by the *Calhoun County & Battle Creek Area Stormwater Management Program* through a management system which does not include a stormwater outlet. All characteristics of the site's development are maintained from Example Problem 1, however in this case the developer is evaluating the increase in cost and resources required to satisfy the requirements for a site without an outlet. Since the stormwater standards require sites without an outlet to treat the 100-year/24-hour volume across the whole site, it is expected that the basin size will need to be significantly larger than what was sized in Example Problem 1 for the 25-year/24- hour storm event. This increase in size is likely to result in additional costs in excavation and a loss in the area available for floor plan development.

Design Process:

1. As a first step in the stormwater management process, the developer and local reviewing agency held a conceptual plan meeting. Since the site did not contain any portion of a wellhead protection area, the developer was able to proceed without special provisions from the reviewing agency. In addition, the developer was required to submit a *No Outlet Certificate*, to demonstrate no positive outlet was available.
2. Next, the developer performed sizing calculations for an infiltration and retention basin on the development site, using the *TRM Stormwater Calculation Tool* provided by the reviewing agency.
    a. The first step in this process was to define the pre-development and post-development site conditions, which are consistent with those from Example Problem 1, shown in Table 1.

Table 1

		Runoff Coefficient	Pre-Development	Post-Development
		(*C*)	Acres	Acres
Land Cover	Pasture / Grasslands	0.25	5.45	2.10
	Surface Water	1.00	0.25	0.25
	New Impervious	0.90		3.35
	Total Area		5.7	5.7
Weighted Curve Number (CN)			63	84
Time of Concentration (T_c) in hours			0.50	0.25

Site conditions were then entered in the *Input* tab of the *TRM Stormwater Calculation Tool* (Figure 1). Land cover was selected through the dropdown menu and the runoff characteristics were entered manually by the developer (Figure 1).

PRE-DEVELOPMENT CONDITIONS

Sub-Drainage District ID	Area (acres)	Description/Hydrologic Group (select from list)	Runoff Coefficient (C) (min. 0.25 for undeveloped pervious surfaces)	A*C	Curve Number (CN)	A*CN
1				0.000		0.00
2	5.45	Pasture/Grasslands (Type B)	0.25	1.363	61	332.45
3		Pasture/Grasslands (Type B)	1.00	0.250	98	24.50
4		Pasture/Grasslands (Type C)		0.000		0.00
5		Meadow (Type A)		0.000		0.00
6		Meadow (Type B)		0.000		0.00
TOTAL AREA (acres) (must be equal to entire site)	5.70	Meadow (Type C)	Weighted C	0.28	Weighted CN	63
		Brush (Type A)				
		Brush (Type B)				
		Brush (Type C)				

Figure 1

b. Since the site's total impervious area was greater than 0.5 acres, the developer was obligated to satisfy the requirements set by the *Calhoun County & Battle Creek Area Stormwater Management Program*. To satisfy water quality requirements, infiltration was necessary for the greater of the first flush (1-inch) volume (Equation 1) or the difference between the pre-development and post-development 2-year/24-hour runoff volume, i.e. channel protection, (Equation 2). In addition, the infiltration basin was required to dewater (i.e. have no standing water) within 48 hours of the end of the storm event. The volume of the first flush and 2-year/24-hour storms were calculated within the *TRM Stormwater Calculation Tool*, through the following process:

Equation 1: First Flush Volume

$$V_{WQ} = \frac{1}{12} * A_m * C$$

Where:

V_{WQ} = Water Quality Volume (ft^3)

A_M = Total Site Area (ft^2)

C = Weighted Runoff Coefficient

Equation 2: Difference in Pre- vs. Post-Development runoff volume for 2-year/24-hour storm event

$$V_{difference} = V_{post} - V_{pre}$$

Where:

$V_{difference}$ = volume increase following development

V_{post} = volume runoff following development[1]

V_{pre} = volume runoff before development[1]

$$Volume_{runoff} = \sum_{land\ use} \frac{1}{12} * Area * \frac{P - (0.2 * S)^2}{P + 0.8 * S}$$

Where:

A = Area of land use (ft^2)

P = rainfall (in.)

S = function of the watershed soil and cover conditions, represented by the runoff curve number (CN)

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

Using Equations 1 and 2, the *TRM Stormwater Calculation Tool* found the 2-year/24-hour runoff volume to be greater than the first flush volume (Table 2), therefore, the 2-year/24-hour runoff volume governed the design.

Table 2

Event	Volume (ft^3)	Description
Water Quality (WQ) Volume	13,758	Runoff volume from 1 inch of Rainfall
Channel Protection (CP) Volume	24,195	Volume difference between pre- and post-development for the 2-yr, 24-hr storm

c. Soil test pits were performed at the proposed subgrade (i.e. bottom of the BMP excavation) of the infiltration basin. No ground water was encountered through the seven-foot test pits and sandy, loamy sandy soils were observed. The average infiltration rate (K_{sat}) across the site was 1.15 inches/hour. Since the infiltration rate was greater than 0.4 inches/hour, the infiltration BMPs were sized for the required infiltration volume and underdrains were not permitted.
Calculations were then performed to determine the infiltration area necessary to satisfy the 48-hour dewatering requirement for infiltration basins (Equation 3):

Equation 3: Time of Dewatering

$$Time_{dewatering} = \frac{Volume_{infiltrated}}{\frac{1}{12} * k * Area_{infiltraiton}}$$

Where:

$V_{infiltrated}$ = Required infiltration volume (ft^3) (first flush or 2-year/24-hour)
$A_{infiltration}$ = Bottom area of infiltration basin (ft^2)
k = designed infiltration rate (inches per hour)

An infiltration area of 6,209 ft^2 at an infiltration rate of 1.15 inches per hour was found to provide full dewatering of the 24,195 ft^3 in 41 hours, which satisfied the maximum allowable time of 48 hours.

d. Flood control requirements were then considered by the developer. While no outlet designs are discouraged by the *Calhoun County & Battle Creek Area Stormwater Management Program,* it was determined that no positive outlet existed on the site. In other words, the developer and reviewing agency found there was no practical means for providing a stormwater outlet from the site. As a result, the developer was granted a *No Outlet Certification* by the local reviewing agency and the 100-year/24-hour post-development runoff volume was used in sizing a centralized infiltration and retention basin, as required by the stormwater guidelines.
Using the *TRM Stormwater Calculation Tool,* the developer found the total runoff volume (Equation 2b), and subsequent required storage volume during the 100-year/24-hour storm event to be 85,555 ft^3 (Table 3).

Table 3

Flood Protection Volume: 100-yr						
Site Name:	Harper Village					
Total Site Area (acres):	5.70					
100-Year, 24-Hour Rainfall:	5.71					
Pre-development Conditions						
Cover Type/Soil Type	**Area (sf)**	**Area (ac)**	**CN**	**S**	**Q Runoff (in)**	**Runoff Volume (ft^3)**
Surface Water	10,890	0.25	100	0.0	5.71	5,182
Pasture/Grasslands (Type B)	237,402	5.45	61	6.4	1.81	35,888
0	0	0.00				0
TOTAL	**248,292**	**5.70**	**N/A**	**N/A**	**N/A**	**41,070**
Post-development Conditions						
Cover Type/Soil Type	**Area (sf)**	**Area (ac)**	**CN**	**S**	**Q Runoff (in)**	**Runoff Volume (ft^3)**
Surface Water	10,890	0.25	100	0.0	5.71	5,182
Pasture/Grasslands (Type B)	91,476	2.10	61	6.4	1.81	13,828
Impervious Cover (Type B)	145,926	3.35	98	0.2	5.47	66,545
TOTAL	**248,292**	**5.70**	**N/A**	**N/A**	**N/A**	**85,555**
V_{100} Runoff Volume Increase (ft^3) =			**44,485**			
100-year peak detention pond discharge (cfs) =			**8.31**			

Unlike Example 1, where the infiltration volume was credited towards the 25-year/24-hour storage volume, the *Calhoun County & Battle Creek Area Stormwater Management Requirements* do not allow infiltration volumes to be credited in no outlet scenarios. As a result, the developer was required to provide the 100-year/24-hour retention volume of 85,555 ft^3, in addition to the 24,195 ft^3 for the infiltration volume.

In addition to retaining 85,555 ft^3, the basin was also required to fully dewater within 72 of the 100-year/24-hour storm event. Equation 3 was used to determine an infiltration area of at least 12,400 ft^2 necessary to satisfy the 72-hour requirement.

In comparison to the stormwater management system in Example Problem 1, which included a stormwater outlet, this no outlet scenario will require over six times more storage volume (with outlet: 13,607 ft^3 vs. no outlet: 85,555 ft^3) and an infiltration area for dewatering that is twice as large (with outlet: 6,209 ft^2 vs. no outlet: 12,400 ft^2). By increasing the BMP size, costs associated with excavation and construction will be elevated and more of the site will be consumed by the stormwater basin. In many cases, these additional costs may exceed the benefits associated with the no outlet design and developers may reconsider their design to include an outlet.

Example Problem 3: re-development with outlet

Overview:

A re-development is being constructed on a 3.0-acre site. The existing site contains a 1.3-acre parking lot. The remainder of the existing site is a 1.7-acre open meadow. The re-development of the property will result in a 0.3-acre increase in existing impervious surface through the construction of a 0.2-acre building and 0.1-acres of additional parking spaces.

Design Process:

1. As a first step in the stormwater management process, the developer and local reviewing agency held a conceptual plan meeting. Since the site did not contain any portion of a wellhead protection area, the developer was able to proceed without special provisions from the reviewing agency. In addition, a local creek ran approximately 120 feet from the site boundary which was able to provide a stormwater outlet. Soil testing found well infiltrated soils with an average k_{sat} of 0.5 inches per hour and a ground water elevation below all of the 6-foot test pits. Based on these findings, there were no limitations to on-site infiltration.
2. Next, the developer performed sizing calculations for an infiltration and detention basin on the development site, using the *TRM Stormwater Calculation Tool* provided by the reviewing agency.
    a. The first step in this process was to define the pre-development and post-development site conditions, shown in Table 1.

