City of Jackson

Stormwater Management Manual

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SECTION I – Design Requirements

1.0 INTRODUCTION

The intent of this document is to provide information specific to the City of Jackson's design standards to address stormwater quantity and quality. This manual will provide the policy framework, implementation procedures and design standards for stormwater controls.

The Jackson City Council adopted two ordinances on January 11, 2011:

> The first is Ordinance No. 2011.01 known as the Post-Construction Stormwater Management Ordinance. This ordinance requires that a stormwater management permit be obtained prior to commencing any land disturbance activities in connection with new development and redevelopment projects, as defined in the ordinance.
>
> The second is Ordinance No. 2011.02, known as the Stormwater Utility Ordinance. The Design Requirements section of this manual deals with the Post-Construction Stormwater Management Ordinance and the Credit Requirements section deals with the Stormwater Utility Ordinance.

Section I outlines design requirements for stormwater quantity and quality, and flood control. The City of Jackson has adopted the *State's Low Impact Development (LID) Manual for Michigan* to guide the design of proposed Best Management Practices (BMPs) for water quality and quantity so they meet the minimum treatment volume and channel protection standards provided in this document.

This edition of the rules for the management of stormwater within the City of Jackson reflects a stormwater management philosophy that considers stream channel protection and stormwater quality management in addition to flood control. These revisions are based upon the most current State Permit requirements concerning stormwater management. This manual will be updated periodically as additional BMPs are developed and/or as requirements change.

The following section outlines basic ideas and principals of stormwater management, and provides a conceptual foundation for the design standards contained in this document.

2.0 THE ROLE OF THE DEPARTMENT OF PUBLIC WORKS AND THE MICHIGAN LID MANUAL

The Department of Public Works will review all plans submitted to the standards outlined in this document. Those sites that must submit to this office for review are listed below. The Department exercises authority over permitted activities of structural facilities that convey and treat stormwater runoff that will be generated from a site as a result of its design. The Department rules will govern the design of such management facilities with the following objectives:

- Incorporate design standards to control both water quantity and quality.
- Encourage innovative stormwater management practices that meet the criteria contained within these rules.
- Ensure future maintenance of facilities by planning for it as a part of system design.
- Make the safety of facilities a priority.
- Strengthen the protection of natural features.
- Encourage more effective soil erosion and sedimentation control measures.

With the change in land surface generated by land development, not only does the peak rate of runoff increase but also the total volume of runoff often dramatically increases. LID focuses on both peak rates and total volumes of runoff. LID application techniques are designed to hold constant peak rates of runoff for larger storms and prevent runoff volume increases for the much more frequent, smaller storms. Thus, the natural flow pattern is kept in better balance, avoiding many of the adverse impacts associated with stormwater runoff. In design, LID is structured to maximize the use of natural features to mimic predevelopment hydrology.

3.0 APPLICABILITY

To prevent an increase in non-point source pollution, these Standards and requirements shall apply to the following:

1) Any new development or redevelopment project that have earth-disturbing activities greater than or equal to 1-acre, or earth disturbing activities less than 1-acre on parcels that are part of a larger plan of development, or include a net increase in impervious area of 1,000 square feet or more, or result in the alteration of existing storm water flow patterns and discharges to a surface water of the state.
2) Any new development or redevelopment project that would change alter or convert the use of land to a stormwater hotspot.

3.1 Sites That Are Hot Spots

Hotspots are defined in the ordinance. They are sites that have a higher potential risk for spills, leaks or illicit discharges and include: any site that handles vehicles for fueling, salvage, service and maintenance, and cleaning; fleet storage areas; industrial sites; outdoor liquid container storage; recycling facilities; etc.

3.2 Stormwater Plan Submittal Requirements

These requirements have been developed in the context of plat submittal under Act 288 of the Public Acts of 1967, as amended, the Michigan Land Division Act. However, they shall also be followed for all other categories of development, including site condominiums and site plans.

The following developments will be submitted to the City for review and approval:

1. Plats submitted under Act 288 of the Public Acts of 1967, as amended, the Michigan Land Division Act
2. Site Condominium plans prepared under Act 59, P.A. 1978, as amended, where local government ordinances require.
3. Mobile home plans prepared under Act 96, PA. 1987.

The developer will describe the mechanism to be established for long-term maintenance and schedule of the development's private stormwater management system (see ordinance for details).

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

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

Preliminary plan approval shall remain in effect for one year. Extensions must be requested in writing.

3.3 Submittal Process

City of Jackson Post-Construction Stormwater Management Permit Application Submission Schedule – City Ordinance Section 27-120

STEP 1: Pre-Application Conference - Before an application for a stormwater permit is submitted, the developer shall meet with the City Engineer to discuss the permit application process.

STEP 2: Preliminary Plan Submittal - The developer may be required to submit a conceptual design based on the pre-application conference. If the preliminary plan is required, approval is required before the City Engineer will proceed with review of a final stormwater management plan.

STEP 3: Permit Application & Plan Submittal: The developer of a proposed covered development project shall be required to submit a stormwater management permit application and plan. The application must be complete before a review can begin.

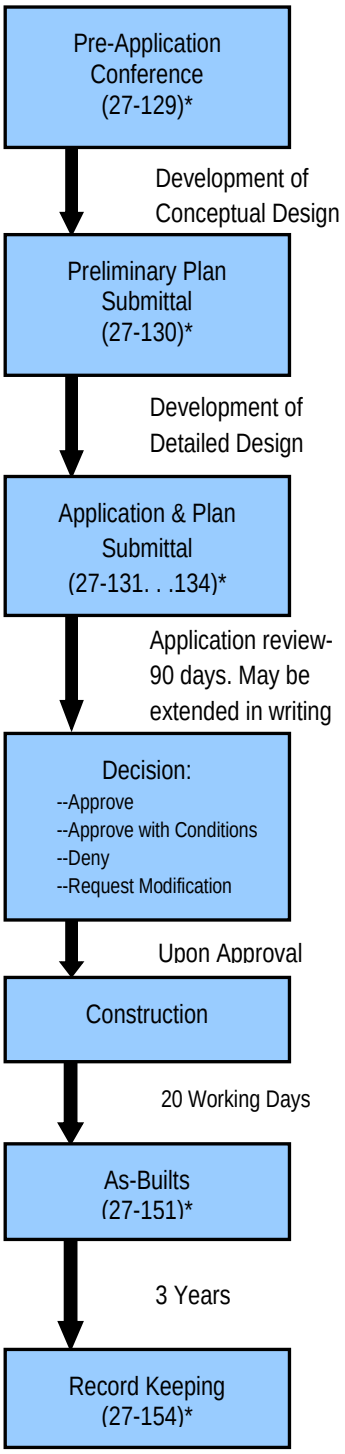
STEP 4: Review Process And Decision- Within 90 days of receipt of a completed application the City Engineer shall reach one of the following decisions: Approve, Approve With Conditions, Deny, or Request a Modification to the Application. The review process may be extended in writing by both city and applicant.

STEP 5: Construction—The Developer constructs the project insuring that soil erosion control measures are used properly and the BMPs are installed.

STEP 6: As Builts – Within 20 working days of the date of completion of a stormwater management system, as-builts shall be submitted to the City Engineer.

STEP 7: Post Construction & Record Keeping – Developer shall retain and preserve for no less than 3 years any and all records, etc., related to stormwater management system.

Figure 1:
Submittal Process Flow Chart



* Ordinance Section Numbers

4.0 DESIGN MANUAL AND STANDARD DETAILS

This document together with the State Low Impact Development (LID) manual will provide information on water quality and quantity standards as well examples of acceptable stormwater treatment practices, including the specific design criteria for each stormwater practice. This document and the LID manual may be updated and expanded from time to time based on federal and state requirements, improvements in engineering, science, monitoring, and local maintenance experience. Stormwater treatment practices that are designed and constructed in accordance with the design and sizing criteria contained in the LID manual should meet the minimum water quality and channel protection performance standards outlined in this document. Calculations to demonstrate that BMP designs will perform to meet required water quality and flood control standards are to be submitted to the City of Jackson. Failure to construct stormwater treatment practices in accordance with these standards may subject the violator to a civil penalty as described in the ordinance.

5.0 REQUIREMENTS

Preliminary Plan Requirements

To maximize the efficiency and effectiveness of the pre-application conference, the City Engineer may require the developer to submit a preliminary stormwater management plan prior to the conference. All preliminary plans will include the following information:

(a) The preliminary plan may be used by the City Engineer to evaluate the type of stormwater management measures that may be necessary and appropriate for the proposed development and to ensure adequate planning for stormwater management on the site consistent with the requirements of this manual.

(b) The preliminary stormwater management plan shall include all of the information and shall meet all of the requirements for final stormwater management plans unless any such information or requirements are determined unnecessary by the City Engineer for the development in question.

(c) All required elements of the preliminary plan, such as maps, plans, easements, details, and calculations may be preliminary rather than final, and detailed construction drawings shall not be required, unless determined necessary by the City Engineer for the development in question.

(d) In all cases, the preliminary plan shall include all information, documents, items, and materials, in the form and at the level of detail, as determined necessary by the City Engineer to adequately evaluate, before the permit application is submitted, the environmental characteristics of the project site, the potential impacts of the proposed development of the site on water resources, and the effectiveness of any measures proposed by the applicant to manage stormwater generated at the project site as required by this manual.

(e) If a preliminary stormwater management plan is required, approval of the preliminary plan by the City Engineer shall be required before the City Engineer will proceed with review of a final stormwater management plan. The City Engineer shall review the submitted preliminary plan and specify any modifications that must be made to the preliminary plan for purposes of preparing a final stormwater management plan that meets requirements. The applicant shall prepare and submit to the City Engineer a final stormwater management plan that incorporates any modifications required to the preliminary plan as specified by the City Engineer and that meets requirements of this manual.

6.0 STORMWATER MASTER PLAN INFORMATION

This section sets forth the requirements that shall apply to final stormwater management plans for proposed development projects.

(a) General.

1. The stormwater management plan shall display and present the information required by this section through the use of maps, illustrations, reports, and calculations.
2. The stormwater management plan shall specify the type, location, and size of stormwater management system to be provided, using final calculations and detailed construction drawings.
3. If the development will be completed in phases, the stormwater management plan shall be prepared and submitted for the total project and for all phases. Further, upon completion of each phase, the stormwater management plan for the project shall be fully functional for the phases already completed and its functionality shall not be reliant in any way upon the completion of future phases. Final approval of one or more phases shall not ensure approval of subsequent phases.

(b) **Plan preparation**. The stormwater management plan shall be prepared, signed, and sealed by a professional civil engineer registered in the State of Michigan.

(c) **Scale for mapping**. The stormwater management plan shall be drawn to a scale not less than 1" = 50', or as otherwise required by the civil engineer.

(d) **Required elements and information**. A stormwater management permit shall not be approved unless the applicant has provided a final stormwater management plan that contains all of the submittals required by this subsection. (The City Engineer may require the same or similar requirements for a preliminary stormwater management plan submitted by an applicant during earlier stages of the stormwater management permit review process, but using preliminary calculations and without requiring detailed construction drawings, as determined appropriate by the City Engineer.) A final stormwater management plan shall include all of the following elements and information:

1. *Location and size*. The location of the development by means of a small location map, drawn to a scale no less than 1" = 2000', and the size of the development in acres.
2. *Zoning*. The zoning classification of the development site and all abutting parcels.
3. *On-site and off-site features*. The location and description of all on-site features and all adjacent off-site features within fifty (50) feet (unless another distance is specified by the City Engineer based on the circumstances at the site), and all other off-site features that may be impacted in determining the overall requirements for the development.

   This shall include:

   (a) Property lines of the development and of adjoining developments.
   (b) Existing site topography with contours at two-foot intervals (one foot preferred) based on the NAVD88 datum.
   (c) On-site public and private streets and street right-of-way lines; and adjoining public and private streets and street right-of-way lines.
   (d) Railroads.
   (e) Power lines or underground transmission lines, gas mains, telephone, monitoring wells.

(f) Cemeteries.
(g) Parks.
(h) Natural and artificial watercourses, wetlands and wetland boundaries, environmental feature boundaries, floodplains, existing stormwater storage facilities, conveyance swales (natural or artificial) with identification of permanent water elevations.
(i) Location of woodlands.
(j) Designated natural areas.
(k) Any proposed environmental mitigation features.
(l) Existing and proposed public and private drains, storm sewers, sanitary sewers, and water mains, and any related easements.
(m) A map, at the U.S.G.S. scale, showing the drainage boundary of the proposed development and its relationship with existing drainage patterns.
(n) Boundaries of any off-site drainage area contributing flow to the development.
(o) All watercourses passing through the development, along with the following:
    (1) Area of upstream watershed and current zoning.
    (2) Final calculations of runoff from the upstream area for both the one hundred-year and two-year 24-hour design storms, for fully developed conditions according to the current land use plan for the area.
(p) Soil borings at the sites of proposed retention/detention and infiltration facilities, and as needed in areas where high groundwater tables or bedrock near the surface exist, and at any other locations as required by the City Engineer.
(q) Proposed development site improvements including lot divisions and building footprints.
(r) Drinking water wells, public wellheads, wellhead protection areas (WHPAs), underground storage tanks, and brownfields.
(s) Any areas of unique geological formations (e.g., karst areas).
(t) Any other on-site or off-site features as determined necessary by the City Engineer.

4. *Stormwater BMP construction plans.* The stormwater management plan shall include final stormwater BMP construction plans. The BMP construction plans shall be drawn to a scale not less than 1" = 50', and on sheets no larger than 24" × 36". The scales used shall be standard engineering scales and shall be consistent throughout the plans. When plans have been completed with computer aided design technology, locations should be geo-referenced and a copy of the electronic file shall also be provided. The construction plans and related documents shall, at a minimum, include:
    (a) Location and specifications of all proposed stormwater management practices, methods, and facilities (plan and profile).
    (b) Proposed storm drains, including rim elevations, invert elevations, pipe sizes, and pipe materials.
    (c) Calculations of runoff from upstream areas for both the one hundred-year and two-year, 24-hour design storms for fully developed conditions according to the current land use plan for the area.
    (d) Identification of stormwater quality and quantity treatment facilities and method of stormwater conveyance.
    (e) Calculation of runoff volume captured by BMPs for treatment facilities.

(f) Proposed open channel facilities including slope, cross-section detail, bottom elevations, and surface material.
(g) Final sizing calculations for stormwater quality and quantity treatment facilities and stormwater conveyance facilities.
(h) Storage provided by one-foot elevation increments.
(i) Tributary area map for the stormwater management system and all components thereof indicating total size and average runoff coefficient for each sub-area.
(j) Analysis of existing soil conditions and groundwater elevation (including submission of soil boring logs) as required for proposed retention and infiltration facilities.
(k) Plans and details of proposed soil erosion and sedimentation control measures, both during construction (as required by Part 91 of the Public Acts of 1994) and permanent measures.
(l) Details of all stormwater BMPs, including but not limited to:
    (1) Outlet structures.
    (2) Overflow structures and spillways.
    (3) Riprap.
    (4) Manufactured treatment systems.
    (5) Underground detention cross-section and product details.
    (6) Cross section of infiltration and/or bio-retention facilities.
(m) Location of proposed stormwater management facility easements.
(n) Final landscaping plans and details.