Table 1

		Runoff Coefficient	Pre-Development	Post-Development
		(*C*)	Acres	Acres
Land Cover	Meadow	0.3	1.7	1.4
	Original Impervious	0.9	1.3	1.3
	New Impervious	0.9		0.3
	Total Area		3.0	3.0
Weighted Curve Number (CN)			75	79
Time of Concentration (T_c) in hours			0.40	0.30

Site conditions were then entered in the Input tab of the TRM Stormwater Calculation Tool. Land cover was selected through the dropdown menu and the runoff characteristics were entered manually by the developer (Figure 1).

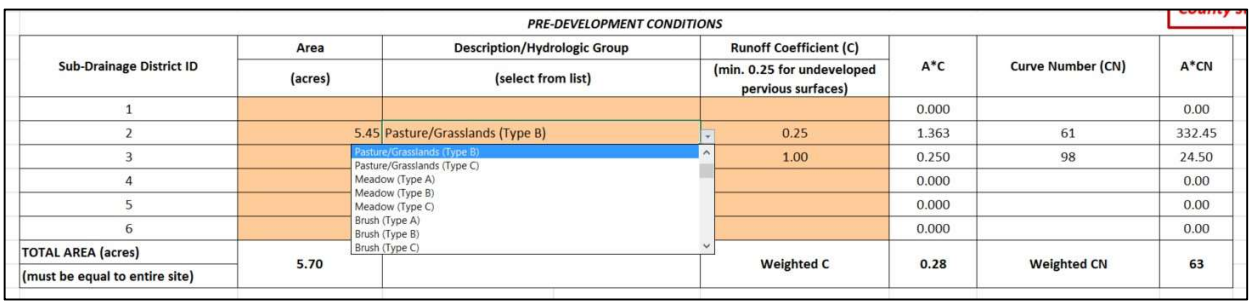


Figure 1

b. Since the site's total impervious area was greater than 0.5 acres, the developer was obligated to satisfy the requirements set by the *Calhoun County & Battle Creek Area Stormwater Management Program*. To manage water quality requirements, infiltration was necessary for the greater of the first flush (1-inch) volume (Equation 1) or the difference between the pre-development and post-development 2-year/24-hour runoff volume, i.e. channel protection, (Equation 2). In addition, the infiltration basin was required to dewater (i.e. have no standing water) within 48 hours of the end of the storm event. The volume of the first flush and 2-year/24-hour storms were calculated within the *TRM Stormwater Calculation Tool*, through the following process:

Equation 1: First Flush Volume

$$V_{WQ} = \frac{1}{12} * A_m * C$$

Where:

V_{WQ} = Water Quality Volume (ft^3)

A_M = Total Site Area (ft^2)

C = Weighted Runoff Coefficient

Equation 2: Difference in Pre- vs. Post-Development runoff volume for 2-year/24-hour storm event

$$V_{difference} = V_{post} - V_{pre}$$

Where:

$V_{difference}$ = volume increase following development

V_{post} = volume runoff following development[1]

V_{pre} = volume runoff before development[1]

$$Volume_{runoff} = \sum_{land\ use} \frac{1}{12} * Area * \frac{P - (0.2 * S)^2}{P + 0.8 * S}$$

Where:

A = Area of land use (ft^2)

P = rainfall (in.)

S = function of the watershed soil and cover conditions, represented by the runoff curve number (CN)

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

Using the above equations, the TRM Stormwater Calculation Tool found the first flush runoff volume to be greater than the 2-year/24-hour runoff volume (Table 2), therefore, the first flush runoff volume governed the design.

Table 2

Event	Volume (ft^3)	Description
Water Quality (WQ) Volume	6,752	Runoff volume from 1-inch of Rainfall
Channel Protection (CP) Volume	2,227	Volume difference between pre- and post-development for the 2-yr, 24-hr storm

a. Soil test pits were performed at the proposed subgrade (i.e. bottom of the BMP excavation) of the infiltration basin. No ground water was encountered through the six- foot test pits and sandy, loamy sandy soils were observed. The average infiltration rate (K_{sat}) across the site was 0.5 inches per hour. Since the infiltration rate was greater than 0.4 inches per hour, the infiltration BMPs were sized for the required infiltration volume and no underdrain was permitted.
Calculations were then performed to determine the infiltration area necessary to satisfy the dewatering requirement of 48-hours for infiltration basins (Equation 3):

Equation 3: Time of Dewatering

$$Time_{dewatering} = \frac{Volume_{infiltrate}}{\frac{1}{12} * k * Area_{infiltraiton}}$$

Where:

$V_{infiltrated}$ = Required infiltration volume (ft^3) (first flush or 2-year/24-hour)
$A_{infiltration}$ = Bottom area of infiltration basin (ft^2)
k = designed infiltration rate (inches per hour)

An infiltration area of 3,400 ft^2 with an infiltration rate of 0.5 inches per hour was found to provide full dewatering of the 6,752 ft3 in 47 hours, which satisfied the maximum allowable time of 48 hours.

Since the site had less than 5 acres of residential land use and 2.5 acres of impervious surface, the developer was not required to incorporate pre-treatment before the infiltration basin. As a result, the BMP was not designed to provide pre-treatment methods focused on max TSS concentrations.

b. Flood control requirements were then considered by the developer. Since the site had an unrestricted hydraulic outlet, the 25-year storm event was used in sizing the flood control basin. As a result, the design focused on not increasing the peak runoff flow rate from pre-development to post-development.

As a first step in limiting the post-development peak runoff flowrate, the required storage volume, i.e. difference in pre-development and post-development runoff volume during the 25-year/24-hour storm event, was found. The same methodology as that used for the 2-year/24-hour volume difference (Equation 2) was applied. The *TRM Stormwater Calculation Tool* found the increase in runoff following the development of the site to be 3,565 ft^3 (Table 3).

Table 3

Flood Protection Volume: 25-yr						
Site Name:	Redevelopment					
Total Site Area (acres):	3.00					
100-Year, 24-Hour Rainfall:	4.33					
Pre-development Conditions						
Cover Type/Soil Type	**Area (sf)**	**Area (ac)**	**CN**	**S**	**Q Runoff (in)**	**Runoff Volume (ft^3)**
Impervious Cover (Type B)	56,628	1.30	98	0.2	4.09	19,321
Meadow (Type B)	74,052	1.70	58	7.2	0.82	5,062
TOTAL	**130,680**	**3.00**	**N/A**	**N/A**	**N/A**	**24,384**
Post-development Conditions						
Cover Type/Soil Type	**Area (sf)**	**Area (ac)**	**CN**	**S**	**Q Runoff (in)**	**Runoff Volume (ft^3)**
Impervious Cover (Type B)	69,696	1.60	98	0.2	4.09	23,780
Meadow (Type B)	60,984	1.40	58	7.2	0.82	4,169
TOTAL	**130,680**	**3.00**	**N/A**	**N/A**	**N/A**	**27,949**
V_{100} Runoff Volume Increase (ft^3) =			**3,565**			
100-year peak detention pond discharge (cfs) =			**5.15**			

While the difference in runoff volume during the 25-year/24-hour storm event was found to be 3,565 ft^3, the water quality requirement (i.e. the greater of the first flush or 2-year/24-hour storm) was 6,752 ft^3. Under these circumstances, the volume of runoff treated through the infiltration basin exceeded the volume required for flood control by 3,517 ft^3. As a result, the infiltration basin was able to handle the 25-year/24-hour pre- vs. post-development runoff volume and an additional basin for flood control basin was not necessary.

APPENDIX C Stormwater Management Maintenance Agreements

Appendix C-1

Stormwater Management Maintenance Agreement

for the City of Battle Creek

THIS AGREEMENT is made this day of _____, 20____, by and between the City of Battle Creek, a Michigan municipal corporation, 10 N. Division St., Battle Creek, MI 49014, hereinafter "City" and _____ a [type of entity] with principal offices located _____, hereinafter "Responsible Party" by virtue of _____, proof of which is attached hereto as Exhibit A.

Responsible Party for the property described below, in accordance with City of Battle Creek City Ordinance 1048 and all regulations adopted thereby, agrees to install and maintain stormwater management system(s) on the subject property in accordance with approved plans and conditions. The Owner further agrees to the terms stated in this document to ensure that the stormwater management system continue serving the intended function in perpetuity. This Agreement includes the following exhibits:

Exhibit A: A Legal document required by 1048.16 of Battle Creek City Ordinance, or the Liber and Page number of the recorded document showing that the individual is the Responsible Party and has the authority for the construction and maintenance of the stormwater management system on the real estate identified in Exhibit B. The legal document is defined as a Deed, Master Deed, Property Owners Association Charter or other evidence of authority.

Exhibit B: Legal description of the real estate for which this Agreement applies ("Property").

Exhibit C: Map(s) showing a location of the property and an accurate location of each component of the stormwater management system affected by this Agreement.

Exhibit D: Operation and Maintenance Plan showing the activities and schedule required to operate and maintain the permitted facilities otherwise known as the stormwater management system.

Through this Agreement, the Responsible Party hereby subjects the Property to the following covenants, conditions, and restrictions:

1. The Responsible Party, at its expense, shall secure from any affected owners of land all easements, drainage acceptance covenants, and releases of rights-of-way necessary for utilization of the stormwater system identified in Exhibit C and shall record them with the Calhoun County Register of Deeds. These easements and releases of rights-of-way shall not be altered, amended, vacated, released or abandoned without prior written approval of the City of Battle Creek.

2. The Responsible Party shall be solely responsible for the installation, maintenance and repair of the stormwater management system, drainage easements, and associated landscaping identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D).

3. No alterations or changes to the stormwater management system identified in Exhibit C shall be permitted unless they are deemed to comply with this Agreement and are approved in writing by the City of Battle Creek.

4. The construction and performance of stormwater management system need to be verified by the Responsible Party's licensed professional engineer. Documentation of the verification is required to obtain an occupancy permit.

5. The Responsible Party shall retain the services of a qualified inspector to ensure the maintenance of the stormwater management system identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D).

6. The Responsible Party shall keep records (logs, invoices, reports, data, etc.) of inspections, maintenance, and repair of the stormwater management system and drainage easements identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D) and provide the same to the City upon request.

7. The City of Battle Creek or its designee is authorized to, but not obligated to, access the property as necessary to conduct inspections of the stormwater management system including drainage easements to ascertain compliance with the intent of this Agreement and the activities prescribed in Exhibit D. Upon written notification by the City of Battle Creek or their designee of required maintenance or repairs, the Responsible Party shall complete the specified maintenance or repairs within a reasonable time frame determined by the City of Battle Creek. The Responsible Party shall be liable for the failure to undertake any maintenance or repairs so that the public health, safety, and welfare shall not be endangered.

8. If the Responsible Party does not keep the stormwater management system in reasonable order and condition, or complete maintenance activities in accordance with the Plan contained in Exhibit D, or the reporting or the required maintenance or repairs under 6 above within the specified time frames, the City of Battle Creek is authorized, but not required, to perform inspections, maintenance, or repairs, in order to preserve the intended functions of the system and prevent the system from becoming a threat to public health, safety, general welfare or the environment. In the case of an emergency, as determined by the City of Battle Creek, no notice shall be required prior to the City of Battle Creek performing emergency maintenance or repairs. In addition to any other remedy provided for by law, the City of Battle Creek may levy the costs

and expenses of such inspections, maintenance, or repairs, plus a ten percent (10%) administrative fee against the Responsible Party. The City of Battle Creek at the time of entering upon said stormwater management system for the purpose of maintenance or repair may file a notice of lien in the office of the Calhoun County Register of Deeds upon the property affected by the lien. If said costs and expenses are not paid by the Responsible Party, the City of Battle Creek may pursue the collection of same through appropriate court actions and in such a case, the Responsible Party shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

9. The Responsible Party hereby conveys to the City of Battle Creek an easement over, on and in the property described in Exhibit B for the purpose of access to the stormwater management system for the inspection, maintenance and repair thereof, should the Responsible Party fail to properly inspect, maintain and repair the system.

10. The Responsible Party agrees that this Agreement shall be recorded and that the land described in Exhibit “B” shall be subject to the covenants and obligations contained herein, and this agreement shall bind all current and future owners of the property.

11. The Responsible Party agrees in the event that the Property is sold, transferred, or leased to provide information to the new owner, operator, or lessee regarding proper inspection, maintenance and repair of the stormwater management system. The information shall accompany the first deed transfer and include Exhibits C and D and this Agreement. The transfer of this information shall also be required with any subsequent sale, transfer or lease of the Property until property is reverted to original conditions or a new site plan with a new Maintenance Plan has been approved.

12. The Responsible Party agrees that the rights, obligations and responsibilities hereunder shall commence upon execution of the Agreement.

13. The parties whose signatures appear below hereby represent and warrant that they have the authority and capacity to sign this agreement and bind the respective parties hereto.

14. The Responsible Party, its agents, representatives, successors and assigns shall defend, indemnify and hold the City of Battle Creek harmless from and against any claims, demands, actions, damages, injuries, costs or expenses of any nature whatsoever, hereinafter “Claims”, fixed or contingent, known or unknown, arising out of or in any way connected with the design, construction, use, maintenance, repair or operation (or omissions in such regard) of the storm drainage system referred to in the plan as Exhibit “D” hereto, appurtenances, connections and attachments thereto which are the subject of this Agreement. This indemnity and hold harmless shall include any costs, expenses and attorney fees incurred by the City of Battle Creek in connection with such Claims or the enforcement of this Agreement.

IN WITNESS WHEREOF, the Responsible Party and city of Battle Creek have executed this Agreement on the day and year first above written.

Responsible Party:

WITNESSES:

_____ By: _____

_____ Its: _____

The foregoing instrument was acknowledged before me on this _____ day of _____, 20__, by _____, the _____ of _____

_____

Notary Public

_____County of Michigan

My Commission Expires On:

City of Battle Creek:

WITNESSES:

_____ By: _____

_____ Its: _____

The foregoing instrument was acknowledged before me on this _____ day of _____, 20__, by _____, the _____ of _____

_____

Notary Public

_____County of Michigan

My Commission Expires On:

INSTRUMENT DRAFTED BY: Eileen W. Wicklund (P41373) Battle Creek City Attorney 10 N. Division St. Battle Creek, MI 49014	WHEN RECORDED RETURN TO: Eileen W. Wicklund

Appendix C-2

Stormwater Management Maintenance Agreement

for _____ (reviewing agency)

THIS AGREEMENT is made this day of _____, 20____, by _____ [developer], hereinafter "Responsible Party" and between the _____ [reviewing agency], hereinafter "Reviewing Agency".

Responsible Party for the property described below, in accordance with the reviewing agency _____ [governing ordinance] and all regulations adopted thereby, agrees to install and maintain stormwater management system(s) on the subject property in accordance with approved plans and conditions. The Responsible Party further agrees to the terms stated in this document to ensure that the stormwater management system continue serving the intended function in perpetuity. This Agreement includes the following exhibits:

Exhibit A: A Legal document required by _____ or the Reviewing Agency, or the Liber and Page number of the recorded document showing that the individual is the Responsible Party and has the authority for the construction and maintenance of the stormwater management system on the real estate identified in Exhibit B. The legal document is defined as a Deed, Master Deed, Property Owners Association Charter or other evidence of authority.

Exhibit B: Legal description of the real estate for which this Agreement applies ("Property").

Exhibit C: Map(s) showing a location of the property and an accurate location of each component of the stormwater management system affected by this Agreement.

Exhibit D: Operation and Maintenance Plan showing the activities and schedule required to operate and maintain the permitted facilities otherwise known as the stormwater management system.

Through this Agreement, the Responsible Party hereby subjects the Property to the following covenants, conditions, and restrictions:

1. The Responsible Party, at its expense, shall secure from any affected owners of land all easements, drainage acceptance covenants, and releases of rights-of-way necessary for utilization of the stormwater system identified in Exhibit C and shall record them with the Calhoun County Register of Deeds. These easements and releases of rights-of-way shall not be altered, amended, vacated, released or abandoned without prior written approval of the Reviewing Agency.

2. The Responsible Party shall be solely responsible for the installation, maintenance and repair of the stormwater management system, drainage easements, and associated landscaping identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D).

3. No alterations or changes to the stormwater management system identified in Exhibit C shall be permitted unless they are deemed to comply with this Agreement and are approved in writing by the Reviewing Agency.

4. The construction and performance of stormwater management system need to be verified by the Responsible Party's licensed professional engineer. Documentation of the verification is required to obtain an occupancy permit.

5. The Responsible Party shall retain the services of a qualified inspector to ensure the maintenance of the stormwater management system identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D).

6. The Responsible Party shall keep records (logs, invoices, reports, data, etc.) of inspections, maintenance, and repair of the stormwater management system and drainage easements identified in Exhibit C in accordance with the Maintenance Plan (Exhibit D) and provide the same to the City upon request.

7. The Reviewing Agency or its designee is authorized to, but not obligated to, access the property as necessary to conduct inspections of the stormwater management system including drainage easements to ascertain compliance with the intent of this Agreement and the activities prescribed in Exhibit D. Upon written notification by the Reviewing Agency or their designee of required maintenance or repairs, the Responsible Party shall complete the specified maintenance or repairs within a reasonable time frame determined by the Reviewing Agency. The Responsible Party shall be liable for the failure to undertake any maintenance or repairs so that the public health, safety, and welfare shall not be endangered.

8. If the Responsible Party does not keep the stormwater management system in reasonable order and condition, or complete maintenance activities in accordance with the Plan contained in Exhibit D, or the reporting or the required maintenance or repairs under 6 above within the specified time frames, the Reviewing Agency is authorized, but not required, to perform inspections, maintenance, or repairs, in order to preserve the intended functions of the system and prevent the system from becoming a threat to public health, safety, general welfare or the environment. In the case of an emergency, as determined by the Reviewing Agency, no notice shall be required prior to the Reviewing Agency performing emergency maintenance or repairs. In addition to any other remedy provided for by law, the Reviewing Agency may levy the costs and

expenses of such inspections, maintenance, or repairs, plus a ten percent (10%) administrative fee against the Responsible Party. The Reviewing Agency, at the time of entering upon said stormwater management system for the purpose of maintenance or repair, may file a notice of lien in the office of the Calhoun County Register of Deeds upon the property affected by the lien. If said costs and expenses are not paid by the Responsible Party, the Reviewing Agency may pursue the collection of same through appropriate court actions and in such a case, the Responsible Party shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

9. The Responsible Party hereby conveys to the Reviewing Agency an easement over, on and in the property described in Exhibit B for the purpose of access to the stormwater management system for the inspection, maintenance and repair thereof, should the Responsible Party fail to properly inspect, maintain and repair the system.

10. The Responsible Party agrees that this Agreement shall be recorded and that the land described in Exhibit "B" shall be subject to the covenants and obligations contained herein, and this agreement shall bind all current and future owners of the property.

11. The Responsible Party agrees in the event that the Property is sold, transferred, or leased to provide information to the new owner, operator, or lessee regarding proper inspection, maintenance and repair of the stormwater management system. The information shall accompany the first deed transfer and include Exhibits C and D and this Agreement. The transfer of this information shall also be required with any subsequent sale, transfer or lease of the Property.

12. The Responsible Party agrees that the rights, obligations and responsibilities hereunder shall commence upon execution of the Agreement.

13. The parties whose signatures appear below hereby represent and warrant that they have the authority and capacity to sign this agreement and bind the respective parties hereto.

14. The Responsible Party, its agents, representatives, successors and assigns shall defend, indemnify and hold the Reviewing Agency harmless from and against any claims, demands, actions, damages, injuries, costs or expenses of any nature whatsoever, hereinafter "Claims", fixed or contingent, known or unknown, arising out of or in any way connected with the design, construction, use, maintenance, repair or operation (or omissions in such regard) of the storm drainage system referred to in the plan as Exhibit "D" hereto, appurtenances, connections and attachments thereto which are the subject of this Agreement. This indemnity and hold harmless shall include any costs, expenses and attorney fees incurred by the Reviewing Agency in connection with such Claims or the enforcement of this Agreement.

IN WITNESS WHEREOF, the Responsible Party and city of Battle Creek have executed this Agreement on the day and year first above written.