7.0 PERMIT APPLICATION

The developer of a proposed covered development project shall be required to submit a stormwater management permit application and all required accompanying submittals and shall meet the other requirements provided by the ordinance.

(a) An application for a stormwater management permit shall be submitted by the applicant to the City Engineer on the form provided by the City Engineer.
(b) The applicant may be the property owner or the property owner's authorized representative. The permittee, however, shall be the property owner.
(c) The submitted application shall include all information, documents, items, and materials as specified by the application form. In addition to what is required by the application form, the City Engineer may require the applicant to submit any other materials as determined necessary by the City Engineer to fully and adequately review and evaluate the application for purposes of this article.
(d) All of the required application materials shall be submitted in as many copies, and shall be prepared in the form, manner, and level of detail, as specified by the application form or as otherwise required by the City Engineer.
(e) A permit application shall not be deemed complete until the City Engineer has determined that all required information, documents, items and materials have been provided, along with the fully paid stormwater management permit review fee, and, if requested, the fully paid escrow fee and completed escrow fee acknowledgement form.
(f) If the City Engineer determines that an application is not complete, the City Engineer shall specify in writing to the applicant what the applicant must do to complete the application.
(g) Any period for approving, denying, or modifying an application as specified by this article shall not begin to run until the City Engineer has determined that the application is complete as provided by this section.
(h) An application may be considered withdrawn and the application file may be closed by the City Engineer if an applicant fails to respond to any written request from the City Engineer for information, documents, items, or materials regarding the application within thirty (30) days of the request, or within any longer period of time if the City Engineer and the applicant agree in writing that an extension of time is appropriate and the amount of additional time is set forth in the agreement.
(i) At any time during the permit application review and approval process, the City Engineer may forward copies of the application to other city departments and other public bodies for their information, review and input, and to coordinate, to the extent possible, the stormwater management permit review process with other public reviews and approvals that may also be required for the development.
(j) Filing an application for a stormwater management permit grants the city permission to enter the site to verify information in the application and to inspect for compliance with any permit that may be issued.

8.0 PERMIT APPLICATION FEE:

A non-refundable application fee shall be submitted to the City Engineer with the initial submittal of the permit application form. The application fee shall be in an amount sufficient to cover reasonable costs and expenses generally associated with the review by the City Engineer of stormwater management permit applications, including routine administrative and technical reviews and on-site inspections. The amount of the application fee shall be established from time to time by resolution of the City Council.

9.0 ESCROW FEE:

In addition to the application fee, based on the size, complexity, or other aspects of a proposed development, the City Engineer may determine that the applicant must submit to the city as part of the permit application an escrow fee in an amount sufficient, as determined by the City Engineer, to pay for the estimated reasonable costs and expenses of any city personnel and any professional consultants whose services are deemed necessary by the City Engineer to adequately review the application for purposes of compliance with the requirements of the ordinance:

(a) If the City Engineer requires payment of an escrow fee, the applicant must complete and submit an escrow fee acknowledgment form provided by the City Engineer.
(b) The amount of the escrow fee shall be determined at the time of project review based on a specific scope of work, and shall be calculated at the rates determined by the City Engineer.
(c) The services for which an escrow fee may be used may include, but shall not be limited to, hydrologic and drainage analysis, wildlife evaluation, stormwater quality analysis, wetland survey and delineation, site inspections, as-built plan review, analysis of legal issues, and any other city personnel and professional consultant services deemed necessary by the City Engineer.
(d) If the actual total cost of the services of the city personnel and consultants is less than the escrow fee submitted, the city shall refund the balance to the applicant.
(e) If the actual total cost of the services of the city personnel and consultants exceeds the amount of the escrow fee submitted, the applicant shall provide to the city an additional escrow amount equal to no less than one-half (½) the original escrow amount. All review by the city of the stormwater management permit application shall cease until such additional escrow amount is deposited with the city, and the number of days that review of the stormwater management permit application ceases shall be deducted from the period within which the City Engineer may otherwise be required to act upon the application.
(f) Payment of an escrow fee as provided by this section may be required by the City Engineer at any point during the stormwater management permit review process, as determined necessary by the City Engineer.
(g) A denial of an application for a stormwater management permit shall not affect in any way the applicant's obligation to pay the escrow fees required by this section.

All fees required shall be paid by cash, check, or money order. All forms of payment other than cash shall be made payable to the City of Jackson.

10.0 INSPECTION FEES:

Inspection fees may be charged, at the discretion of the City, especially for as-built inspections and if maintenance schedules appears to be not being followed.

11.0 EXPLANATION OF REQUIREMENTS

City Of Jackson Design Criteria

In an effort to standardize design procedures for storm sewers and open channels the City of Jackson has developed these standards. It is intended that these standards will facilitate planning from both the position of the design and reviewing engineer.

It is recognized that design conditions vary and there is no substitute for the professional judgment of an experienced engineer. In all cases this judgment should be applied.

The design engineer should always use the more restrictive requirement/methodology if there is a conflict between the LID standards and the City of Jackson flood control requirements.

Where insufficient data is available to develop basin hydrology by the above method, the developer shall determine flows along the watercourse by the Soil Conservation Service (SCS) based methods, the rational method (for peak flow only), Storm Water Management Model (SWMM), or a combination of these methods. The basin hydrology shall be approved by the City Engineer's office prior to proceeding with the final design of a given project.

The development shall meet the following stormwater design requirements:

- *A* A minimum treatment volume standard *to minimize water quality impacts*
- *B Channel Protection Criteria*
- *C Be compatible/integrate with the City of Jackson's Flood Control requirements*
- *D A requirement for the project developer to write and implement site plans, which shall incorporate the requirements of the City of Jackson ordinances*
- *E Easement for Stormwater Management System*
- *F Implementation Plan*
- *G Enforcement mechanisms with recordkeeping procedures*
- *H Performance Guarantee*
- *I Other information and materials*
- *J Operation and maintenance requirements*

Following is a detailed description for each of the requirements (A-J). There is a table after the *Operation and Maintenance Requirements* section that summarizes the stormwater requirements within the City of Jackson.

Requirement A: "A minimum treatment volume standard to minimize water quality impacts."

The calculated site runoff is from the 90 percent annual non-exceedance storm for the region or locality, according to (a) or (b) below, respectively:

To address water quality impacts of storm runoff, all stormwater management plans shall comply with the minimum treatment volume standard provided by this section.

(a) The minimum treatment volume standard shall be one (1) inch of runoff from the entire site.
(b) Treatment methods shall be designed on a site-specific basis to achieve either of the following:
    (1) A minimum of eighty (80) percent removal of total suspended solids (TSS), as compared with uncontrolled runoff; or
    (2) Discharge concentrations of TSS not to exceed eighty (80) milligrams per liter (mg/l).
(c) A minimum treatment volume standard is not required where site conditions are such that TSS concentrations in stormwater discharges will not exceed eighty (80) mg/l.

Sites are in compliance with this permit requirement if the minimum treatment volume from the site is treated by properly designed BMPs that achieve either 80% removal of total suspended solids, or discharge 80 mg/l or less of total suspended solids according to accepted literature. It is also important to note that new development will often be in compliance with this permit requirement if the volume control specified in the channel protection requirement of this permit is achieved.

Compliance may be shown through calculation or through direct measurement. Calculations or measurements must show reductions to the calculated TSS concentration in uncontrolled runoff using the data provided here or another acceptable literature source. The State LID Manual summarizes the potential application and the quantity and quality function for most BMPs, when designed correctly, either individually or as a suite of BMPs.

Requirement B: **"**Channel Protection Criteria."

All stormwater management plans shall comply with the channel protection criteria provided by this section to address post-development site runoff volume and peak flow rates.

(a) A stormwater management plan shall require such stormwater management practices, methods, and facilities as necessary to maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event, as determined adequate by the City Engineer. "Existing levels" means the runoff flow volume and rate for the last land use prior to the proposed development. The City Engineer may specify more restrictive criteria if determined necessary by the City Engineer to meet the goals of reducing runoff volume and peak flows to less than existing levels on the property to be developed.
(b) To ensure that the required channel protection criteria are met, the City Engineer shall use the procedures, methods, techniques, formulas, and data sources as contained in the city's stormwater management manual or as otherwise determined appropriate by the City Engineer.

Requirement C: **"**Be compatible/integrate with the City of Jackson's Flood Control requirements.**"**

Structures are to be sized to accommodate a twenty-four hour, 100-year storm. The maximum allowable discharge is based a thirty-minute, ten-year storm. Furthermore, See Chapter 11 of the City of Jackson code of ordinances for further details regarding permissible uses in the floodplain.

Requirement D: **"**A requirement for the project developer to write and implement site plans, which shall incorporate the requirements of the City of Jackson ordinances." This includes:

<u>Soil Erosion Control</u>

(a) All development and other land disturbance activities shall be designed, constructed, and completed in such a manner that the exposed area of any disturbed land is limited to the shortest practical period of time.
(b) Proposed erosion control measures shall be submitted to Jackson County for determination that such measures comply with the county's soil erosion and sedimentation control requirements. The project developer must obtain part 91 permit from the County.
(c) Approved soil erosion control measures shall be installed and maintained between the disturbed area and any down-gradient watercourses (including rivers, streams, creeks, lakes, ponds, and other watercourses), wetlands, roadways, and property lines.
(d) Sediment resulting from accelerated soil erosion shall be removed from runoff water before it leaves the site of the development.
(e) Temporary and permanent soil measures designed and constructed for the conveyance of water around, through, or away from the development or land disturbance activity area shall be designed to limit the water flow to a non-erosive velocity.
(f) Temporary soil measures shall be removed after permanent soil measures have been implemented and stabilized. All developments and land disturbance activity areas shall be stabilized with permanent soil measures.
(g) If inland lakes, ponds, rivers, creeks, streams, or other watercourses and wetlands are located on or near the site, measures that trap sediment shall be provided. The use of temporary sediment basins, sediment traps, filter fabric, and rock filters shall be employed as required by the City Engineer. Other measures may be required if reasonably determined to be necessary by the City Engineer to protect a watercourse or wetland.
(h) If it is not possible to permanently stabilize a disturbed area after an earth change has been completed or where significant land disturbance activity ceases, temporary soil erosion control measures shall be implemented within two (2) calendar days.
(i) Permanent soil measures for all slopes, channels, ditches, or any disturbed land area shall be completed within fifteen (15) calendar days after final grading or the final land disturbance activity has been completed. All temporary soil measures shall be maintained until permanent soil measures are implemented and stabilized.
(j) Vegetated filter strips, twenty-five (25) feet in width, preferably vegetated with native plant species, shall be created or retained along the edges of all lakes, creeks, streams, wetlands, and other watercourses. The width of a particular filter strip may be reduced to the extent it is demonstrated to the City Engineer's satisfaction that a portion of the width will serve no useful

function, e.g., to the extent the grade is such that water flow will be away from the watercourse and the filter strip does not serve to protect wildlife habitat or other useful function.

Discharge of Stormwater to Wetlands

(a) Wetlands shall be protected from damaging modification and adverse changes in runoff quality and quantity associated with land disturbance activities. Before approval of a final plat or site plan, all necessary wetland permits from the MDNRE and/or the city must first be obtained.
(b) Wetlands shall be protected during development by appropriate soil erosion and sedimentation control measures that are continuously maintained throughout the construction phase.

Requirement E: Easements for stormwater management system. The applicant shall provide all stormwater management easements as determined necessary by the City Engineer to implement the approved final stormwater management plan and to otherwise comply with the ordinance.

(a) Stormwater management easements may be required for any of the following purposes:
    (1) To provide access for stormwater management facility inspections and maintenance.
    (2) To preserve stormwater runoff conveyance, infiltration, and detention areas and facilities, including flood routes for storm events.
    (3) To preserve primary and secondary drainage ways that are needed to serve stormwater management needs of other properties.
    (4) To accomplish purposes such as those listed above for all areas used for off-site stormwater control, including undeveloped or undisturbed lands, as applicable.
    (5) To serve other purposes and objectives as necessary to achieve the purposes of this article as determined by the City Engineer.
(b) All stormwater management easements shall meet the following requirements:
    (1) The purpose of each easement shall be specified in writing.
    (2) The easements shall be acceptable to the city attorney in form and substance and shall be recorded with the county register of deeds.

Requirement F: Implementation Plans. The applicant shall provide an implementation plan for construction and inspection during and after construction of all stormwater management system components required by the final stormwater management plan, including a schedule of the estimated dates of completing construction of the stormwater management system shown on the plan; identification of the proposed inspection procedures to ensure that the stormwater management system components are constructed and operating in accordance with the final stormwater management plan; and recordkeeping requirements. The implementation plan will include arrangements acceptable to the City Engineer for notification by the applicant to the City Engineer before the commencement of construction of the stormwater management system (and before construction of critical components of the system) and for final verification of construction by a registered professional engineer.

Requirement G: "Enforcement mechanisms with record keeping procedures."

Enforcement of the requirements will be achieved through the stormwater ordinance that supports the City of Jackson stormwater program. In particular, maintenance agreements shall implement and track maintenance activities to ensure long-term O&M plans for the **water quality treatment** controls.

The BMP owner-operator must track and record, and if required by the City, report all field inspection findings to ensure proper O&M occurs for the life of the BMP. As per the ordinance, the BMP/owner operator must maintain inspection and maintenance information for the life of the BMP and make this information available to City staff during inspections.

Requirement H: Performance guarantee. The applicant shall provide a performance guarantee in a form and amount satisfactory to the City Engineer and the city attorney as provided by this section.

(a) The applicant shall submit a performance bond (or other financial guarantee acceptable to the city) for the timely and satisfactory construction of all stormwater management system components in accordance with the final stormwater management plan. The performance bond or other financial guarantee shall be accompanied by a detailed cost estimate provided by the applicant. Upon written certification by a registered professional engineer that all components of the required stormwater management system have been completed in accordance with the final stormwater management plan, including, but not limited to, the provisions contained in the implementation plan and as-built certification and final inspection, and subject to final acceptance and approval by the City Engineer, the city may release the performance bond or other financial guarantee.

(b) Except as provided in item c below, the amount of the financial guarantee shall be in the amount of the cost estimate for the work provided by the applicant, unless the City Engineer determines that a greater amount is appropriate, in which case the basis for such determination shall be provided to the applicant in writing. In determining whether a greater amount is appropriate, the City Engineer shall consider the size and type of the development, the size and type of the on-site stormwater system, and the nature of the off-site stormwater management system the development will use.

(c) The City Engineer may, but shall not be required to, waive or reduce the amount of the financial guarantee for a development that will not increase the impervious surface of the development site by more than two thousand (2,000) square feet.