Responsible Party:

WITNESSES:

_____ By: _____

_____ Its: _____

The foregoing instrument was acknowledged before me on this _____ day of _____, 20__, by _____, the _____ of _____

_____

Notary Public

_____County of Michigan

My Commission Expires On:

Reviewing Agency:

WITNESSES:

_____ By: _____

_____ Its: _____

The foregoing instrument was acknowledged before me on this _____ day of _____, 20__, by _____, the _____ of _____

_____

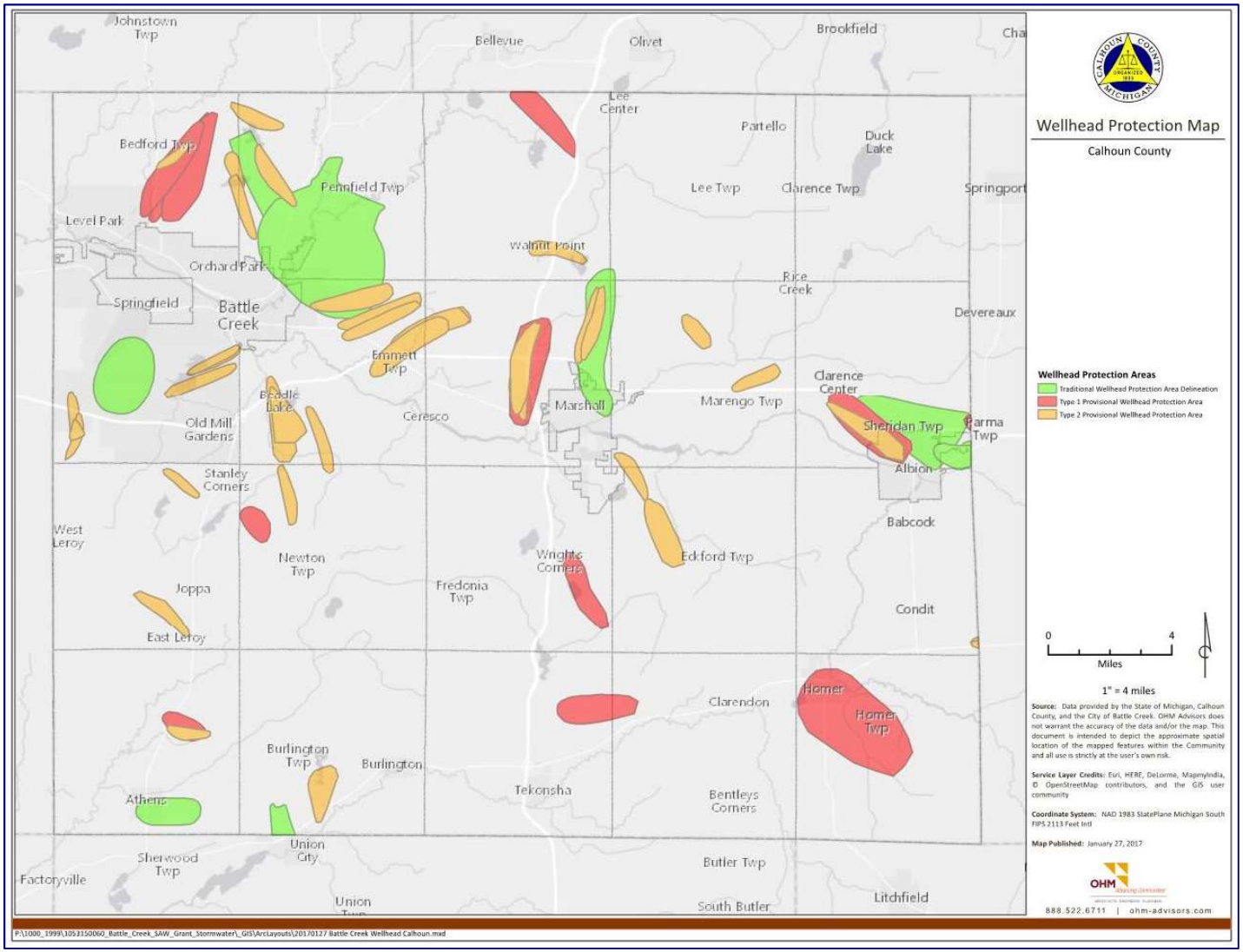
Notary Public

_____County of Michigan

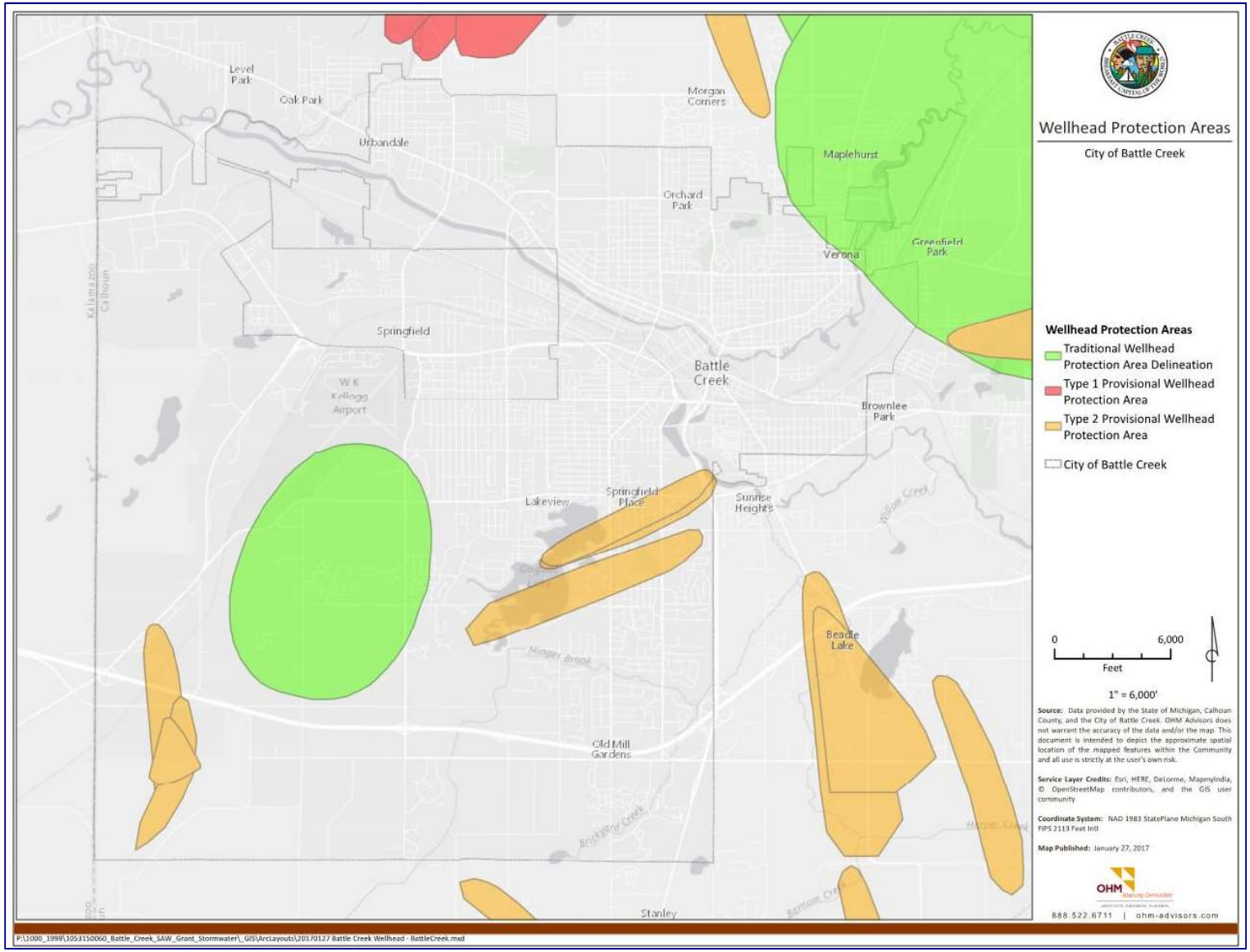
My Commission Expires On:

INSTRUMENT DRAFTED BY: _____ [Draftee Name] _____ [Draftee Address] _____ _____	WHEN RECORDED RETURN TO: _____ [Draftee Name]

APPENDIX D Wellhead Protection Areas



Wellhead protection areas in Calhoun County



Wellhead protection areas in the City of Battle Creek

APPENDIX E Drainage Acceptance Covenant

DRAINAGE COVENANT

DRAINAGE ACCEPTANCE COVENANT

The Grantor, _____

_____ 1. husband and wife

_____ 2. a married man

_____ 3. a single man

_____ 4. a single woman

_____ 5. a _____ corporation

_____ 6. other, described as _____

_____ 7. a municipality

Whose address is_____, as owner of property described or as shown on the attached map as Exhibit A, agrees to accept the stormwater runoff emanating from the property described or as shown on the attached map as Exhibit B, as provided by drainage plans dated__and filed with the City of Battle Creek Departments of Public Works and Planning. The undersigned, with full knowledge of the alteration in drainage patters from preexisting conditions as provided by said drainage plans agrees for:

_____ 1. themselves

_____ 2. him/herself

_____ 3. itself

Their/his/her/its heirs, successors and assigns, to indemnify, defend and save harmlessthe Approval Entity, its agents, officers and employees from and against any and all liability, expense, including defense costs and legal fees, and claim for damages of any nature whatsoever, including but not limited to bodily injury, death, personal injury, or property damage, arising from or connected with stormwater runoff due to the alteration in drainage patterns described herein.

WITNESS: GRANTOR(S):

_____ _____

_____ _____

APPENDIX F Drainage and Stormwater Management Site Development Review Checklist

TO: _____
_____
ATTN: _____
_____

REVIEW OF HYDROLOGY STUDY "_____ CHECK"

DATE _____

USGS QUADRANGLE _____

ADDRESS _____
_____

TRANSMITTAL _____

COORDINATES [LATITUDE], DD, MM, SS _____
[LONGITUDE], DD, MM, SS _____

Your hydrology study has been reviewed and is disapproved. Make corrections as shown on the returned hydrology study with associated plans as noted below. Resubmit these sheets with check print and two (2) revised sets of the hydrology study for further consideration. Additional changes may be required as determined by further review.

DRAINAGE MAP CONTENTS:

1. (_____) The on-site drainage map must be of a scale not greater than 1" = 50', with elevation contours at 1-foot intervals.
2. (_____) The off-site drainage map must be of a scale of not less than 1" = 1000'.
3. (_____) Provide the Professional Engineer's signature, stamp and expiration date.
4. (_____) Provide a location map at a scale not greater than 1" = 200'.
5. (_____) Provide a North Arrow and scale.
6. (_____) Provide a table showing the hydrologic data used to calculate the design rate of flow (Q). (i.e. storm frequency, rainfall zone, soil type, DPA zone, burn factor, bulking factor, percent impervious, etc.).
7. (_____) Clearly show proposed and existing drainage patterns.
8. (_____) Provide soil testing results and infiltration characteristics.
9. (_____) Show and label street locations, names, slopes, and provide typical sections.

DRAINAGE MAP CONTENTS: (continued)

10. (_____) Show and label proposed and existing drainage devices and storm drain improvements identified by number or name. Indicate the design flow and tributary area for each existing drain.
11. (_____) Provide adequate topography to support the area boundary determinations.
12. (_____) Show and label boundaries and acreages for each sub-area. Boundaries of sub-areas should be distinctly outlined with color.
13. (_____) Clearly indicate flows and summation of areas at locations where flows leave the site for conditions before and after development.
14. (_____) Show and label main line design flows and flows for each sub-area. Sub-area flows should be prorated to provide design flows for all inlets and structures.
15. (_____) Show and label summation of areas at every junction and at the outlet.
16. (_____) Show and label time of concentration (t_c) for each sub-area.
17. (_____) Provide drainage area and flow tributary to downstream drains that discharge to streets across lot pads.
18. (_____) Provide the completed maintenance plan, as outlined in Appendix K.
19. (_____) Complete and provide the following appendices:
    a. Appendix __
    b. Appendix __
    c. Appendix __
    d. Appendix __

CALCULATIONS COMMENTS:

1. (_____) A pre-development hydrology study and a post-development hydrology study will be required when offsite drainage will occur (See Figure 2 Flow Chart in Section 1 for details).
2. (_____) Flow calculations must be done in accordance with criteria presented in the Technical Reference Manual.
3. (_____) Time of concentration calculations shall be provided.
4. (_____) A catch basin or inlet study must be included and the t_c for each sub-area must be calculated to determine the peak flowrate.
5. (_____) The minimum t_c that must be used is 5 minutes.
6. (_____) Submit soils information in the form of backhoe cut reports or soil borings and logs used in calculating saturated infiltration rates and dewatering rates. Verify soil field conditions for saturated infiltration rates and dewatering rates. *(Care should be taken during construction to prevent soil compaction, which can alter calculated saturated infiltration rates and dewatering rates.)*
7. (_____) OTHER COMMENTS:

APPENDIX G Professional Engineer's Certificate of Outlet

Date: _____

Development Name: _____

City, Village or Township of: _____ Section: _____

County of: _____ State: _____

I hereby certify that the existing drain is the only reasonably achievable stormwater outlet for the proposed stormwater management system and that the existing drain has sufficient capacity to serve as an adequate outlet for the proposed system, without detriment to or diminution of the drainage serve that the existing outlet presently provides.

Signed: _____
Registered Professional Engineer

Note: The professional engineer's certificate must be stamped with the engineer's seal. The certificate submitted must be the original.

APPENDIX H Required Easement Language

433 Agreement – Required Easement & District Language for Chapter 18 Drainage Districts

Language Required for Platted Subdivisions
The following language shall be included in a section of the subdivision deed restrictions that describes the drainage district.

. . .subject to a perpetual and permanent easement in favor of the Calhoun County Water Resources Commissioner, the _____
Drainage District, (collectively referred to as "grantee"), and grantee's successors, assigns and transferees, in, over, under and through the property described on the plat (liber, page) hereto, which easement may not be amended or revoked except with the written approval of grantee, and which contains the following terms and conditions and grants the following rights:

1. The easement shall be for the purposes of developing, establishing, constructing, repairing, maintaining, deepening, cleaning, widening and performing any associated construction activities and grading in connections with any type of drainage facilities or storm drains, in any size, form, shape or capacity;
2. The grantee shall have the right to sell, assign, transfer or convey this easement to any other governmental unit for the purposes identified in subsection (1) above;
3. No owner in the subdivision shall build or convey to others any permanent structures on the said easement;
4. No owner in the subdivision shall build or place on the area covered by the easement any type of structure, fixture or object, or engage in any activity to take any action, or convey any property interest or right, that would in any way either actually or threaten to impair, obstruct, or adversely affect the rights of grantee under the said easement;
5. The grantee and its agents, contractors and designated representative shall have right of entry on, and to gain access to, the easement property;
6. All owners in the subdivision release grantee and its successors, assigns or transferees from any and all claims to damages in any way arising from or incident to the construction and maintenance of a drain or sewer or otherwise rising from or incident to the exercise by grantee of its rights under the said easement, and all owners covenant not to sue grantee for such damages.

The rights granted to the Calhoun County Water Resources Commissioner, the _____ _____ Drainage District, and their successors and assigns, under Section _____of these restrictions may not, however, be amended without the express written consent of the grantee hereunder. Any purported amendment or modification of the rights granted there under shall be void and without legal effect unless agreed to in writing by the grantee, its successors or assigns.
Language Required for Site Condominiums
The following language shall be included in a section of the Master Deed that describes the drainage district.

. . .subject to a perpetual and permanent easement in favor of the Calhoun County Water Resources Commissioner, the _____

Drainage District, (collectively referred to as "grantee"), and grantee's successors, assigns and transferees, in, over, under and through the property described on Exhibit B hereto, which easement may not be amended or revoked except with the written approval of grantee, and which contains the following terms and conditions and grants the following rights:

1. The easement shall be for the purposes of developing, establishing, constructing, repairing, maintaining, deepening, cleaning, widening and performing any associated construction activities and grading in connections with any type of drainage facilities or storm drains, in any size, form, shape or capacity;
2. The grantee shall have the right to sell, assign, transfer or convey this easement to any other governmental unit for the purposes identified in subsection (1) above;
3. No owner in the condominium shall build or convey to others any permanent structures on the said easement;
4. No owner in the condominium shall build or place on the area covered by the easement any type of structure, fixture or object, or engage in any activity to take any action, or convey any property interest or right, that would in any way either actually or threaten to impair, obstruct, or adversely affect the rights of grantee under the said easement;
5. The grantee and its agents, contractors and designated representative shall have right of entry on, and to gain access to, the easement property;
6. All owners in the condominium release grantee and its successors, assigns or transferees from any and all claims to damages in any way arising from or incident to the construction and maintenance of a drain or sewer or otherwise rising from or incident to the exercise by grantee of its rights under the said easement, and all owners covenant not to sue grantee for such damages. The rights granted to the Calhoun County Water Resources Commissioner, the _____ Drainage District, and their successors and assigns, under Section _____ of these restrictions may not, however, be amended without the express written consent of the grantee hereunder. Any purported amendment or modification of the rights granted there under shall be void and without legal effect unless agreed to in writing by the grantee, its successors or assigns.

APPENDIX I Glossary of Terms

100-year Storm
A 24-hour rainfall amount that has a 1% chance of being exceeded in a given year.

25-year Storm
A 24-hour rainfall amount that has a 4% chance of being exceeded in a given year.

10-year Storm
A 24-hour rainfall amount that has a 10% chance of being exceeded in a given year.

2-year Storm
A 24-hour rainfall amount that has a 50% chance of being exceeded in a given year.

Bankfull Flow
A condition where flow completely fills the stream channel to the top of the bank. In undisturbed watersheds, this occurs on average every 1.5 - 2 years and controls the shape and form of natural channels.

Best Management Practice (BMP)
Structural and non-structural practices and techniques that mitigate the adverse impacts caused by land development on water quality and/or water quantity.

Bioretention
A stormwater management design feature that utilizes landscaping and soils to treat stormwater runoff by collecting it in shallow depressions before filtering through a fabricated planting soil media prior to discharge to groundwater, an underdrain, or a combination of the two.

Bioswale

A water quality practice that utilizes landscaping and soils to treat stormwater runoff by collecting it in shallow vegetated channel providing both filtration and infiltration into soil media.

Cistern
Containers that store large quantities of stormwater above or below ground. They can be used on residential, commercial, and industrial sites.

Constructed Wetland
An open detention basin that uses a variety of water depths and wetland plants to provide pollutant removal and provide temporary storage of stormwater runoff to prevent downstream flooding and the attenuation of runoff peaks.

Construction Activity
A human-made activity, including without limitation, clearing, grading, excavating, construction and paving, that results in an earth change or disturbance in the existing cover or topography of land, including any modification or alteration of a site or the “footprint” of a building that results in an earth change or disturbance in the existing cover or topography of land.

County Drain
The Calhoun County Water Resources Commissioner, through legislative enactment, has acquired jurisdiction over a stormwater conveyance system. Example: an enclosed drain or an open watercourse.

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

Curve Number (CN)
Determines the loss rate of rainfall that impacts the peak flow and total flow volume of stormwater runoff. The Curve Number is based on land cover type, hydrologic condition, antecedent runoff condition and hydrologic soil group (HSG). The Curve Number is an integral component of the NRCS (SCS) methodology for calculating stormwater runoff.

Design Storm
The rainfall event used as the basis of design for stormwater drainage facilities, expressed as a frequency of expected exceedance (i.e. 25-year storm) or annual probability of exceedance (i.e. 4% storm).

Design Water Level
The water surface elevation in a detention system at which the storage volume in the system (above the permanent pool water level, if any) equals the required flood control storage volume.

Detention Basin
A constructed basin that temporarily stores water before discharging at a controlled flow rate into a downstream drainage system. Basins can be classified as follows:

1. **Dry Detention Basin**
   A basin that remains dry except for short periods following rain storms or snow melt events.
2. **Extended Dry Detention Basin**
   A dry detention basin that has been designed to increase the length of time that stormwater will be detained beyond the normal dewatering time of 24-48 hours.
3. **Wet Detention Basin**
   A basin that contains a permanent pool of water that will effectively remove nutrients in addition to other pollutants.
4. **Extended Wet Detention Basin**
   A wet detention basin that has been designed to increase the length of time that stormwater will be detained beyond the normal dewatering time of 24-48 hours.
5. **Regional Detention Basin**
   A wet or dry detention basin that receives water from multiple sites.
6. **Underground Detention System**
   One or more underground pipes and/or other structures that are utilized as a detention system.
7. **In-line Detention Basin**
   A detention basin constructed on an existing stream or river in which it intercepts all stream/river inflow and restricts the discharge via an outlet structure. In-line detention basins effectively act as small dams, as they create an impoundment area for the stream/river.

Discharge
The flow rate of water passing through the outlet at a given time. Usually expressed as cubic feet per second (cfs).

Disturbed Area
An area where the construction activity has removed or altered the existing ground cover.