(d) Nothing in this section or this article shall be construed or interpreted as relieving any person of their obligation to pay all costs associated with on-site private stormwater management systems, as well as those costs arising from the need to make other drainage improvements to reduce a development's impact on a drain consistent with adopted design standards.

Requirement I: Other information and material. The stormwater management plan shall include any other information, documents, items, and materials determined necessary by the City Engineer to verify that the stormwater management plan complies with the city's design and performance standards for drains and stormwater management systems, and that the plan otherwise complies with the requirements of the ordinance and other applicable laws and regulations.

Requirement J: "Operation and Maintenance Requirements."

All structural and vegetative BMPs installed as a requirement of the permit shall include a plan for maintaining maximum design performance through long-term operation and maintenance (O&M). The O&M plans will ensure that the BMP continues to meet the **water quality treatment** controls outlined in this manual. The maintenance plan shall be subject to approval by the City and enforceable. The applicant shall provide a stormwater O&M plan and agreement.

(a) The O&M plan and agreement shall be provided by the applicant in such form and substance as required by the city attorney.
(b) The O&M plan and agreement shall contain provisions to ensure that the maximum design performance of stormwater BMPs is maintained on a long-term basis and that the city's standards for stormwater quality and quantity are met.
(c) At a minimum, the O&M plans and agreements shall include all of the following information and contents:
    (1) The names and addresses of the property owners, and, the owners of all components of the stormwater system.
    (2) The names and addresses of the persons responsible for operation and maintenance.
    (3) The names and addresses of the persons responsible for financing operation and maintenance and emergency repairs.
    (4) The signatures of the owners and any other persons to be bound by the agreement.
    (5) A detailed annual estimated budget for the expected life of the BMPs; and a demonstrated means of financing operation and maintenance and emergency repairs.
    (6) A map showing the location of the stormwater systems and facilities, including catch basins, manholes/access lids, main, and stormwater devices.
    (7) A schedule for routine, non-routine, emergency, and long-term inspection and maintenance of all structural and vegetative stormwater BMPs, with detailed tasks to be performed, and detailed inspection and maintenance checklists.
    (8) Operating instructions for stormwater outlet components.
    (9) Vegetation maintenance schedule.
    (10) Recordkeeping, tracking, inspection, and notice checklists and requirements.
    (11) A statement recognizing the city's right to enter the property for the purpose of inspections.
    (12) Provisions regarding the city's right to perform, or cause to be performed, any required operation and maintenance if the responsible persons fail or refuse to do so, and the obligation of property owner to fully reimburse the city for the costs and expenses incurred by the city in connection with such activity.

The O&M plan and agreement shall be binding on all current and subsequent owners of land served by the stormwater BMPs and shall be recorded in the county register of deeds as directed by the city attorney.

Any person responsible for the operation and maintenance of a stormwater management facility shall provide records of all maintenance and repairs to the City Engineer upon request.

An example of a stormwater maintenance agreement can be found in the LID Manual for Michigan.

The City of Jackson stormwater program requirements should be designed to be compatible/integrate the with the flood damage requirements as outlines in Chapter 11.

Table 1 summarizes City of Jackson water quality requirements.

Table 1: Stormwater Requirements

Treatment Category	Design Requirement
Minimum Treatment Volume	One (1) inch of runoff from the entire site.
Total Suspended Solids (TSS)	Minimum of 80% removal of (TSS), compared with uncontrolled runoff – or – Discharge concentrations of TSS not to exceed 80 (mg/l).
Channel Protection Criteria	Maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event
Maintenance	All required structural and vegetative BMPs installed will include a plan for maintaining maximum design performance through long-term operation and maintenance (O&M)
Flood Control	Structures are to be sized to accommodate a twenty-four hour, 100-year storm. The maximum allowable discharge is based a thirty-minute, ten-year storm.

12.0 APPEAL PROCEDURES

Any person aggrieved by a notice of violation, order, or other action taken by the City Engineer under the ordinance may request review and reconsideration by the City Engineer and/or may appeal to the stormwater board of appeals. If review and reconsideration or appeal is not properly and timely requested in connection with an action as provided, the action shall be deemed final. The person requesting the appeal shall pay an appeal fee in the amount determined from time to time by the City Council. The appeal fee shall be paid at the time that the appeal is requested.

A request for a review and reconsideration by the City Engineer must be made in writing within seven (7) days from the date of the City Engineer's action in question. The request must state the reasons for the review and shall include all supporting documents and dates. A hearing on the request shall be scheduled at the earliest practicable date as determined by the City Engineer. The hearing shall be conducted on an informal basis at the City Engineer's offices or at another location designated by the City Engineer. The City Engineer shall conduct the hearing. Following the informal hearing, the City Engineer may affirm or reverse, in whole or in part, the action appealed from, or may make any order, requirement, decision, or determination as, in the City Engineer's opinion, ought to be made in the case under consideration. The City Engineer shall notify the aggrieved person of the decision on the request in writing within fourteen (14) days of the hearing. The City Engineer may request additional information and extend the time for his/her decision by an additional seven (7) days in writing following the submission of the additional information. The decision of the City Engineer may be appealed to the Stormwater Board of Appeals. All supporting documentation and information shall be provided by the person requesting the appeal at no cost to the city.

The building code board of examiners and appeals of the city shall serve as a Stormwater Board of Appeals ("SWBA"). The SWBA shall consider appeals from final decisions of the City Engineer. The SWBA shall adopt its own rules of procedure, and keep a record of its proceedings, showing findings of fact, the action of the board, and the vote of each member upon each question considered. The presence of five (5) members of the SWBA shall be necessary to constitute a quorum.

The following provisions shall govern appeals of final decision of the City Engineer made to the SWBA:

(a) An appeal from any final action of the City Engineer must be made to the SWBA within seven (7) days from the date of the action appealed. The appeal may be taken by any person aggrieved by the action. The appellant shall file a written notice of appeal with the City Engineer and with the SWBA. The notice of appeal shall specify the grounds for the appeal and shall be accompanied by a non-refundable appeal fee. Failure to file a timely notice of appeal shall be deemed to be a waiver of the right to appeal.

(b) Prior to a hearing before the SWBA regarding an appeal, the City Engineer shall transmit to the SWBA a written summary of all previous action taken in connection with the action being appealed. The SWBA may, at the SWBA's discretion, request the City Engineer to provide further information regarding the action that is the subject of the appeal.

(c) The SWBA shall fix a reasonable time for the hearing of the appeal. Notice of the hearing shall be provided at least ten (10) days in advance of the hearing to require the attendance and testimony of witnesses and the production of evidence relevant to any matter involved in the hearing. The appellant must submit an exhibit and witness list to the SWBA at least five (5) days before the hearing or as directed by the SWBA.

(d) The SWBA shall conduct the hearing. At the hearing, attorneys may represent the parties and they may file briefs, present evidence, and call, examine and cross-examine witnesses. Any testimony taken at the hearing shall be under oath and recorded. A copy of the transcript of the hearing shall be made available at cost to any person upon payment of applicable charges for the transcript.
(e) The SWBA shall admit all testimony having reasonable probative value and shall exclude irrelevant or unduly repetitious testimony, as determined by the SWBA. The SWBA shall not be bound by common law or statutory rules of evidence. The appellant shall have the burden of proof and persuasion for showing that the City Engineer's decision was clearly erroneous.
(f) If the action of the City Engineer subject to the appeal involves the City Engineer's grant or denial of a waiver, the SWBA's decision to grant or deny the appeal shall be based on the standards and conditions provided in the ordinance.
(g) Within thirty (30) days after the completion of the hearing, the SWBA shall mail or otherwise deliver to all of the parties a written decision granting, denying or modifying the decision appealed and/or relief being sought.
(h) The decision of the SWBA on the matter shall be final, and shall be a final determination for purposes of judicial review.
(i) If the City Engineer or his or her designee sits on the building code board of examiners and appeals because of additional responsibilities as the director of public works, the City Engineer shall abstain from any decision before the SWBA.

All charges, penalties, fines, fees, surcharges, costs, or expenses outstanding during any appeal process shall be due and payable to the city. Upon resolution of any appeal, the amounts due and payable shall be adjusted accordingly. The city may suspend discharges to the MS4 if a corrective course of action is not taken or if service charges, penalties, fines, fees, surcharges, costs, or expenses are not timely paid in full.

If an appeal is not demanded as provided by this division within the periods specified, the City Engineer's action shall be deemed final.

If an appeal is properly demanded, the action appealed shall be suspended until a final determination has been made by the SWBA, except for emergency orders or actions where a suspension or delay might endanger human health, safety, welfare, the environment, or the MS4; and as otherwise expressly provided by this section regarding permit appeals.

If an appeal involves a final decision made by the City Engineer in connection with issuing or implementing a stormwater management permit, the following provisions shall apply:

(a) The person appealing the decision must specify in its notice of appeal the action of the City Engineer being appealed and the grounds for the appeal. If a particular permit provision is objected to, the notice of appeal must specify in detail the reasons for the objection, and the specific alternative provision, if any, sought to be placed in the permit.
(b) If, after considering the record on appeal including any statements provided by the City Engineer in response to the appeal, the SWBA determines that a permit or any provision of a permit should be reconsidered, the SWBA shall remand the matter to the City Engineer for further action as determined appropriate by the SWBA. Only the specific provisions of a permit that are remanded by the SWBA for reconsideration by the City Engineer shall be stayed pending further final action taken by the City Engineer as required by the decision of the SWBA.

(c) A decision of the SWBA not to remand any matter shall be considered final administrative action for purposes of judicial review.
(d) Except as otherwise expressly provided above, no action taken or request filed by any permittee shall operate to stay the effect of any permit or of any provision, term or condition of any permit.

Appeals from a final determination of the SWBA may be made to the county circuit court as provided by law. All findings of fact made by the SWBA, if supported by the evidence, shall be deemed conclusive.

APPENDIX A

Blank Worksheets

Worksheet 1. General Watershed/ Site Information

NOTE: If the project extends over more than 1 Watershed, fill out Worksheet 1 for each Watershed

Date: _____

Project Name: _____

Municipality: _____

County: _____

Total Area (acres): _____

Major Watershed: _____

http://cfpub.epa.gov/surf/state.cfm?statepostal=MI

Subwatershed: _____

Nearest Surface Water(s) to Receive Runoff: _____

Part 4 - Designated Water Use: _____

http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714---,00.html

Michigan Natural Rivers watershed? Yes ☐ No ☐

http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442-95823--,00.html

Impaired according to Chapter 303(d) List? Yes ☐ No ☐

http://www.deq.state.mi.us/documents/deq-wb-intreport-appendixj.pdf

List Causes of Impairment:

Areas of impairment not local to project

Is project subject to, or part of:

Phase I or Phase II Municipal Separate Storm Sewer System (MS4) Requirements? (Is the site greater than 1 acre?) Yes ☐ No ☐

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html

Existing or planned drinking water supply? Yes ☐ No ☐

If yes, distance from proposed discharge (miles): _____

Approved Watershed Management Plan? Yes ☐ No ☐

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714_4012-95955--,00.html

Worksheet 2. Sensitive Natural Resources

Project: _____

INSTRUCTIONS:

1. Provide Sensitive Resources Map for the site. This map should identify waterbodies, floodplains, riparian areas, wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural features.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres).

Small wooded area identified on the site to be protected.

3. Summarize total proposed Protected/Undisturbed Area. Use the following BMPs to define Protected/Undisturbed Area; protect sensitive areas, protect riparian buffers, protect natural flow pathways, cluster development, and minimize disturbed area.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once (include as either floodplain or wetland, not both).

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? (yes, no, n/a)	TOTAL AREA (Ac.)	PROTECTED/ UNDISTURBED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Special Habitat Areas			
Other:			
TOTAL EXISTING:			

Worksheet 3. Runoff Reduction Credits

PROTECTED/ UNDISTURBED AREA

Protected/Undisturbed Area* (from WS 2) _____ **Ac.**

TOTAL PROPOSED PROTECTED/UNDISTURBED AREA _____ **Ac.**

Total Site Area	*minus*	Protected/ Undisturbed Area	*equals*	Disturbed Area (To be managed)
	-		=	

This is the area that requires stormwater management

Transfer to WS 4

NON STRUCTURAL BMP CREDITS**

BMP: Minimize Soil Compaction Area: _____ **Ac.**

Soil Type _____ Existing CN _____ Credited CN _____

BMP: Soil Amendment and Restoration Area: _____ **Ac.**

Soil Type _____ Existing CN _____ Credited CN _____

Areas complying with the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a "Good" condition instead of "Fair" as required for other disturbed pervious areas. For example, lawn areas with B soils would be given a CN of 61 instead of 69; lawns with C soils a CN of 74 instead of 79. Curve Numbers were developed as part of the U.S. Soil Conservation Service TR-55 hydrologic analysis model.

Protect Existing Trees within Disturbed Area (part of Minimize Disturbed Area)

Number of Trees: _____

Total Area: _____ **Ac.**

Soil Type _____ Existing CN _____ Credited CN _____

Trees protected under the requirements of this BMP can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 800 SF per tree or the entire area of the tree canopies protected, whichever is greater.

BMPS: Native Revegetation and Riparian Corridor Restoration

Number of Trees: _____

Number of Shrubs: _____

Total Area: _____ **Ac.**

Soil Type _____ Existing CN _____ Credited CN _____

Proposed trees and shrubs to be planted under the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 200 SF per tree or the estimated tree canopy, whichever is greater. For shrubs, an area of 25 SF per shrub.

** *A checklist is provided for each BMP in chapter 6 and 7 to ensure certain criteria is being met and credit can be given.*

City of Jackson
Department of Engineering

WORKSHEET 4A. Calculations for Channel Protection Volume

PROJECT NAME: _____

2-Year, 24-Hour Rainfall): _____ **in**

Total Site Area: _____ **acres**
Disturbed Area to be managed: _____ **acres** (From WS 3)

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S[3]	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30			
Woods	B	**0**		55			
Meadow	B	**0**		58			
Woods	C	**0**		70			
Meadow	C	**0**		71			
Woods	D	**0**		77			
Meadow	D	**0**		78			
Impervious	N/A	**0**		98			
Other:		**0**					
TOTAL:	**N/A**	**-**	**0.00**	**N/A**	**N/A**		

Post-Development Conditions**

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
		-					
		-					
		-					
		-					
		-					
TOTAL:	**N/A**	**-**	**0.00**	**N/A**	**N/A**		

Runoff Volume Increase (ft^3): _____ ***Transfer to WS 5***

Runoff Volume Increase = (Post-Dev. Runoff Volume) MINUS (Pre-Dev. Runoff Volume)

1. **Runoff (in)** = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where:
   - P = 2-Year, 24-Hour Rainfall (in)
   - **3. S =** 1000/ CN - 10
   - CN = Curve Number
   - Q = Runoff (in)
2. **Runoff Volume (ft^3)** = Q x 1/12 x Area — Area = Area of specific land cover (ft^2)

* Runoff Volume must be calculated separately for pervious and impervious areas (without using a weighted CN), unless Non-Structural BMP Rooftop/Downspout Disconnection is applied.