Drainage Area
The entire upstream land area from which stormwater runoff drains to a particular location. For a particular development, the drainage area shall include any upstream (offsite) areas that drain to and through the development.

Drawdown time
The time required for the gradual reduction in water level in a BMP due to the combined effect of infiltration, evaporation and discharge from the peak or storage to full dewatering to the lowest outlet elevation.

Dry well
Small infiltration pits or trenches filled with aggregate that receive clean runoff primarily from rooftops.

Easement
A legal right, granted by a property owner to another entity, allowing that entity to make limited use of the property involved for a specific purpose. Easements are recorded on the title to the land and transfer with the sale of land.

Emergency Spillway
A channel constructed in the embankment of an open detention or retention basin that is used to control flows in excess of the overflow structure capacity to prevent erosion of the berm.

First Flush
The volume of runoff from the first inch of precipitation over a developed or redeveloped site. The first flush runoff occurs during the early stages of a storm and has a highly concentrated pollutant load due to the washing effect of runoff on pollutants that have accumulated on the land.

Floodplain
For a given flood event, that area of land adjoining a continuous watercourse that has been covered temporarily by water. The term floodplain includes all physical floodplains weather or not they have been officially mapped by FEMA.

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

Freeboard
The vertical distance from the design water level to the top of the embankment of an open detention basin or retention basin.

French Drain
A subgrade drain consisting of a trench filled with aggregate to permit water movement through the trench and into the soil. The trench may also contain perforated pipe to enhance the efficiency of the system. [reference in Underdrain definition]

Green infrastructure
Management of wet weather flows using BMPs that use or mimic natural processes and result in improved water quality. This is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits, and reduces and treats stormwater at its source while delivering environmental, social, and economic benefits.

Green Roof
Conventional rooftops that include a thin covering of vegetation allowing the roof to function more like a vegetated surface. The layer thickness varies between 2-6 inches and consists of vegetation, waterproofing, insulation, fabrics, growth media, and other synthetic components.

Ground Water Table
The uppermost extent of naturally existing water beneath the earth's surface between saturated soil particles and rock. At least two feet of separation is required between the normal ground water elevation and the bottom of the bioretention filter media.

Impervious Surface
A surface that prevents the infiltration of water into the ground such as all roofs, streets, sidewalks, driveways, parking lots, and compacted soils and gravel.

Infiltration Capacity
The maximum rate at which the in-situ (native) soils can absorb inflow, expressed in inches/hour. Also known as Infiltration Rate (see below), Saturated Soil Conductivity, (K_{sat}), and In-Situ Infiltration Rate (see below).

Infiltration Rate
The rate of infiltration (inches/hour) of in-situ soils at the base (subgrade) of a designed BMP, as determined by on-site soil evaluation certified by a Professional Engineer. Also known as the Saturated Soil Conductivity (K_{sat}), In-Situ Infiltration Rate, or Infiltration Capacity.

In-Situ Infiltration Rate
The rate of infiltration (inches/hour) of in-situ soils at the base (subgrade) of a designed BMP, as determined by on-site soil evaluation certified by a Professional Engineer. Also known as the Saturated Soil Conductivity (K_{sat}), Infiltration Rate, or Infiltration Capacity.

Inlets
A stormwater collection structure designed to collect and convey surface water into the stormwater management system via a grated cover.

1. **Standard Inlet**
   A stormwater collection structure designed to collect and convey surface water from a paved area into the stormwater management system. An Inlet is normally 2 feet in diameter, is designed so that stormwater is collected via a grated cover and falls directly into the storm drain. (*GIS Feature Class HydroDrainInlet, Subtype 1 Standard Inlet*)
2. **Catch Basin**
   A stormwater collection structure designed to collect and convey surface water from a paved area into the stormwater management system. A catch basin is normally 4 feet in diameter, is designed so that stormwater is collected via a grate cover and sediment falls to the bottom of the catch basin sump not directly into the storm drain. (*GIS Feature Class HydroDrainInlet, Subtype 2 CatchBasin*)
3. **Rear Yard Catch Basin**
   A stormwater collection structure designed to collect and convey surface water from an unpaved area into the stormwater management system. A rear yard catch basin is normally 4 feet in diameter, is designed so that stormwater is collected via a grate cover and sediment falls to the bottom of the catch basin sump not directly into the storm drain. (*GIS Feature Class HydroDrainInlet, Subtype 3 RearYardCatchBasin*)
4. **Yard Inlet**
   A stormwater collection structure designed to collect and convey surface water from an unpaved area into the stormwater management system. A yard inlet consists of a 2 ft. diameter manhole, is designed so that stormwater is collected via a grated cover and falls directly into the

storm drain then into a water quality BMP. (*GIS Feature Class HydroDrainInlet, Subtype 4 YardInlet*)

5. **Leaching Basin**
   A stormwater collection structure designed to collect and convey surface water into the soil subgrade. A leaching basin consists of a square or round structure with perforated sides and no base cookie, is designed so that stormwater is collected via a grated cover or delivered through a connecting storm drain and is filtered through stone and infiltrated the soil. *(GIS Feature Class HydroDrainInlet, Subtype 5 LeachingBasin*)

Level-Spreader
A device used to spread stormwater runoff uniformly over the ground surface as sheet flow to prevent concentrated, erosive flow from occurring, and to enhance infiltration.

Low Impact Development (LID)
Systems and practices that use or mimic natural processes that result in the infiltration, evapotranspiration or use of stormwater in order to protect water quality and associated aquatic habitat. The EPA currently uses the term green infrastructure to refer to the management of wet weather flows using these processes.

Manhole
A stormwater structure designed to allow access into a closed conduit or other underground component of a stormwater management system. A manhole has a minimum diameter of 4 feet, is designed with a concrete flow channel at the bottom of the manhole and is fitted with a solid cover.

Manufactured Treatment Device
A pre-fabricated stormwater treatment structure utilizing settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to remove pollutants from stormwater runoff. The TSS removal rate for manufactured treatment devices must meet the NJDEP certification of the pollutant removal rates.

Municipal Separate Storm Sewer System (MS4)
A system of conveyances that include, but are not limited to, catch basins, curbs, gutters, ditches, man-made channels, pipes, tunnels, and/or storm drains, and similar means of collecting or conveying runoff that do not connect with a wastewater collection system or treatment plant and instead discharge into Waters of the State.

Native Plants
Plant species that occur naturally in the Southwest Michigan ecosystem, and habitat without direct or indirect human actions.

Natural Resources Conservation Service (NRCS)
A federal agency of the United States Department of Agriculture (USDA) that works with farmers, ranchers, forest landowners, local and state governments, and other federal agencies to maintain healthy and productive working landscapes, and to protect our natural resources through conservation. Previously known as Soil Conservation Service (SCS).

Natural Wetland
Michigan's wetland statute, Part 303, Wetlands Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, defines a wetland as "land characterized by the presence of water at a frequency and duration sufficient to support, and that under normal circumstances does support, wetland vegetation or aquatic life, and is commonly referred to as a bog, swamp, or marsh." The definition applies to public and private lands regardless of zoning or ownership. Many wetland areas

have only a high ground water table and standing water may not be visible. Types of wetlands include deciduous swamps, wet meadows, emergent marshes, conifer swamps, wet prairies, shrub-scrub swamps, fens, and bogs.

Non-point Source Pollution
Stormwater conveyed pollution that is not identifiable to one particular source, and is occurring at locations scattered throughout the drainage basin. Typical sources include erosion, agricultural activities, and runoff from urban lands.

Non-structural BMPs
Stormwater runoff treatment techniques that use natural measures to reduce pollution levels that do not involve the construction or installation of devices (e.g. management actions). [site BMPs]

Ordinary High Water Mark
The line between upland and bottomland which persists through successive changes in water level, below which the presence of water is so common or recurrent that the character of the soil and vegetation is markedly different from the upland.

Outlet Control Structure
A horizontal pipe or series of pipes or vertical riser pipe designed to gradually release stormwater from a basin over a 24-48-hour interval.

Overflow Structure
A structure designed to allow unrestricted discharge from a component of a stormwater management system when the water level exceeds the design water level. [cross reference with emergency overflow]

Peak Discharge
The maximum instantaneous rate of flow during a storm, usually in reference to a specific design storm event.

Peak Flow Rate
The maximum instantaneous rate of flow at a particular location within a stormwater management system, usually in reference to a specific design storm event.

Permanent Pool
A pool in a wet detention basin that provides additional removal of pollutants through settling and biological uptake.

Pervious
Allows liquid to pass through. Porous.

Pervious Pavement
An infiltration technique that combines stormwater infiltration, storage, and structural pavement that consists of a permeable surface underlain by a storage reservoir.

Planter Box
A device containing trees and plants near streets and buildings constructed to prevent stormwater from directly draining into drainage systems.

Plunge Pool
A small permanent pool located at either the inlet to, or outfall from a BMP. The primary purpose of the pool is to dissipate the velocity of stormwater runoff, but it can also provide some pre-treatment.

Ponding Area
In bioretention areas, the area where excess stormwater runoff is temporarily stored prior to infiltration into the ground.

Pre-development
Pre-development conditions shall be calculated based on the existing condition of the site as of the date of the site plan submittal.

Pretreatment System
A structure, feature, or appurtenance, or combination thereof that is used as a component of a stormwater management system to remove incoming pollutants from stormwater. Pretreatment systems include water quality infiltration BMPs for tributary areas of 2.5 acres and manufactured treatment systems for tributary areas greater than 5 acres.

Professional Engineer (PE)
Only an engineer licensed in the State of Michigan may prepare, sign and seal, and submit engineering plans and drawings for approval, including soil testing data and infiltration certifications as outlined in this TRM. PEs must continuously demonstrate their competency and maintain and improve their skills by fulfilling the State of Michigan continuing education requirements.

Protected Wetland
Any wetland protected by federal, state, and or local government regulation.

Rain Barrel
A barrel designed to retain small volumes of stormwater runoff for reuse for landscaping.

Rain Garden
Landscape elements that combine plantings and depressions that allow water to pool for a short time, less than 48 hours, after a rainfall and then be slowly absorbed by the soil and vegetation.

Rational Method Formula
A technique for estimating peak flow rates at a particular location within a stormwater management system, based on the drainage area (A), rainfall intensity (i), watershed time of concentration, and a runoff coefficient (c).

$$Q = ciA$$

Release Rate
The rate of discharge in volume per unit time from a detention facility [reference PEAK flow and differentiate between pre-vs post and prescribed rate]

Regional Detention
Detention provided at an off-site regional detention facility as an alternative to storage on-site.