** Pre- and Post-development areas shall match. Post development conditions shall reflect non-structural BMPs applied on WS 3

WORKSHEET 4B. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: _____

1-Year, 24-Hour Rainfall): _____ **in**

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3		
Woods	B	**0**		55	8.2		
Meadow	B	**0**		58	7.2		
Woods	C	**0**		70	4.3		
Meadow	C	**0**		71	4.1		
Woods	D	**0**		77	3.0		
Meadow	D	**0**		78	2.8		
Impervious	N/A	**0**		98	0.20		
Other:		**0**					
TOTAL:	**N/A**	**-**		**N/A**	**N/A**		

Post-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
		0					
		0					
		0					
		0					
		0					
TOTAL:	**N/A**	**-**		**N/A**	**N/A**		

Runoff Volume Increase (ft^3): **0**

PEAK FLOW RATE ANALYSIS

(Use detailed information to complete Worksheets 4C & 4D, or use simplified Graphical Method below)

Storm Event	Duration (Hr)	Pre-Settlement Peak Discharge[A]	Post-Settlement Peak Discharge Rate	Difference (Post - Pre)	Are the criteria met? (Y/N)**
1-year	24				
2-year	24				

[A] Graphical Peak Discharge method = Qp = Qu*A*Q

Where: Qp = Peak Discharge (cfs)
Qu = Unit Peak Discharge (csm/in)
A = Drainage Area (mi) Q = Runoff

*To determine Qu through graphical methods see Worksheets 4C & D, and attached figure assuming a minimum Time of Concentration of 6 minutes to fill out the table below for the peak flow table above.

Ia = 0.2*(1000/CN-10) Where : CN = weighted curve number P = Rainfall

	Weighted CN	I_a	I_a/P 1-yr, 24Hr	I_a/P 2-yr, 24Hr	Qu 1-yr	Qu 2-yr
Pre						
Post						

** If the peak flow rate increases after development, then BMPs must be designed to address the increase.

WORKSHEET 4C. Time of Concentration

PROJECT NAME: _____

2-Year, 24-Hour Rainfall): _____ **in**

Pre-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
					0.00
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.00*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved				0.00
	Paved				0.00
				Shallow Concentrated Subtotal	*0.00*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Time of Concentration (hr)	
				Adjusted Time of Concentration (hr)**	

Post-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1				
	2				
	3				
				Sheet Flow Subtotal	
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved				
	Paved				
				Shallow Concentrated Subtotal	
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				
	2				
	3				
				Channel Flow Subtotal	
				Total Time of Concentration (hr)	
				Adjusted Time of Concentration (hr)**	

*** minimum allowed Tc is 0.1hr; maximum allowable is 10 hrs*

Roughness Coefficient (Manning's n) for sheet flow

Surface Description	**n**
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover <= 20%	0.06
Residue cover > 20%	0.17
Grass	
Short grass prairie	0.15
Dense grassess	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods	
Light underbrush	0.4
Dense underbrush	0.8

WORKSHEET 4D. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: _____

PEAK FLOW RATE ANALYSIS

Storm Event	P (in)	Develop-ment	Tc[1] (hr)	Weighted Avg CN[2]	Ia/P[3]	Peak Unit qu (csm/in)[4]	Peak Runoff (cfs)[5]	Peak Runoff (cfs/ac)[6]
1-year 24-hour		Pre-						
		Post-						
2-year 24-hour		Pre-						
		Post-						

1. From Worksheet 4C
2. From Worksheet 4B
3. From Worksheet 4B

4. Peak Unit qu (csm/in) =

10^((-2.744*(Ia/P)^3)+(0.312*(Ia/P)^2-(0.212*(Ia/P))+2.574)

Where:
Ia/P = From Table above

5. Peak Runoff (cfs) =

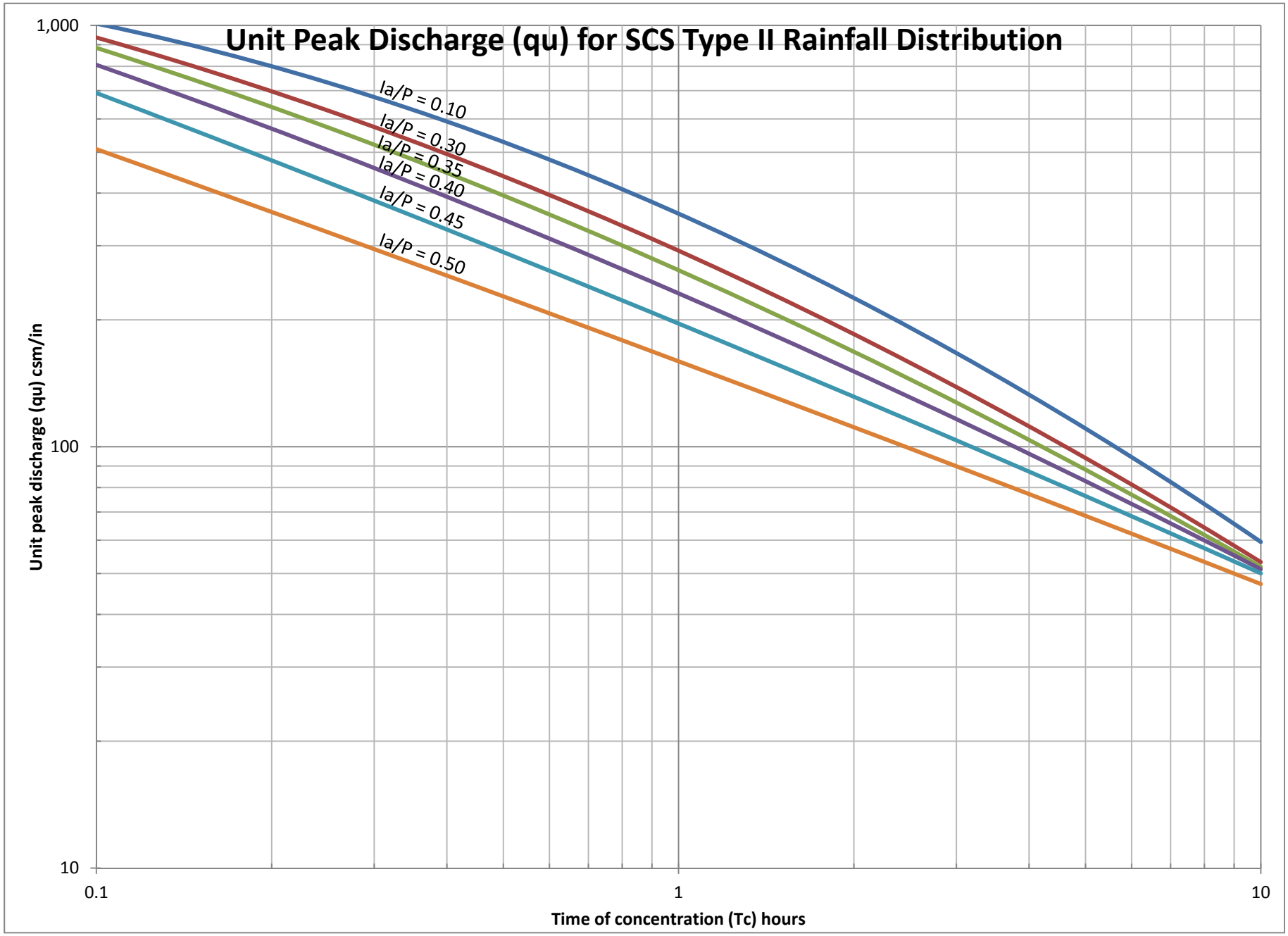
$$\frac{(qu*A)}{640} * Q$$

Where:
qu = From Table above
A = Total site area, pre/post
Q = Total site runoff pre/post
(A & Q from Worksheet 4B)

6. Peak Runoff (cfs/ac) =

$$\frac{\text{Peak Runoff}}{A}$$

Where:
A = Total site area, pre/post
(A from Worksheet 4B)


Unit Peak Discharge (qu) for SCS Type II Rainfall Distribution
Ia/P = 0.10
Ia/P = 0.30
Ia/P = 0.35
Ia/P = 0.40
Ia/P = 0.45
Ia/P = 0.50
1,000
100
10
0.1
1
10
Unit peak discharge (qu) csm/in
Time of concentration (Tc) hours

WORKSHEET 5. STRUCTURAL BMP VOLUME REDUCTION**

PROJECT: _____

This worksheet is to be used to tabulate the volume reduction as a result of the installation of structural BMPs. To meet Channel Protection Criteria for volume reduction, the Permanently Removed Storage Volume will be considered as sufficient support documentation. The Infiltration Volume During Storm calculations may be provided in addition at the developer's discretion.

Runoff Volume Increase (cubic feet) *from Worksheet 4A* : _____

Proposed BMP[A]	Area (ft^2)	Permanently Removed Storage Volume[B] (ft^3)	*Ave. Design Infiltration Rate (in./hr.)	*Infiltration Volume During Storm[C] (ft^3)	Total Volume Reduction[D] (ft^3)
Porous Pavement					
Infiltration Basin					
Subsurface Infiltration Bed					
Infiltration Trench					
Bioretention					
Dry Well					
Vegetated Swale					
Retentive Grading					
Vegetated Roof			N/A	N/A	
Capture and Re-use			N/A	N/A	

Total Volume Reduction Credit by Proposed Structural BMPs (ft^3): -

Runoff Volume Increase (cubic feet): _____

* Optional information

**** FOR PERMANENTLY REMOVED VOLUME ONLY, TEMPORARY DETENTION VOLUMES ARE NOT INCLUDED HERE. PERMANENTLY REMOVED STORAGE NOT TO BE INCLUDED IN PEAK DISCHARGE DETENTION CALCULATIONS**

[A] Follow design guidance and Protocols from Manual for each Structural BMP type

[B] Storage volume as defined in individual BMP writeups found in the Low Impact Development for Michigan- this represents permanently removed volume, not detention storage

[C] Can be approximated as the average design infiltration rate over 6 hours multiplied by the BMP area:

Design Infiltration Rate x 6 hours x BMP Area x Unit Conversions = Infiltration Volume (ft^3)

[D] Total Volume Reduction is sum of Storage Volume and Infiltration Volume During Storm.

Other Proposed BMPs *Not Volume Reducing*	Area (ft^2)
Constructed Filter	
Constructed Wetlands	
Wet Detention Pond	
Dry Extended Detention Basin	
Water Quality Devices	
Level Spreader	

WORKSHEET 6. WATER QUALITY WORKSHEET

PROJECT: _____

This worksheet calculates water quality volume based on the criteria of 1 inch of runoff from the entire site pervious and impervious.

A	B		C	D	E	F
BMP Tributary Area[A]	**Total Disturbed Area (ft^2)**	**Impervious Area (ft^2)**	**Disturbed Pervious Area (ft^2)**	**Water Quality Volume for Impervious Area (ft^3)**	**Water Quality Volume for Pervious (ft^3)[B]**	**Total Water Quality Volume to BMPs (ft^3)[C]**
				Col B x 1 inch/12	**Col C x 1 inch/12**	**Col D + Col E**
A						
B						
C						
D						
E						
F						
G						
Totals:						

Total area: _____ acres Total Site: _____ acres (From WS 3)

A - Only indicate the areas tributary to a particular BMP. The sum of all areas shall equal the total site area used to calculate channel protection and flood control criteria.

If only 1 water quality BMP is proposed for a given area, then it must be rated "High" for TSS Removal **. A TSS removal of "High" indicates a minimum of 80% TSS removal.

Indicate below which areas are treated by

Through BMP	BMP	TSS Removal Rating[B]
	Bioretention	High
	Capture/Reuse	Medium
	Constructed Wetlands	High
	Wet Ponds	High
	Dry Ponds	Medium
	Constructed Filters	High
	Porous Pavement*	High
	Infiltration Systems*	High

Fill in other if not listed

If 2 or more water quality BMPs are proposed in series, any that are rated "Low/Medium" or better for TSS Removal are acceptable. List proposed BMPs here:

* Requires appropriate pretreatment to prevent clogging

** Proprietary, manufactured water quality devices are not acceptable unless they have been field tested by a third-party according to approved testing protocols.

WORKSHEET 7. Maximum Allowable Discharge and Detention Calculations

The Runoff Detention calculation is required for non-residential construction that results in an increase of impervious area greater than 1000 square feet

Purpose: Development typically includes impervious parking lots and roofs. Rain water that used to soak into the ground immediately runs off into storm sewers that were originally designed and installed to accommodate storm runoff from residential property. To assure that storm sewers are not overloaded, runoff from new development is limited.

PROJECT NAME: _____

SITE LOCATION: _____

Maximum Allowable Discharge[B]: _____ **ft^3/s**

Post-Development Conditions

Total Site Drainage Area[A]: _____ **acres** **Impervious :** _____ **acres**

Existing "C": _____ **Pervious :** _____ **acres**

DURATION (min)	Rainfall Intensity 100-year Storm[C] t(hr)	I(in/hr)	R(in)	Average Coefficient[D]	100-year Runoff[E] (ft^3)	Permitted Outflow[F] (ft^3)	Required Storage[G] (ft^3)
20	0.33	4.9 =	1.62				
30	0.5	3.85 =	1.93				
40	0.67	3.33 =	2.23				
50	0.83	2.83 =	2.35				
60	1	2.52 =	2.52				
90	1.5	1.92 =	2.88				
120	2	1.58 =	3.16				
24 hrs	24	0.23 =	5.52				

Pond Size Required (ft^3): _____

INSTRUCTIONS

A) SITE DRAINAGE AREAS shall be calculated in acres and divided into impervious and pervious areas.

B) MAXIMUM ALLOWABLE DISCHARGE (Q) (ft^3) shall be for a 2 yr, 24-hr storm

Q = C*I*A — C = 0.40 for Previously Develped areas

I=2.60 inches/hr — C = 0.15 for Previously Unevelped areas

A = Site Area in acres — or C = Design Value for storm system

C) Inches of rainfall, given for a 100 year storm, source: Rainfall Frequency Atlas of the Midwest by Floyd A. Huff and James R. Angel. Bulletin 71 (MCC Research Report 92-03). Midwestern Climate Center and Illinois State Water Survey. 1992.

D) AVERAGE COEFFICIENT for runoff, used for all durations, is calculated by the weighted average of pervious and impervious areas, using a pervious coefficient of 0.15 and an impervious coefficient of 0.90.

(ie: AVE COEF = (Impervious*0.90)+(Pervious*0.15)/Total Site Area)

E) Runoff: multiply the total site drainage area by the average coefficient then by inches of rainfall converted into feet, then by 43,560 to convert acres into square feet, result will be in cubic feet.

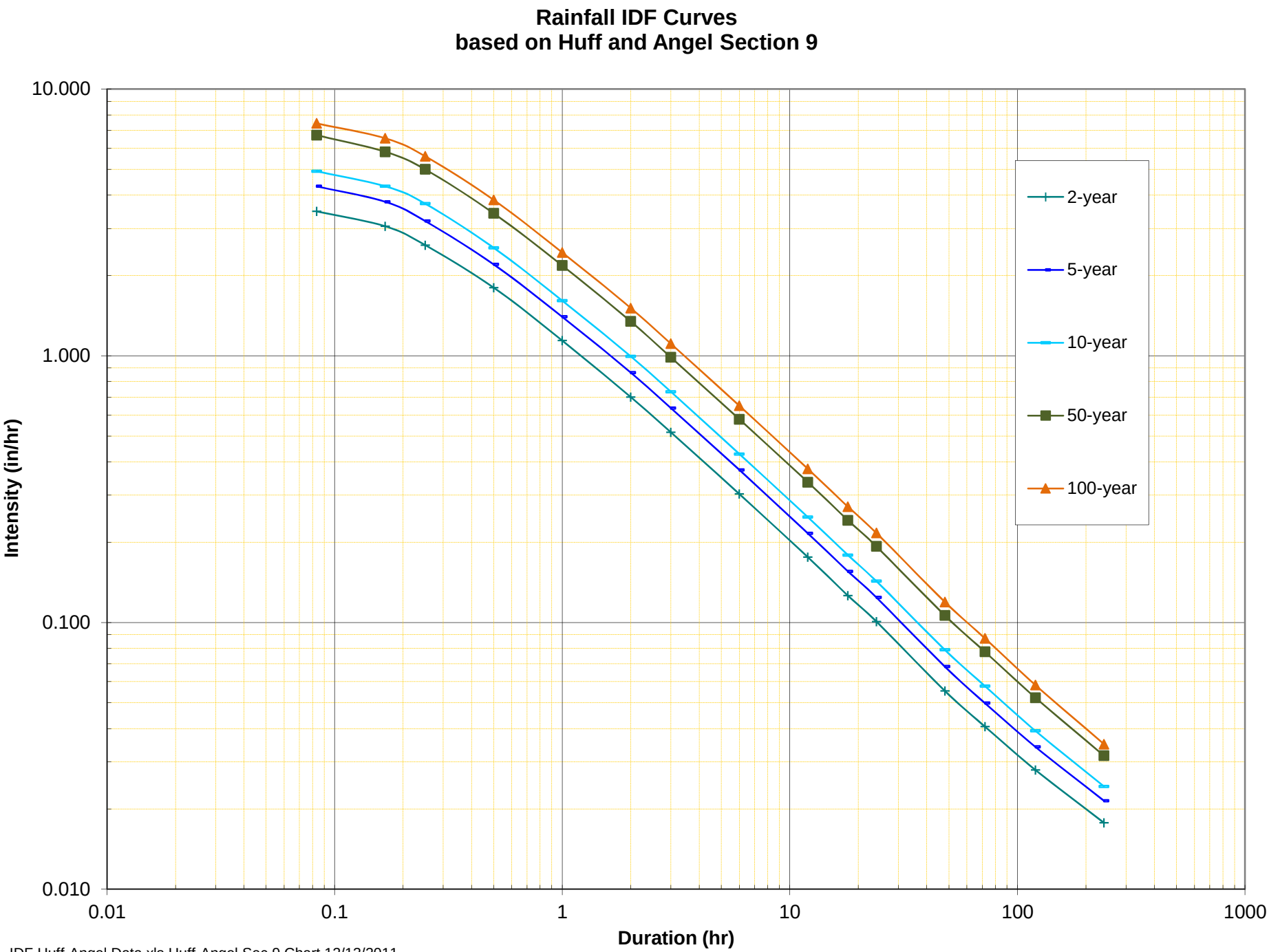
(ie: RUNOFF = DRAIN AREA*AVE COEF*(RAINFALL/12)*43560)

F) Permitted Outflow: Multiply maximum allowable outflow by time in hours, then by 3600

(ie: PERMITTED OUTFLOW = MAX ALLOWABLE DISCHARGE (FT^3/SEC)*TIME(HR)*3600(SEC/HR))

G) REQUIRED STORAGE: Subtract Permitted Outflow from 100-Year Runoff. Storage volume will increase to a peak and then decrease.

H) The Pond Size Required is the peak volume from the Required Storage column.



IDF Huff-Angel Data.xls Huff-Angel Sec 9 Chart 12/13/2011

City of Jackson
Department of Engineering

WORKSHEET 8. Criteria Summary Sheet

PROJECT:

Total Site Area	_____	acres	
Impervious	_____	acres	Pre-Development
	_____	acres	Post-Development
Pervious	_____	acres	Pre-Development
	_____	acres	Post-Development

Channel Protection Criteria

Criteria Satisfied?

Maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event.

Volume:

Pre-Development Volume	_____	ft^3	(From Worksheet 4A)
Post-Development Volume	_____	ft^3	(From Worksheet 4A)
Difference	_____	~~ft^4~~ ft3	
BMP Storage	_____	ft^3	(From Worksheet 5)

***Criteria for channel protection volume may be satisfied if the site provides adequate BMP storage to handle the increase in runoff from pre- to post-development conditions.** _____

Peak Flow Rate:

Pre-Development Peak Flow Rate	_____	ft^3/s	(From Worksheet 4B)
Post-Development Peak Flow Rate	_____	ft^3/s	(From Worksheet 4B)

*** Criteria for channel protection peak rate analysis may be satisfied if the post-development rate is less than the pre-development rate. If not, the criteria can be achieved if the development has included BMPs in the site plan.** _____

Flood Control Criteria

Structures are to be sized to accommodate a twenty-four-hour, fifty-year storm. Maximum allowable discharge is based on a thirty-minute, ten-year storm

Maximum Allowable Discharge	_____	ft^3 /sec	(From Worksheet 7)
Required Storage - Flood Control	_____	ft^3	(From Worksheet 7)
Excess BMP Storage	_____	ft^3	(BMP Storage-Ch. Pro. Vol)
On-Site Detention/Retention	_____	ft^3	Provide separate calculations.**
Volume Provided - Volume Required	_____	ft^3	(Excess BMP Storage+On-site storage-Flood Control volume requirements)

***Criteria for flood control may be satisfied if the site provides for enough storage to retain the post development runoff and to detain/retain the volume of water required to maintain the maximum allowable discharge. This may be completed through utilization of available BMP storage , including storage provided by any on-site re-/detention ponds.** _____

(Detention and discharge calculations should be submitted based upon selected detention method.

** Volume provided in sewer system through oversized piping, or non-BMP storage. Cannot apply towards channel protection.

Water Quality Criteria

Minimum of 80% removal of Total Suspended Solids (TSS), compared with uncontrolled runoff - or - Discharge concentrations of TSS not to exceed 80 (mg/l).

Water Quality Volume _____ ft^3 (From Worksheet 6) _____

Maintenance Criteria

All BMPs installed require a plan for maintaining maximum design performance through long-term operation and maintenance (O&M). An easment is necessary to perform periodic assessment of BMP condition.

O&M Plans Provided? Y / N

Easement Agreement? (Attach Signed Agreement) Y / N

Soil Erosion Control

Has a soil erosion control plan been developed and submitted? Y / N

Wetland Protection

Have acceptable wetland protection measures been taken? Y / N

APPENDIX B

Site Plan Examples

EXAMPLE #1 – Small Commercial Site (Total area < 1 acre)

DESCRIPTION:

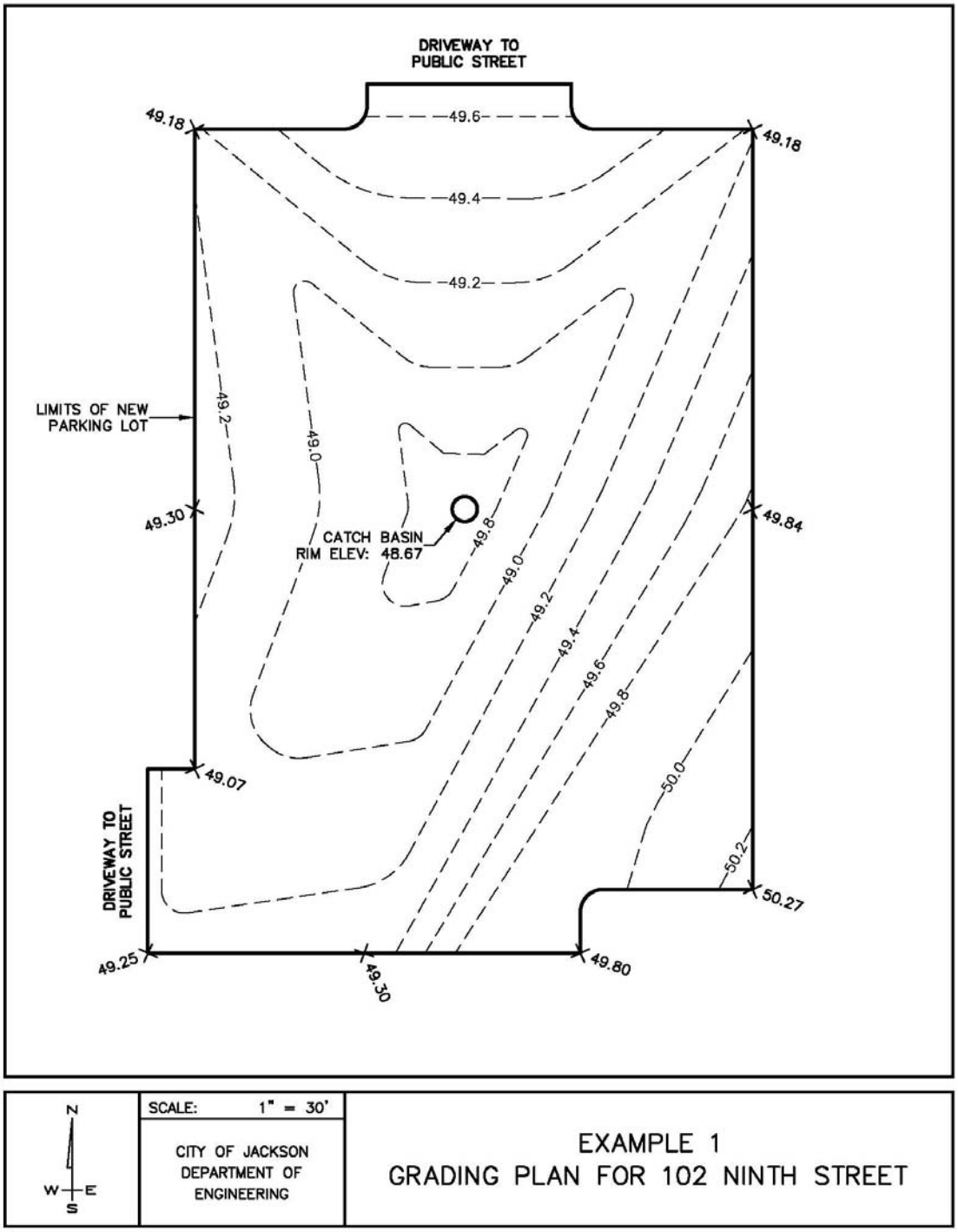
The owner of an office building at 102 Ninth Street needs additional parking. To this end, she has purchased an adjacent vacant lot for the purpose of building a parking lot. The 66 foot x 103 foot, approximately 0.156 acre lot was previously a house and garage which have since been demolished and left to seed. The new parking lot will be constructed to collect storm water runoff in a centrally located catch basin that will outlet to the City's storm sewer main under the adjacent street. The parking lot will be graded to retain the runoff on its surface. The outlet to the City storm sewer main will need to be restricted in the new catch basin to ensure that discharge to the sewer main does not exceed the allowable rate.

Around the perimeter of the new parking lot, a small band of grass and shrubs will be installed to meet the landscaping and screening requirements of the Zoning Ordinance. The remainder of the site will be hard surfaced with either asphalt or concrete. The grassed area of the developed site will be 1393 sft (0.032 acres). The hard surfaced area will be 5400 sft (0.124 acres).

Using this information in the City of Jackson's Runoff Detention Worksheet as shown below, it is determined that the required storage volume is 557 cft and the allowable discharge rate is 0.16 cfs.

STEPS REQUIRED:

1. For sites less than 1 acre, determine the increase in impervious area, if greater than 1000 sft, fill out Worksheet 7, for determining Runoff Detention. This will provide both the maximum allowable discharge rate for this site and the required on-site storage volume required for flood protection.
2. Use the site plan to determine the available on site storage volume.
3. Determine the high water elevation based on stored runoff.
4. Calculate the recommended outlet orifice size to maintain the maximum allowable discharge rate as stated on Worksheet 7.



Use the proposed grading plan to determine the post-development pervious and impervious areas. For this example, the areas were given in the narrative; however actual areas may be calculated

directly from a scaled drawing or done using computerized methods. Use these areas to fill out Worksheet 7, Runoff Detention as shown in the following example:
Worksheet 7 provides us with the following values:

Maximum Allowable Discharge = 0.16 cfs Required Storage = 557 cft

To determine if the site grading plan satisfies these requirements the applicant shall check if there is adequate storage available, and if any measures need to be taken to restrict the rate of flow from the site to the City storm sewer system.

With no on-site detention facilities, all runoff generated that is greater than the permitted outflow must be maintained on site. In this example, the applicant verifies the on-site storage capacity through using the contour lines as shown on the site grading plan. The amount of water that will pond and stay within the property limits can be found by starting at the catch basin rim and calculating the area at each contour up to the last one which lies completely within the site boundary, as shown in the table below.

Sample Calculation Table:

Elevation	Area (sft)	Δ H (ft)	Average Area (sft)	Volume (cft)	∑ Volume (cft)
49.2	3125	0.20	2125.5	425.1	565.9
49.0	1126	0.20	648.5	129.7	140.8
48.8	171	0.13	85.5	11.1	11.1
48.67	0				

Provided Storage Volume > Required Storage Volume
569.5 cft > 557 cft

-> Sufficient Storage Provided

To determine the high water elevation on the site during the event, interpolate using the provided and required volumes in the numerator and the provided elevations in the denominator to solve for the actual high water level:

$$\frac{(565.9 - 140.8)}{(49.2 - 49.0)} = \frac{(565.9-557)}{(49.2 - X)}$$

X = High water elevation = 49.2

In this example, there is no on-site detention so an orifice will be required on the catch basin discharge pipe to regulate the amount of flow discharging to the storm sewer system. The allowable area of an orifice can be calculated using the maximum allowable flow and high water elevation found above. Alternatively, on-site storm water control could be implemented, should the developer choose to do so, that will reduce the discharge rate to the desired level.