Retention Basin
The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass. Retention is discouraged under all circumstances unless there is no practical way to provide an outlet. Pre-treatment in the form of infiltration BMPs, sediment forebays, and mechanical swirl separators is required for sediment removal when the tributary area has at least 5 acres of residential land use or at least 2.5 acres of impervious surface, as described in Section IV.

Return Interval
A statistical term for the average time of expected interval that an event of some kind will equal or exceed given conditions (e.g., a stormwater flow that is exceeded once every 2 years).

Riparian Buffer
An area next to a stream or river (sometimes also used for lakes) that preserves water quality by filtering sediments and pollutants from stormwater before it enters the water body. It also protects banks from erosion, provides natural storage for flood waters, preserves open space, and provides habitat for wildlife. Development is often restricted or prohibited in this area. The buffers should be vegetated with herbaceous and woody native plants, or left in their natural state.

Riser
A temporary, vertical pipe extending from the bottom of a basin that is used to control the discharge rate from the basin for a specified design storm. This is used for soil erosion control during construction.

Runoff
The excess portion of precipitation that does not infiltrate into the ground, but "runs off" into streams, water bodies, and/or storm sewers.

Runoff Coefficient (c)
A dimensionless coefficient relating the amount of runoff to the amount of precipitation received. It is a larger value for areas with low infiltration and high runoff (pavement, steep gradient), and lower for permeable, well vegetated, and undeveloped areas. Used for calculating peak flows under the Rational Method and for estimating runoff volumes for the 1-inch (water quality) event. The runoff coefficient is typically only used for small sites with uniform land use. See "Curve Number" for estimating runoff potential for larger storm events.

Safety Shelf
A flat-sloped area (5% or flatter), typically a minimum width of 10 feet, along a detention pond cross section that allows for a safety refuge for those who enter a wet detention pond.

Saturated Soil Conductivity (K_{sat})
The rate of infiltration (inches/hour) of in-situ soils at the base (subgrade) of a designed BMP, as determined by on-site soil evaluation certified by a Professional Engineer. Also referred to as Infiltration Rate, In-Situ Infiltration Rate, or Infiltration Capacity.

Sediment
Soil material that is transported from its site of origin by water. May be in the form of bed load, suspended or dissolved.

Sheet Flow
Runoff which flows over the ground surface as a thin, even layer, and not concentrated in a channel. Maximum allowable sheet flow length is 100 feet.

Short Circuiting
The passage of runoff through a BMP in less than the theoretical or design detention time. This typically occurs when the inlet and outlet are spaced too closely together, which limits the capacity of a BMP to provide a water quality benefit.

Soil Erosion
The increased loss of the land surface that occurs as a result of the wearing away of land by the action of wind, water, gravity, or a combination of wind, water, gravity or human activities.

Soil Group, Hydrologic
A classification of soils by the NRCS (SCS) into four runoff potential groups. The groups range from "A Soils" which are very permeable and produce little runoff, to "D Soils" which are relatively impermeable and produce much more runoff.

Spillway
A depression in the embankment of a pond or basin, used to pass peak discharges in excess of the design storm.

Stabilization
The establishment of vegetation or the proper placement, grading, or covering of soil to ensure its resistance to soil erosion, sliding, or other earth movement.

Stormwater
Water resulting from precipitation, including without limitation rain, snow, and snowmelt. Also referred to as "runoff".

Stormwater Management Plan
Ordinances, orders, rules, regulations, and other mechanisms that provide for the management of stormwater to prevent flooding, improving water quality and ensuring restoration and/or protection of surface waters.

Stormwater Management System
Any structure, feature, or appurtenance subject to this TRM, or a rule promulgated pursuant to this TRM, that is designed to collect, detain, retain, treat, or convey stormwater runoff, including without limitation buffer strips, swales, gutters, catch basins, closed conduits, detention systems, pretreatment systems, wetlands, pavement, unpaved surfaces, structures, watercourses, or surface waters, whether public or private.

Stream
By EGLE 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." Even if water flow is intermittent, it is classified as a stream.

Structural BMPs
Devices constructed for temporary storage and treatment of stormwater runoff.

Surcharge
A condition in which the water level in a storm drain rises above the crown of the conduit.

Surface Water
A body of water, including without limitation seasonal and intermittent waters, in which the surface of the water is exposed to the atmosphere, including without limitation lakes, open detention basins, forebays, watercourses, bioretention areas, retention basins, wetlands, and impoundments.

Tailwater
The depth of water at the downstream end of a culvert, crossing, or discharge structure. Under design conditions. Tailwater may adversely impact the discharge capacity of a hydraulic structure.

Time of Concentration
The time duration (typically in minutes) that is required for stormwater runoff from the most remote area of the watershed to reach a given location in a stormwater management system.

Total Suspended Solids (TSS)
Particles or other solid material suspended in stormwater or stormwater runoff. "Total suspended solids" is commonly expressed in concentration (mg/l) or parts per million (PPM).

Underdrain
One or more underground pipes installed beneath bioretention areas, terraced side slopes, or other structures to facilitate conveyance of stormwater runoff from beneath the structure to another part of the stormwater management system.

Upland Zone
The area within an open detention basin or retention basin between the bank full elevation to the 100-year flood elevation and beyond.

Vegetated Filter Strip
Uniformly graded vegetated surface located between pollutant source areas and downstream receiving waters.

Vegetated Swale
A conveyance, open to the atmosphere, consisting of a broad, shallow channel lined with vegetation to slow and filter stormwater runoff and promote infiltration.

Watercourse
A natural or artificial channel for flowing water.

Watershed
The complete area or region of land draining into a single outlet, watercourse, surface water, or closed conduit that is separate from other watersheds by a divide.

Waters of the State (Michigan)
Any groundwater, lakes, including the Great Lakes bordering the state, rivers, streams, and all other water courses and bodies of water within the jurisdiction of the state including wetlands.

Weir
A structure that extends across the width of a body of water, channel, watercourse, or closed conduit, and is used to impound, measure, or in some way alter the flow of water through the channel.

Wetland
An area that is saturated by surface or groundwater with vegetation adapted for life under those soil conditions, such as swamps, bogs, fens, marshes and estuaries.

Wetland Mitigation
A regulatory term that refers to the process of constructing new wetland acreage to compensate for the loss of natural wetlands during the development process. Mitigation seeks to replace structural and functional qualities of the natural wetland type that has been destroyed. Stormwater wetlands typically do not count for credit as mitigation, because their construction does not replicate all the ecosystem functions of a natural wetland.

APPENDIX J Permit to Cross or Parallel County Drain

_____ DRAIN

PERMIT TO CROSS OR PARALLEL A COUNTY DRAIN

WHEREAS, the _____ Drain ("Drain") is an established county drain, under the jurisdiction of the Calhoun County Water Resources Commissioner ("CCWRC"), 315 West Green Street, Marshall, MI 49068; and,

WHEREAS, the Drain traverses property within Sections _____, _____ Township/City/Village, Calhoun County, Michigan; and,

WHEREAS, the _____ Drain Drainage District ("Drainage District") was granted easements that are on file with the Office of the Calhoun County Water Resources Commissioner and said easements are for the operation, maintenance, and improvement of the Drain across a portion Section _____, _____ Township/City/Village with said easement being _____-feet total width (____-feet either side of drain measured from center line of the drain) ("Drain Easement"); and,

WHEREAS, _____ ("Permittee"), is a _____corporation with its principal place of business located at _____; and,

WHEREAS, Permittee has submitted an application to the CCWRC to install _____ _____ along _____, _____ Township/City/Village, Calhoun County, part of which is proposed to be located within the legally established Drain Easement (the "_____,"); and,

WHEREAS, Permittee is requesting a Permit to install the _____ that crosses and/or parallels a portion of the Drain Easement for _____; and,

WHEREAS, the Permittee has submitted to the Office of the CCWRC, a permit application and drawings showing the location, of the _____ crossing and occupying a portion of the Drain Easement. The application dated _____, 20____ is attached hereto as **Exhibit A**; and,

WHEREAS, the CCWRC's engineer has reviewed the permit application and drawings and has recommended the issuance of a Permit to Cross or Parallel a County Drain and permission to occupy a portion of the Drain Easement as requested on certain terms and conditions pursuant to the Rules of the CCWRC and subject to the Engineer's review and recommendations; and,

NOW THEREFORE the CCWRC, acting on behalf of the Drainage District, pursuant to the Rules of the CCWRC, does hereby grant to the Permittee a Permit to encroach and cross, or parallel the Drain, and permission to occupy a portion of the Drain Easement which hereinafter shall be known as Permit to Cross or Parallel a County Drain ("Permit"), on the following terms and conditions:

1. The Permittee shall not alter the Drain connection nor occupy a portion of the Drain Easement in a location and manner except as set forth in **Exhibit A**.

2. Except as otherwise stated herein, this Permit shall be deemed to include and require Permittee to comply with all provisions and requirements of the Application for Permit, Permit Requirements to Cross or Parallel a County Drain, including CCWRC's engineer's review and recommendations dated _____, 20____ (**Exhibit B**), and the Rules of the CCWRC, as amended.

3. Permittee certifies that the _____, as set forth in **Exhibit A**, has or will be installed a minimum of four (4) feet below the established drain bottom when crossing or paralleling the Drain or Drain Easement. [If applicable].

4. All utilities and/or facilities must be a minimum of four (4) feet below the established drain bottom when crossing or paralleling the Drain or Drain Easement.

5. Any structures removed such as headwalls, wingwalls, concrete slabs, rip rap, erosion protection, tiling, culverts-metal or concrete, must be replaced with new materials and reconstructed to original condition or better.

6. All ditch banks, when disturbed, must be reshaped to original slope, compacted, top-soiled and seeded, fertilized and mulched or hydro-seeded. Permittee shall use mulch blankets on ditch banks.

7. Permittee agrees that installation of the _____, has or will be accomplished without disruption to the Drain. Permittee shall not obstruct the flow of water in the Drain as defined by Sections 421 and 422 of the Drain Code, as amended (MCL 280.421 and 280.422), unless specifically authorized in writing by the CCWRC. Permittee is responsible for maintaining all storm drainage during time of construction, whether be use

of pumping equipment or construction of a bypass system. Permittee shall not store equipment and materials in any way so as to cause blockage of the Drain.