Example orifice calculation:

$A = Q/((0.62)*\sqrt{(2*g*h)})$

A = Area of outlet orifice, sft Q = Maximum allowable discharge = 0.16 cfs

g = Gravity = 32.2 h = average head = (2/3) *(49.2-45.12) = 2.72

$A = 0.16/((0.62)*\sqrt{(2*32.2*2.72)})$

A = 0.019 sft -> A 1.75-inch diameter opening has an area of 0.017 sft

-> Place a cap over the outlet pipe with a 1.75-inch diameter hole at the invert

WORKSHEET 7. Maximum Allowable Discharge and Detention Calculations

The Runoff Detention calculation is required for non-residential construction that results in an increase of impervious area greater than 1000 square feet

Purpose: Development typically includes impervious parking lots and roofs. Rain water that used to soak into the ground immediately runs off into storm sewers that were originally designed and installed to accommodate storm runoff from residential property. To assure that storm sewers are not overloaded, runoff from new development is limited.

PROJECT NAME: **Parking Lot**

SITE LOCATION: **102 Ninth Street**

Maximum Allowable Discharge[B]: **0.16224** **ft^3**

Post-Development Conditions

Total Site Drainage Area[A]: **0.156** **acres** **Impervious :** **0.125** **acres**

Existing "C": **0.4** **Pervious :** **0.031** **acres**

DURATION (min)	Rainfall Intensity 100-year Storm[C] t(hr)	I(in/hr)	R(in)	Average Coefficient[D]	100-year Runoff[E] (ft^3)	Permitted Outflow[F] (ft^3)	Required Storage[G] (ft^3)
20	0.33	4.9 =	1.62	0.75096	688.9	**192.74112**	**496.2**
30	0.5	3.85 =	1.93	0.75096	820.7	**292.032**	**528.7**
40	0.67	3.33 =	2.23	0.75096	948.3	**391.32288**	**557.0**
50	0.83	2.83 =	2.35	0.75096	999.3	**484.77312**	**514.6**
60	1	2.52 =	2.52	0.75096	1071.6	**584.064**	**487.6**
90	1.5	1.92 =	2.88	0.75096	1224.7	**876.096**	**348.6**
120	2	1.58 =	3.16	0.75096	1343.8	**1168.128**	**175.7**
24 hrs	24	0.23 =	5.52	0.75096	2347.4	**14017.536**	**-11670.1**

Pond Size Required (ft^3): **556.99**

INSTRUCTIONS

A) SITE DRAINAGE AREAS shall be calculated in acres and divided into impervious and pervious areas.

B) MAXIMUM ALLOWABLE DISCHARGE (Q) (ft^3) shall be for a 2 yr, 24-hr storm

Q = C*I*A — C = 0.40 for Previously Develped areas

I=2.60 inches/hr — C = 0.15 for Previously Unevelped areas

A = Site Area in acres — or C = Design Value for storm system

C) Inches of rainfall, given for a 100 year storm, source: Rainfall Frequency Atlas of the Midwest by Floyd A. Huff and James R. Angel. Bulletin 71 (MCC Research Report 92-03). Midwestern Climate Center and Illinois State Water Survey. 1992.

D) AVERAGE COEFFICIENT for runoff, used for all durations, is calculated by the weighted average of pervious and impervious areas, using a pervious coefficient of 0.15 and an impervious coefficient of 0.90.

(ie: AVE COEF = (Impervious*0.90)+(Pervious*0.15)/Total Site Area)

E) Runoff: multiply the total site drainage area by the average coefficient then by inches of rainfall converted into feet, then by 43,560 to convert acres into square feet, result will be in cubic feet.

(ie: RUNOFF = DRAIN AREA*AVE COEF*(RAINFALL/12)*43560)

F) Permitted Outflow: Multiply maximum allowable outflow by time in hours, then by 3600

(ie: PERMITTED OUTFLOW = MAX ALLOWABLE DISCHARGE (FT^3/SEC)*TIME(HR)*3600(SEC/HR))

G) REQUIRED STORAGE: Subtract Permitted Outflow from 100-Year Runoff. Storage volume will increase to a peak and then decrease.

H) The Pond Size Required is the peak volume from the Required Storage column.

Worksheet Comments: This worksheet indicates the amount of storage required on the site plan, and the maximum allowable discharge to the public storm sewer system.

EXAMPLE #2 – Large Commercial Site, Total area > 1 acre

DESCRIPTION:

A national tire retailer is redeveloping a 1.38 acre parcel that was previously the site of a car dealership. The 272 foot x 220.5 foot lot currently has an impervious area of approximately 0.5 acres consisting of a paved area with the remaining 0.88 acres of pervious surfaces evenly split between wooded and meadow areas. Upon completion of the development, the total impervious area of the proposed building, parking lot and pedestrian facilities will be increased to 0.825 acres.

Three variations of this site plan have been developed to display varying levels of Low Impact Development (LID) in order to meet the requirements of this ordinance, including:

- No LID elements applied – This site plan is of a typical storm sewer system that utilizes oversized 48" piping in order to satisfy maximum discharge limits and achieve detention requirements as established under previous standards.
- Some LID elements applied – This site plan incorporates some LID measures, but falls short of satisfying all ordinance requirements.
- LID design – This site plan contains a comprehensive LID design that will meet, and exceed the current ordinance requirements.

These examples have been attached at the end of this document. The following is a step by step walk through the process of successfully completing these worksheets.

<u>Worksheet #1 - General Watershed / Site Information</u>

Worksheet #1 is for general information about the site including owner identification and site location. Specific watershed information requested can be found for any site by utilizing the reference links embedded in the sheet. The information provided on this worksheet will be unique for any given site, and will change based on the type of development (LID or not).

<u>Worksheet #2 – Sensitive Natural Resources</u>

Worksheet #2 is used to collect information on the presence of any sensitive natural resources found within the limits of the site and a table to summarize if any of these areas are to be disturbed or not. This information is used in conjunction with Worksheet #3 to determine the actual area of the project to be managed for storm water control. Once the area to be protected or undisturbed

has been identified, it is deducted from the total area to be used for determining site runoff calculations. This area will not change based on the type of development.

Worksheet #3 – Runoff Reduction Credits

Worksheet #3 is used to determine if any non-structural Better Management Practices (BMPs) have been incorporated into the site plan. For calculation purposes, a non-structural BMP is one that alters the site hydrology to reduce runoff, rather than manage generated runoff. An example of a non-structural BMP would be to minimize soil compaction on the site. By doing this, the applicant can use an improved "credited" CN for use on Worksheet 4 for calculating the volume of runoff generated on the site.

Worksheet #4 – Calculations for Channel Protection Volume and Peak Flow Rate

Worksheet #4 is used to calculate the pre- and post-development runoff volumes based on areas of given surface types, and consists of worksheets 4A through D. On worksheet 4A, the applicant will complete the upper table for pre-development site conditions, and the lower table based on the proposed post-development conditions, and utilizing the areas with improved "CN" factors from Worksheet 3. If the difference between the pre- and post-development runoff volumes is positive, then that volume from Worksheet 4A is transferred to Worksheet 5 for use in determining whether the Channel Protection Criteria is satisfied. If the post-development runoff is less than the pre-development volume, then this criteria is satisfied. Worksheet 4B is for calculating the pre- and post-development peak flow rate. The peak flow rate analysis is based on a 1 year, 24-hour rainfall event, while the volume analysis is based on a 2 year, 24-hour event. Worksheets 4C and 4D must be completed in order for the calculations in worksheet 4B to work successfully. In cases where the site hydrology is too complicated, the applicant may submit a hydraulic model generated using a program such as EPA SWMM, or similar.

Worksheet #5 - Structural BMP Volume Reduction (Channel Protection)

When site development results in an increase of runoff generated, this runoff must be managed on-site to satisfy Channel Protection Criteria. A table is given on this worksheet with a listing of potential BMPs to be utilized on the site. The applicant will fill in only the areas applicable to BMPs incorporated into their site development, and perform the calculations showing that the BMPs to be implemented can provide enough volume reduction to match or exceed the increase in runoff generated by the site. A table is included on the bottom of the sheet for inclusion of

BMPs that do not treat volume, BMPs that actively decrease the volume of runoff through infiltration into the soils, capture and reuse or evaporation will not contribute to meeting the criteria for channel protection. If the post-development runoff is less than the pre-development volume, this worksheet may still be completed to demonstrate that the amount of on-site storage available in the proposed structural BMPs can be used for the Flood Control Criteria.

Worksheet #6 – Water Quality Worksheet

For a site to meet the criteria for water quality, the first 1-inch of runoff from all pervious and impervious areas on the site shall be treated to achieve 80% removal of total suspended solids (TSS). In order to ensure that all runoff on the site is treated, the site must be designed so that all tributary areas are directed through the appropriate BMPs needed to meet the criteria. The table at the top of the sheet is used to calculate individual tributary areas and the volume of water generated by each. The table at the bottom of the sheet lists the various BMPs and assigns each a TSS removal rating, where a rating of "High" indicates a removal of a minimum of 80% TSS removal. In order to satisfy the criteria for water quality, all on site generated runoff from the first 1-inch of rainfall must pass through one BMP rated High, or two BMPs rated Low or Medium in series.

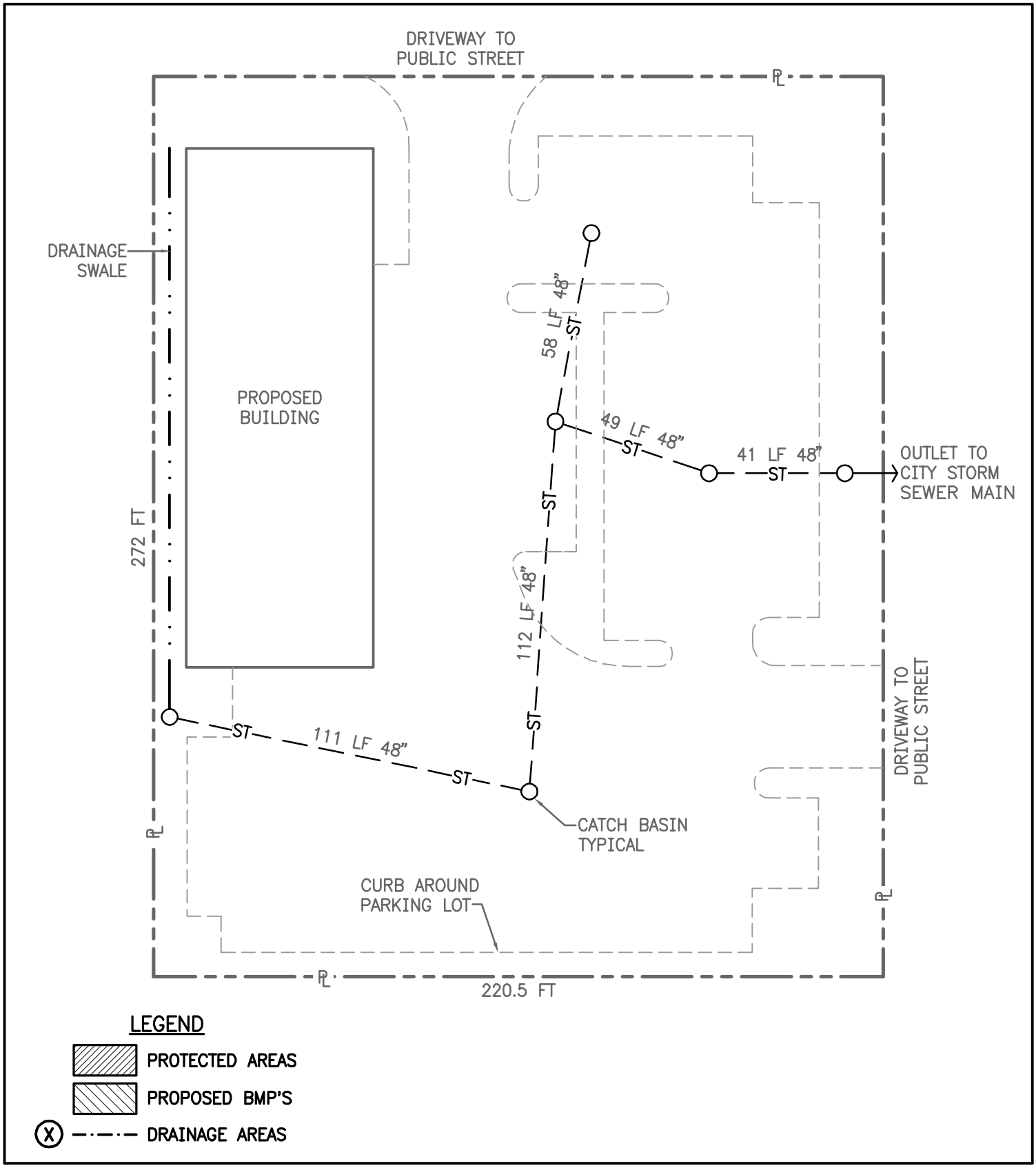
Worksheet #7 – Runoff Detention Calculation Worksheet (Flood Control)

The runoff detention calculation is required for any non-residential construction that results in an increase of impervious area greater than 1000 square feet. Using the instructions on the worksheet, the applicant will enter the site area and divide that into pervious and impervious segments. This will calculate the maximum allowable discharge rate from the site, in addition to the required volume of storage that needs to be available on the site in order to maintain that rate of discharge. The volume of storage required is based on the peak difference calculated between the 100-year runoff and the permitted outflow. Once this volume has been determined, the developer can use this figure to determine if enough on site storage capacity has been provided in the proposed structural BMPs, and/or on site detention. This will be summarized on Worksheet 8.

Worksheet #8 – Criteria Summary Sheet

This worksheet is used to summarize the calculations and results from Worksheets #1-7 to ensure that the site developer has submitted a plan that meets all three storm water criteria: channel protection (worksheets 4 & 5), flood control (worksheets 5 & 7), and water quality (worksheet 6). At the bottom of the worksheet is a section for Maintenance Criteria. This has been included to show that the applicant acknowledges that in order for BMPs to maintain long term operational

effectiveness, a plan for operating and maintaining these facilities needs to be in place. Also, an easement is granted to the City for inspection of on-site BMPs to ensure that the site owner does maintain all on site BMPs in satisfactory operating condition.



N W E S	CITY OF JACKSON DEPARTMENT OF ENGINEERING	EXAMPLE 2A – NO LID SITE PLAN FOR 1603 WISEMAN STREET

Worksheet 1. General Watershed/ Site Information

NOTE: If the project extends over more than 1 Watershed, fill out Worksheet 1 for each Watershed

Date: 8/18/2011

Project Name: Bob's Tire - No LID BMPs

Municipality: City of Jackson

County: Jackson County

Total Area (acres): 1.38

Major Watershed: Upper Grand Watershed 04050004

http://cfpub.epa.gov/surf/state.cfm?statepostal=MI

Subwatershed:

Nearest Surface Water(s) to Receive Runoff: Grand River

Part 4 - Designated Water Use: OSRW

http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714---,00.html (OSRW = Outstanding State Resource Waters)

Michigan Natural Rivers watershed?

http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442-95823--,00.html

Yes	
No	X

Impaired according to Chapter 303(d) List?

http://www.deq.state.mi.us/documents/deq-wb-intreport-appendixj.pdf

Yes	X
No	

List Causes of Impairment:

Areas of impairment not local to project

Is project subject to, or part of:

Phase I or Phase II Municipal Separate Storm Sewer System (MS4) Requirements? (Is site greater than 1 acre?)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html

Yes	X
No	

Existing or planned drinking water supply?

Yes	
No	X

If yes, distance from proposed discharge (miles): _____

Approved Watershed Management Plan?

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714_4012-95955--,00.html

Yes	X
No	

Worksheet Comments:

Information provided on this sheet will be the same for all examples.

Worksheet 2. Sensitive Natural Resources

Project: Bob's Tire (No LID BMPs)

INSTRUCTIONS:

1. Provide Sensitive Resources Map for the site. This map should identify waterbodies, floodplains, riparian areas, wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural features.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres).

3. Summarize total proposed Protected/Undisturbed Area. Use the following BMPs to define Protected/Undisturbed Area; protect sensitive areas, protect riparian buffers, protect natural flow pathways, cluster development, and minimize disturbed area.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once (include as either floodplain or wetland, not both).

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? (yes, no, n/a)	TOTAL AREA (Ac.)	PROTECTED/ UNDISTURBED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands			
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Special Habitat Areas			
Other:			
TOTAL EXISTING:		0	0

Worksheet Comments:

For this example, the developer did not identify any areas to protect during the project.

Worksheet 3. Runoff Reduction Credits

PROTECTED/ UNDISTURBED AREA

Protected/Undisturbed Area* (from WS 2) 0 **Ac.**

TOTAL PROPOSED PROTECTED/UNDISTURBED AREA 0 **Ac.**

Total Site Area	*minus*	Protected/ Undisturbed Area	*equals*	Disturbed Area (To be managed)
1.38	-	0	=	1.38

This is the area that requires stormwater management

Transfer to WS 4

NON STRUCTURAL BMP CREDITS**

BMP: Minimize Soil Compaction Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

BMP: Soil Amendment and Restoration Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Areas complying with the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a "Good" condition instead of "Fair" as required for other disturbed pervious areas. For example, lawn areas with B soils would be given a CN of 61 instead of 69; lawns with C soils a CN of 74 instead of 79. Curve Numbers were developed as part of the U.S. Soil Conservation Service TR-55 hydrologic analysis model.

Protect Existing Trees within Disturbed Area (part of Minimize Disturbed Area)

Number of Trees: -

Total Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Trees protected under the requirements of this BMP can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 800 SF per tree or the entire area of the tree canopies protected, whichever is greater.

BMPS: Native Revegetation and Riparian Corridor Restoration

Number of Trees: -

Number of Shrubs: -

Total Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Proposed trees and shrubs to be planted under the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 200 SF per tree or the estimated tree canopy, whichever is greater. For shrubs, an area of 25 SF per shrub.

** *A checklist is provided for each BMP in chapter 6 and 7 to ensure certain criteria is being met and credit can be given.*

City of Jackson
Department of Engineering

WORKSHEET 4A. Calculations for Channel Protection Volume

PROJECT NAME: Bob's Tire (No LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Total Site Area: 1.38 **acres**
Disturbed Area to be managed: 1.38 **acres** (From WS 3)

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.42**	**667**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**2.19**	**3,977**
Other:		**19166**	0.44	74	3.51	**0.56**	**900**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.11**	**5,545**

Post-Development Conditions**

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	**36154.8**	0.83	98	0.20	**2.19**	**6,602**
Grassland	C	**12196.8**	0.28	79	2.66	**0.78**	**797**
Woods	C	**11761.2**	0.27	73	3.70	**0.52**	**514**
		-		74	3.51	**0.56**	**0**
		-		70	4.29	**0.42**	**0**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.58**	**7,914**

Runoff Volume Increase (ft^3): **2,369** ***Transfer to WS 5***

Runoff Volume Increase = (Post-Dev. Runoff Volume) MINUS (Pre-Dev. Runoff Volume)

1. **Runoff (in)** = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where:
   - P = 2-Year, 24-Hour Rainfall (in)
   - S = 1000/ CN - 10
   - CN = Curve Number
   - Q = Runoff (in)
2. **Runoff Volume (ft^3)** = Q x 1/12 x Area — Area = Area of specific land cover (ft^2)

* Runoff Volume must be calculated separately for pervious and impervious areas (without using a weighted CN), unless Non-Structural BMP Rooftop/Downspout Disconnection is applied.

** Pre- and Post-development areas shall match. Post development conditions shall reflect non-structural BMPs applied on WS 3

Worksheet Comments: This shows that the post-development runoff will increase, volume is then transferred to Worksheet 5.

WORKSHEET 4B. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (No LID BMPs)

1-Year, 24-Hour Rainfall): 2.03 **in**

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.25**	**403**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**1.80**	**3,274**
Other:		**19166**	0.44	74	3.51	**0.36**	**581**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**0.85**	**4,258**

Post-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	36154.8	0.83	98	0.2	**1.80**	**5,436**
Grassland	C	12196.8	0.28	79	2.7	**0.54**	**549**
Woods	C	11761.2	0.27	73	3.7	**0.33**	**327**
		0				**2.03**	**0**
		0				**2.03**	**0**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.26**	**6,312**

Runoff Volume Increase (ft^3): 2,053

PEAK FLOW RATE ANALYSIS

(Use detailed information to complete Worksheets 4C & 4D, or use simplified Graphical Method below)

Storm Event	Duration (Hr)	Pre-Settlement Peak Discharge[A]	Post-Settlement Peak Discharge Rate	Difference (Post - Pre)	Are the criteria met? (Y/N)**
1-year	24	0.054	0.222	0.168	N
2-year	24	0.073	0.287	0.214	N

[A] Graphical Peak Discharge method = Qp = qu*A*Q

Where: Qp = Peak Discharge (cfs)

Qu = Unit Peak Discharge (csm/in)

A = Drainage Area (mi) Q = Runoff

*To determine Qu through graphical methods see Worksheets 4C & D, and attached figure assuming a minimum Time of Concentration of 6 minutes to fill out the table below for the peak flow table above.

Ia = 0.2*(1000/CN-10) Where : CN = weighted curve number P = Rainfall

	Weighted CN	I_a	I_a/P 1-yr, 24Hr	I_a/P 2-yr, 24Hr	qu 1-yr	qu 2-yr
Pre	81.4	0.4564	0.2248	0.1886	**353**	**366**
Post	89.3	0.2408	0.1186	0.0995	**980**	**1011**

** If the peak flow rate increases after development, then BMPs must be designed to address the increase.

Worksheet Comments: The peak flow rate for this site increases, requiring the installation of BMPs.

WORKSHEET 4C. Time of Concentration

PROJECT NAME: Bob's Tire (No LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Pre-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1 overland flow	0.24	300	0.01	0.87
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.87*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved				0.00
	Paved				0.00
				Shallow Concentrated Subtotal	*0.00*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Time of Concentration (hr)	**0.87**
				Adjusted Time of Concentration (hr)**	**0.87**

Post-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1	0.011	50	0.01	0.02
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.02*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved		0	0.01	0.00
	Paved		250	0.01	0.03
				Shallow Concentrated Subtotal	*0.03*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Total Time of Concentration (hr)	**0.05**
				Adjusted Time of Concentration (hr)**	**0.10**

*** minimum allowed Tc is 0.1hr; maximum allowable is 10 hrs*

Roughness Coefficient (Manning's n) for sheet flow

Surface Description	**n**
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	

Residue cover <= 20%	0.06
Residue cover > 20%	0.17
Grass	
Short grass prairie	0.15
Dense grassess	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods	
Light underbrush	0.4
Dense underbrush	0.8

WORKSHEET 4D. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (No LID BMPs)

PEAK FLOW RATE ANALYSIS

Storm Event	P (in)	Develop-ment	Tc (hr)[1]	Weighted Avg CN[2]	Ia/P[3]	Peak Unit qu (csm/in)[4]	Peak Runoff (cfs)[5]	Peak Runoff (cfs/ac)[6]
1-year 24-hour	2.03	Pre-	0.87	81.4	0.22	353	0.054	0.039
	2.03	Post-	0.10	89.3	0.12	980	0.222	0.161
2-year 24-hour	2.42	Pre-	0.87	81.4	0.19	366	0.073	0.053
	2.42	Post-	0.10	89.3	0.10	1011	0.287	0.208

1. From Worksheet 4C
2. From Worksheet 4B
3. From Worksheet 4B

4. Peak Unit qu (csm/in) =

```
10^((-2.744*(Ia/P)^3)+(0.312*(Ia/P)^2-(0.212*(Ia/P))+2.574)
+((5.5616*(Ia/P)^3)-(3.6065*(Ia/P)^2)+(0.686*(Ia/P))-0.6533)*LOG(Tc)
+((-6.2705*(Ia/P)^3)+(6.424*(Ia/P)^2)-(1.5281*(Ia/P))-0.00691)*(LOG(Tc)^2)
```

Where:
Ia/P = From Table above

5. Peak Runoff (cfs) =

$$\frac{(qu*A)}{640} * Q$$

Where:
qu = From Table above
A = Total site area, pre/post
Q = Total site runoff pre/post
(A & Q from Worksheet 4B)

6. Peak Runoff (cfs/ac) =

$$\frac{\text{Peak Runoff}}{A}$$

Where:
A = Total site area, pre/post
(A from Worksheet 4B)

Worksheet Comments:
Using the attached sheets and equations on worksheets 4C & 4D, the same conclusion that peak flow rate increases for the site after development.

WORKSHEET 5. STRUCTURAL BMP VOLUME REDUCTION**

PROJECT: Bob's Tire (No LID BMPs)

This worksheet is to be used to tabulate the volume reduction as a result of the installation of structural BMPs. To meet Channel Protection Criteria for volume reduction, the Permanently Removed Storage Volume will be considered as sufficient support documentation. The Infiltration Volume During Storm calculations may be provided in addition at the developer's discretion.

Runoff Volume Increase (cubic feet) *from Worksheet 4A* : 2,369

Proposed BMP[A]	Area (ft^2)	Permanently Removed Storage Volume[B] (ft^3)	*Ave. Design Infiltration Rate (in./hr.)	*Infiltration Volume During Storm[C] (ft^3)	Total Volume Reduction[D] (ft^3)
Porous Pavement					
Infiltration Basin					
Subsurface Infiltration Bed					
Infiltration Trench					
Bioretention					
Dry Well					
Vegetated Swale					
Retentive Grading					
Vegetated Roof			N/A	N/A	
Capture and Re-use			N/A	N/A	

Total Volume Reduction Credit by Proposed Structural BMPs (ft^3): -

Runoff Volume Increase (cubic feet) *from Worksheet 4* : 2,369

* Optional information

**** FOR PERMANENTLY REMOVED VOLUME ONLY, TEMPORARY DETENTION VOLUMES ARE NOT INCLUDED HERE. PERMANENTLY REMOVED STORAGE NOT TO BE INCLUDED IN PEAK DISCHARGE DETENTION CALCULATIONS**

[A] Follow design guidance and Protocols from Manual for each Structural BMP type

[B] Storage volume as defined in individual BMP writeups found in the Low Impact Development for Michigan- this represents permanently removed volume, not detention storage

[C] Can be approximated as the average design infiltration rate over 6 hours multiplied by the BMP area:

Design Infiltration Rate x 6 hours x BMP Area x Unit Conversions = Infiltration Volume (ft^3)

[D] Total Volume Reduction is sum of Storage Volume and Infiltration Volume During Storm.

Other Proposed BMPs *Not Volume Reducing*	Area (ft^2)
Constructed Filter	
Constructed Wetlands	
Wet Detention Pond	
Dry Extended Detention Basin	
Water Quality Devices	
Level Spreader	

Worksheet Comments: This example provides no BMP storage and will not satisfy the criteria.

WORKSHEET 6. WATER QUALITY WORKSHEET

PROJECT: Bob's Tire (No LID BMPs)

This worksheet calculates water quality volume based on the criteria of 1 inch of runoff from the entire site pervious and impervious.

A	-B- B	C	D	E	F
BMP Tributary Area[A]	**Total Disturbed Area (ft^2)**	**Impervious Area (ft^2)**	**Disturbed Pervious Area (ft^2)**	**Water Quality Volume for Impervious Area (ft^3)**	**Water Quality Volume for Pervious (ft^3)**	**Total Water Quality Volume to BMPs (ft^3)**
				Col B x 1 inch/12	**Col C x 1 inch/12**	**Col D + Col E**
A						
B						
C						
D						
E						
Totals:	0	0	0	0	0	0

A - Only indicate the areas tributary to a particular BMP. The sum of all areas shall equal the total site area used to calculate channel protection and flood control criteria.

If only 1 water quality BMP is proposed for a given area, then it must be rated "High" for TSS Removal **. A TSS removal of "High" indicates a minimum of 80% TSS removal.

Indicate below which areas are treated by

Tributary Areas Passing Through BMP	BMP	TSS Removal Rating
	Bioretention	High
	Capture/Reuse	Medium
	Constructed Wetlands	High
	Wet Ponds	High
	Dry Ponds	Medium
	Constructed Filters	High
	Porous Pavement*	High
	Infiltration Systems*	High

Fill in other if not listed

If 2 or more water quality BMPs are proposed in series, any that are rated "Low/Medium" or better for TSS Removal are acceptable. List proposed BMPs here:

* Requires appropriate pretreatment to prevent clogging

** Proprietary, manufactured water quality devices are not acceptable unless they have been field tested by a third-party according to approved testing protocols.

Worksheet Comments:

This example has no BMPs, therefore cannot meet the criteria for water quality.

WORKSHEET 7. Maximum Allowable Discharge and Detention Calculations

The Runoff Detention calculation is required for non-residential construction that results in an increase of impervious area greater than 1000 square feet

Purpose: Development typically includes impervious parking lots and roofs. Rain water that used to soak into the ground immediately runs off into storm sewers that were originally designed and installed to accommodate storm runoff from residential property. To assure that storm sewers are not overloaded, runoff from new development is limited.

PROJECT NAME: Bob's Tire (No LID BMPs)

SITE LOCATION: 1603 Wiseman Street

Maximum Allowable Discharge[B]: **1.4352** **ft^3/s**

Post-Development Conditions

Total Site Drainage Area[A]: **1.38** **acres** **Impervious :** **0.83** **acres**

Existing "C": **0.4** **Pervious :** **0.55** **acres**

DURATION (min)	Rainfall Intensity 100-year Storm[C] t(hr)	I(in/hr)	R(in)	Average Coefficient[D]	100-year Runoff[E] (ft^3)	Permitted Outflow[F] (ft^3)	Required Storage[G] (ft^3)
20	0.33	4.9 =	1.62	0.60109	4878.0	**1705.0176**	**3172.9**
30	0.5	3.85 =	1.93	0.60109	5811.4	**2583.36**	**3228.0**
40	0.67	3.33 =	2.23	0.60109	6714.7	**3461.7024**	**3253.0**
50	0.83	2.83 =	2.35	0.60109	7076.0	**4288.3776**	**2787.7**
60	1	2.52 =	2.52	0.60109	7587.9	**5166.72**	**2421.2**
90	1.5	1.92 =	2.88	0.60109	8671.9	**7750.08**	**921.8**
120	2	1.58 =	3.16	0.60109	9515.0	**10333.44**	**-818.4**
24 hrs	24	0.23 =	5.52	0.60109	16621.2	**124001.28**	**-107380.1**

Pond Size Required (ft^3): **3,253.02**

INSTRUCTIONS

A) SITE DRAINAGE AREAS shall be calculated in acres and divided into impervious and pervious areas.