8. Inspection. Permittee agrees that the CCWRC's inspector, or an inspector as approved by the CCWRC, must be on site during the installation of the _____ within and/or across the Drain, to inspect the _____, installation within the Drain Easement. Inspection for this Permit will be undertaken by Eng. Engineering & Surveying, 4063 Grand Oak Drive, A109, Lansing, MI 48911 (517- 887-1100), attn. Brian Cenci, P.E. Permittee shall notify Eng. not less than three (3) business days prior to any construction within the Drain and/or Drain Easement. Every attempt to accommodate the Permittee's schedule will be made when notified of the need for an inspector. Permittee shall be directly responsible for all costs and expenses, including all professional fees (engineer, inspector, surveyor, and attorney) arising out of this Permit.

9. Application Fees and Deposit. Permittee shall be responsible for application fees ($250.00), together with any and all costs incurred by the Drainage District arising from this Permit, including, but not limited to, engineering, inspection, enforcement, administrative, attorney fees, court costs, witness fees, and/or costs of litigation arising out of this Permit, and any services rendered attendant thereto. As determined by the CCWRC, the Permittee shall make a cash deposit with the CCWRC for inspection fees. Any portion of the deposit not used will be refunded to Permittee. Any amount incurred by the CCWRC in excess of the deposit will be billed to Permittee. The CCWRC will provide an itemized invoice of all costs within thirty (30) days of installation and completion of the _____. Payment shall be due thirty (30) days after mailing of the invoice.

10. The Permittee acknowledges that this Permit does not authorize any work in the Drain Easement other than that which is identified in this Permit and the exhibits attached hereto. Should work be required that is not otherwise authorized by this Permit on any encroachment or crossing of the Drain or within the Drain Easement, including but not limited to the _____, Permittee agrees to submit the necessary permit application(s).

11. Within thirty (30) days of completion of construction of the encroachment, crossing and/or parallel of the Drain Easement, as authorized herein, Permittee shall provide the CCWRC with one (1) copy of as-built drawings of the encroachment and crossing sealed by a Michigan licensed professional surveyor. The as-built drawing shall show the Drain Easement and the location of the _____. The as-built drawing shall be submitted as a digital (.pdf) file. If Permittee fails to timely provide the as-built drawings, Permittee agrees to be responsible for all costs incurred by the Drainage District and/or CCWRC, including but not limited to the costs incurred to survey and prepare the required as-built drawings, and any related attorney fees.

12. At Permittee's expense, any structures removed or damaged by Permittee such as headwalls, wing walls, concrete slabs, rip rap, erosion protection, tiles or culverts – metal or concrete, must be replaced with new material and reconstructed to original condition or better as

directed and approved by the CCWRC Permittee must present a plan for permanent repairs within seven (7) days of written notice by the CCWRC. Permanent repairs must be completed by Permittee within a reasonable time as determined by the CCWRC.

13. Insurance. Not less than thirty (30) days prior to construction of the encroachment and crossing of the Drain Easement, Permittee shall provide to the CCWRC proof of Contractor's or Commercial General Liability Insurance, in an amount not less than $1,000,000 per occurrence, with an endorsement naming the Drainage District, CCWRC, and its officers, official, employees and contractors, as additional insured under said policy.

14. Indemnification. Permittee agrees to hold harmless, indemnify and pay all costs to defend the Drainage District, CCWRC, CCWRC Office, and their agents, employees and/or contractors from any and all claims, damages, losses, demands, or actions, including but not limited to claims for damages to person or property, administrative sanctions and/or penalties arising out of or in any manner related to the privileges granted pursuant to this Permit, and/or any activity of Permittee within or affecting the Drain or Drain Easement, including but not limited to construction, maintenance, use and/or existence of the _____, and/or any other facility crossing, occupying and/or encroaching upon the Drain Easement. This provision shall not apply in the event an act of gross negligence and/or intentional misconduct of the Drainage District, CCWRC or their agents, employees and/or contractors, and such conduct is a proximate cause of the claim or damage. Notwithstanding the foregoing, nothing contained in this Permit shall constitute a waiver of any privileges and immunities as provided by law.

15. Permittee agrees to pay all increased costs incurred by the Drainage District to maintain or improve the Drain resulting from the approved Drain crossing, occupation and/or encroachment upon the Drain Easement. The issuance of this Permit does not relieve Permittee of any future expense for relocation of said _____, to accommodate for future drain improvements. Permittee does hereby acknowledge and agree that in the event the area within the Drain Easement for which this permit is granted is necessary for future operation and maintenance of the Drain, Permittee, shall: (a) Pay any increased cost to the Drainage District due to its occupying said Drain or Drain Easement, said cost to be determined as a separate bid item during construction or reconstruction, or (b) Relocate the _____, at its own cost, including any utility poles or other appurtenant structures, whether temporarily or permanently as determine necessary by the CCWRC. All expenses pertaining to said relocations shall be paid for by Permittee. Relocation shall be completed by a date determined necessary by the CCWRC, no less than 6 months from receipt of written request by the CCWRC. Additional time may be granted at the discretion of the CCWRC.

16. Permittee shall notify the CCWRC, of any subsequent repairs to the _____, that are herein authorized to occupy the Drain Easement or cross the Drain. Notice shall be conveyed to the CCWRC calling 269-781-0790 during regular office hours, and after regular office hours, by calling the emergency number left on the recorded message at (269) 781-0911.

17. The authority to conduct the activity as authorized by this Permit is granted to the Permittee by the CCWRC, pursuant to Michigan law, including Public Act 40 of 1956, as amended. Approval herein does not convey, provide, or otherwise imply approval of any other governing body or authority vested in any other body by any act, ordinance, or regulation, nor does it waive the Permittee's obligation to acquire any other approvals or authorizations necessary to conduct the permitted activity or activities shown on the approved plans. The issuance of this permit does not relieve or waive Permittee's obligation to obtain all other required federal, state, and/or local permits.

18. This Permit is binding on the Permittee, its heirs, assigns, and successors in interest. Except for assignments to wholly owned subsidiaries or divisions of Permittee, this Permit is not assignable without the written consent of the CCWRC. Consent shall not be unreasonably withheld.

19. This Permit shall not affect nor alter the current liability that such lands subject to this Permit may have for special assessment levied for the purposes of the operation and maintenance of the Drain.

20. Violation of any of these specified terms and conditions shall constitute a breach of this Permit for which the Drainage District may revoke this Permit and order the removal of the facilities installed by Permittee or direct the operation or reconstruction of the encroachment or crossing to comply with the terms of this Permit, with all costs, including but not limited to construction, engineering, inspection, enforcement, and legal, to be paid by the Permittee.

21. This Permit shall be construed under Michigan law, and if any part, term or provision of this permit shall be determined by a court of competent jurisdiction to be unlawful or unenforceable, such determination shall not affect the validity and enforceability of the remaining parts, terms and provisions of this permit.

[SIGNATURES ON FOLLOWING PAGES]

ISSUED BY:

_____ DRAIN DRAINAGE DISTRICT,

a Michigan public body corporate,

_____

BY: Fred A. Heaton
Calhoun County Water Resources Commissioner

STATE OF MICHIGAN)
)ss.
COUNTY OF CALHOUN)

Acknowledged before me, a Notary Public, this ____ day of _____, 20_____by Fred A. Heaton, Calhoun County Water Resources Commissioner.

_____

_____, Notary Public
State of Michigan, County of _____
My Comm. Expires: _____
Acting in the County of _____

The foregoing terms and conditions set forth in this Permit have been reviewed and are accepted by the undersigned who represents that he/she is duly authorized to sign as the Permittee and to legally bind the Permittee to the specified terms and conditions herein.

[PERMITTEE]_____,

_____
BY:
ITS:

STATE OF _____)
)ss.
COUNTY OF _____)

Acknowledged before me, a Notary Public, this ____ day of _____, 20_____ by _____, a duly Authorized Agent of _____, a _____ Corporation.

_____
_____, Notary Public
State of _____, County of _____
My Comm. Expires: _____
Acting in the County of _____

DRAFTED BY AND RETURN TO:
Joseph W. Colaianne
Douglas R. Kelly
Clark Hill, PLC
212 East Grand River Avenue
Lansing, MI 48906
517.318.3100

APPENDIX K Sample Maintenance Plan

"XYZ" Leasing Company
Stormwater Management System Maintenance Plan

1. Responsibility for Maintenance

a. During construction, it is the developer's responsibility to perform the maintenance.

b. Following construction, it will be the responsibility of "XYZ" Company to perform the maintenance.

c. The Master Deed will specify that routine maintenance of the stormwater facilities must be completed within _____ days of receipt of written notification that action is required, unless other acceptable arrangements are made with the (Township of _____ _____), (Calhoun County Water Resources Commissioner) or successors. Emergency maintenance (i.e. when there is endangerment to public health, safety or welfare) shall be performed immediately upon receipt of written notice. Should "XYZ" Company fail to act within these time frames, the (Township) (County) or successors may perform the needed maintenance and assess the costs against "XYZ" Company.

2. Source of Financing

"XYZ" Company is required to pay for all maintenance activities on a continuing basis.

3. Maintenance Tasks and Schedule

a. See the charts on the next two pages: The first describes maintenance tasks during construction to be performed by the developer, the second describes maintenance tasks by "XYZ" Company.

b. Immediately following construction, the developer will have the stormwater management system inspected by an engineer to verify grades of the detention and filtration areas and make recommendations for any necessary sediment.

Refer to the ***Low Impact Development Manual for Michigan*** **(Appendix F pgs. 446-453)** for maintenance task checklists for permanent BMPs and create a table of applicable maintenance tasks and schedules for the project.

The BMP maintenance checklists in the LID Manual include:

- Detention (ponds, basins, wetlands)
- Infiltration (basins, trenches)
- Bioretention
- Bioswales, vegetated filter strips

APPENDIX L Columbia Avenue BID Area Map

Note: The Columbia Avenue Business Interest District on the following page represents just the Columbia Avenue BID. There are other Business Interest Districts within Battle Creek.

N
W E
S

First Flush Covered

First Flush to be Covered in Project

Future First Flush

Existing Storm

Proposed Storm

APPENDIX L
COLUMBIA AVENUE BID AREA

0 210 420 630 840 Feet

Prepared by:

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