B) MAXIMUM ALLOWABLE DISCHARGE (Q) (ft^3) shall be for a 2 yr, 24-hr storm

Q = C*I*A — C = 0.40 for Previously Develped areas

I=2.60 inches/hr — C = 0.15 for Previously Unevelped areas

A = Site Area in acres — or C = Design Value for storm system

C) Inches of rainfall, given for a 100 year storm, source: Rainfall Frequency Atlas of the Midwest by Floyd A. Huff and James R. Angel. Bulletin 71 (MCC Research Report 92-03). Midwestern Climate Center and Illinois State Water Survey. 1992.

D) AVERAGE COEFFICIENT for runoff, used for all durations, is calculated by the weighted average of pervious and impervious areas, using a pervious coefficient of 0.15 and an impervious coefficient of 0.90.

(ie: AVE COEF = (Impervious*0.90)+(Pervious*0.15)/Total Site Area)

E) Runoff: multiply the total site drainage area by the average coefficient then by inches of rainfall converted into feet, then by 43,560 to convert acres into square feet, result will be in cubic feet.

(ie: RUNOFF = DRAIN AREA*AVE COEF*(RAINFALL/12)*43560)

F) Permitted Outflow: Multiply maximum allowable outflow by time in hours, then by 3600

(ie: PERMITTED OUTFLOW = MAX ALLOWABLE DISCHARGE (FT^3/SEC)*TIME(HR)*3600(SEC/HR))

G) REQUIRED STORAGE: Subtract Permitted Outflow from 100-Year Runoff. Storage volume will increase to a peak and then decrease.

H) The Pond Size Required is the peak volume from the Required Storage column.

Worksheet Comments: Sheet calculates amount of detention storage required on the site, same for all examples. BMP storage in excess of what is required for channel protection on sheet 5 may be counted towards this volume.

City of Jackson
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WORKSHEET 8. Criteria Summary Sheet

PROJECT: Bob's Tire (No LID BMPs)

Total Site Area	**1.38**	acres	
Impervious	**0.5**	acres	Pre-Development
	0.88	acres	Post-Development
Pervious	**0.83**	acres	Pre-Development
	0.55	acres	Post-Development

Channel Protection Criteria

Criteria Satisfied?

Maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event.

Volume:

Pre-Development Volume	**5545**	ft^3	(From Worksheet 4A)
Post-Development Volume	**7914**	ft^3	(From Worksheet 4A)
Difference	**2369**	~~ft^4~~ ft3	
BMP Storage	**0**	ft^3	(From Worksheet 5)

***Criteria for channel protection volume may be satisfied if the site provides adequate BMP storage to handle the increase in runoff from pre- to post-development conditions.** **No**

Peak Flow Rate:

Pre-Development Peak Flow Rate	0.07 ~~**0.19**~~	ft^3/s	(From Worksheet 4B)
Post-Development Peak Flow Rate	0.29 ~~**0.28**~~	ft^3/s	(From Worksheet 4B)

*** Criteria for channel protection peak rate analysis may be satisfied if the post-development rate is less than the pre-development rate. If not, the criteria can be achieved if the development has included BMPs in the site plan.** **No**

Flood Control Criteria

Structures are to be sized to accommodate a twenty-four-hour, fifty-year storm. Maximum allowable discharge is based on a thirty-minute, ten-year storm

Maximum Allowable Discharge	**1.4**	ft^3 /sec	(From Worksheet 7)
Required Storage - Flood Control	**3253**	ft^3	(From Worksheet 7)
Excess BMP Storage	**0**	ft^3	(BMP Storage-Ch. Pro. Vol)
On-Site Detention/Retention	**4662****	ft^3	Provide separate calculations.**
Volume Provided - Volume Required	**1409**	ft^3	(Excess BMP Storage+On-site storage-Flood Control volume requirements)

***Criteria for flood control may be satisfied if the site provides for enough storage to retain the post development runoff and to detain/retain the volume of water required to maintain the maximum allowable discharge. This may be completed through utilization of available BMP storage , including storage provided by any on-site re-/detention ponds.** **Yes**

(Detention and discharge calculations should be submitted based upon selected detention method.

** Volume provided in sewer system through oversized piping, or non-BMP storage. Cannot apply towards channel protection.

Water Quality Criteria

Minimum of 80% removal of Total Suspended Solids (TSS), compared with uncontrolled runoff - or - Discharge concentrations of TSS not to exceed 80 (mg/l).

Water Quality Volume **0** ft^3 (From Worksheet 6) **No**

Maintenance Criteria

All BMPs installed require a plan for maintaining maximum design performance through long-term operation and maintenance (O&M). An easment is necessary to perform periodic assessment of BMP condition.

O&M Plans Provided? Y / **N**

Easement Agreement? (Attach Signed Agreement) Y / **N**

Soil Erosion Control

Has a soil erosion control plan been developed and submitted? **Y** / N

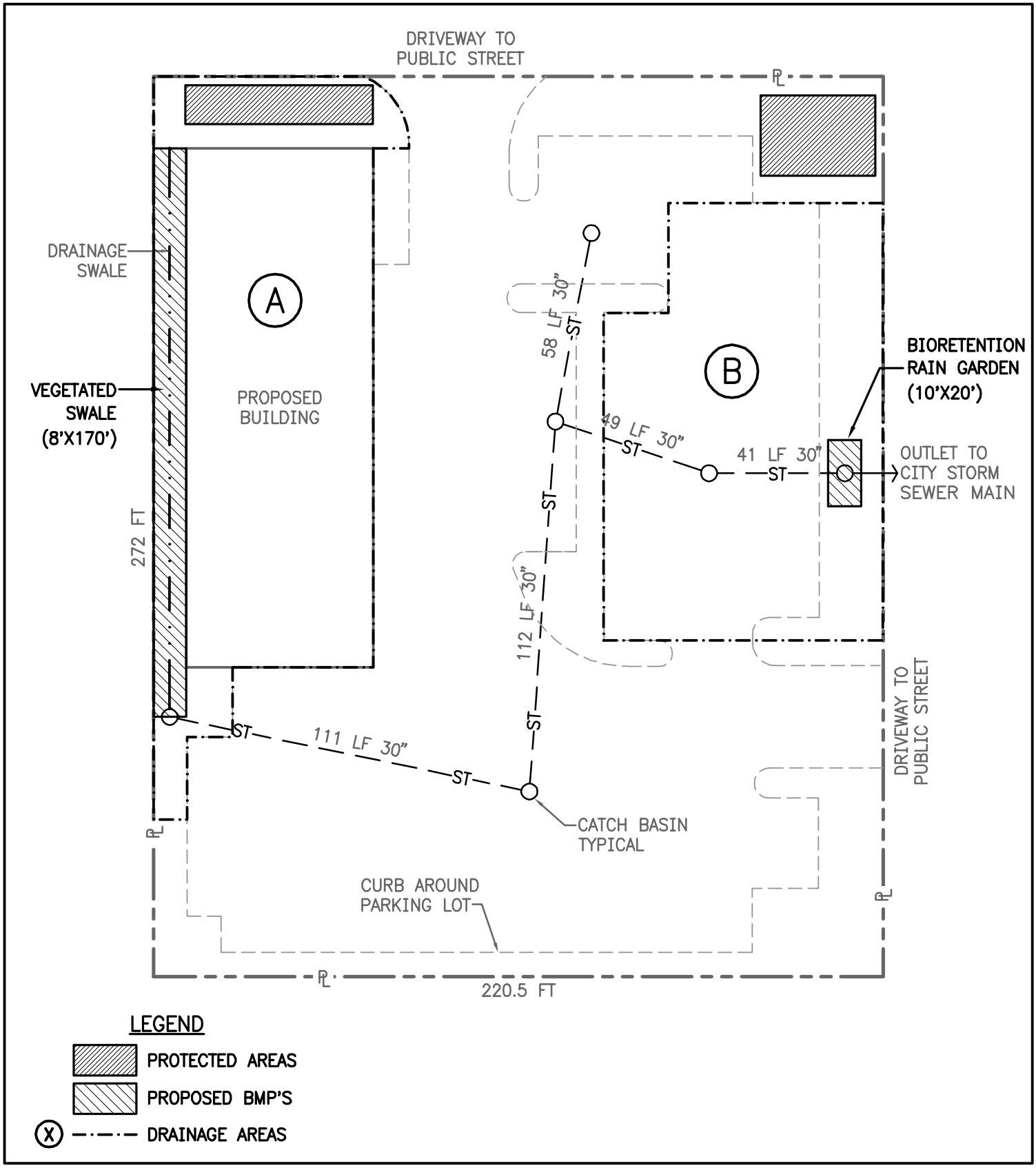
Wetland Protection

Have acceptable wetland protection measures been taken? **Y** / N

Worksheet Comments:

The site as designed will not meet the criteria for Channel Protection, Volume or Peak Flow Rate, or the Criteria for Water Quality.

The site does meet the Criteria for Flood Control based on the availability of storage within the oversized piping system.



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EXAMPLE 2B – SOME LID BMP'S
SITE PLAN FOR 1603 WISEMAN STREET

Worksheet 1. General Watershed/ Site Information

NOTE: If the project extends over more than 1 Watershed, fill out Worksheet 1 for each Watershed

Date: 8/18/2011

Project Name: Bob's Tire (Some LID BMPs)

Municipality: City of Jackson

County: Jackson County

Total Area (acres): 1.38

Major Watershed: Upper Grand Watershed 04050004

http://cfpub.epa.gov/surf/state.cfm?statepostal=MI

Subwatershed:

Nearest Surface Water(s) to Receive Runoff: Grand River

Part 4 - Designated Water Use:

http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714---,00.html

Michigan Natural Rivers watershed?

http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442-95823--,00.html

Yes	
No	X

Impaired according to Chapter 303(d) List?

http://www.deq.state.mi.us/documents/deq-wb-intreport-appendixj.pdf

Yes	X
No	

List Causes of Impairment:

Areas of impairment not local to project

Is project subject to, or part of:

Phase I or Phase II Municipal Separate Storm Sewer System (MS4) Requirements? (Is the site greater than 1 acre?)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html

Yes	X
No	

Existing or planned drinking water supply?

Yes	
No	X

If yes, distance from proposed discharge (miles):

Approved Watershed Management Plan?

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714_4012-95955--,00.html

Yes	X
No	

Worksheet 2. Sensitive Natural Resources

Project: Bob's Tire (Some LID BMPs)

INSTRUCTIONS:

1. Provide Sensitive Resources Map for the site. This map should identify waterbodies, floodplains, riparian areas, wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural features.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres).

Small wooded area identified on the site to be protected.

3. Summarize total proposed Protected/Undisturbed Area. Use the following BMPs to define Protected/Undisturbed Area; protect sensitive areas, protect riparian buffers, protect natural flow pathways, cluster development, and minimize disturbed area.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once (include as either floodplain or wetland, not both).

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? (yes, no, n/a)	TOTAL AREA (Ac.)	PROTECTED/ UNDISTURBED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands	Yes	0.06	0.03
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Special Habitat Areas			
Other:			
TOTAL EXISTING:		0.06	0.03

Worksheet Comments: This sheet indicates that the developer has identified 0.06 acres of the site to be an existing woodland, of which they intend to protect 0.03 acres. That area will be exempt from the site storm water calculations.

Worksheet 3. Runoff Reduction Credits

PROTECTED/ UNDISTURBED AREA

Protected/Undisturbed Area* (from WS 2) **0.03** **Ac.**

TOTAL PROPOSED PROTECTED/UNDISTURBED AREA **0.03** **Ac.**

Total Site Area	*minus*	Protected/ Undisturbed Area	*equals*	Disturbed Area (To be managed)
1.38	-	0.03	=	1.35

This is the area that requires stormwater management

Transfer to WS 4

NON STRUCTURAL BMP CREDITS**

BMP: Minimize Soil Compaction Area: 0.03 **Ac.**

Soil Type C Existing CN 79 Credited CN 74

BMP: Soil Amendment and Restoration Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Areas complying with the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a "Good" condition instead of "Fair" as required for other disturbed pervious areas. For example, lawn areas with B soils would be given a CN of 61 instead of 69; lawns with C soils a CN of 74 instead of 79.

Protect Existing Trees within Disturbed Area (part of Minimize Disturbed Area)

Number of Trees: 5

Total Area: 0.09 **Ac.**

Soil Type C Existing CN 73 Credited CN 70

Trees protected under the requirements of this BMP can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 800 SF per tree or the entire area of the tree canopies protected, whichever is greater.

BMPS: Native Revegetation and Riparian Corridor Restoration

Number of Trees: -

Number of Shrubs: -

Total Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Proposed trees and shrubs to be planted under the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 200 SF per tree or the estimated tree canopy, whichever is greater. For shrubs, an area of 25 SF per shrub.

** *A checklist is provided for each BMP in chapter 6 and 7 to ensure certain criteria is being met and credit can be given.*

Worksheet Comments: This worksheet shows that the developer is employing the non-structural BMPs of minimal soil compaction and protecting existing trees to improve the site CN used on Worksheet 4.

City of Jackson
Department of Engineering

WORKSHEET 4A. Calculations for Channel Protection Volume

PROJECT NAME: Bob's Tire (Some LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Total Site Area: 1.38 **acres**

Disturbed Area to be managed: 1.38 **acres** (From WS 3)

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.42**	**667**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**2.19**	**3,977**
Other:		**19166**	0.44	74	3.51	**0.56**	**900**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.11**	**5,545**

Post-Development Conditions**

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	**36154.8**	0.83	98	0.2	**2.19**	**6,602**
Grassland	C	**10890**	0.25	79	2.7	**0.78**	**712**
Woods	C	**7840.8**	0.18	73	3.7	**0.52**	**343**
Min soil compaction	C	**1306.8**	0.03	74	3.5	**0.56**	**61**
Protect ex. Trees	C	**3920.4**	0.09	70	4.3	**0.42**	**136**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.57**	**7,854**

Runoff Volume Increase (ft^3): **2,310** ***Transfer to WS 5***

Runoff Volume Increase = (Post-Dev. Runoff Volume) MINUS (Pre-Dev. Runoff Volume)

1. **Runoff (in)** = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where:
   - P = 2-Year, 24-Hour Rainfall (in)
   - S = 1000/ CN - 10
   - CN = Curve Number
   - Q = Runoff (in)
2. **Runoff Volume (ft^3)** = Q x 1/12 x Area — Area = Area of specific land cover (ft^2)

* Runoff Volume must be calculated separately for pervious and impervious areas (without using a weighted CN), unless Non-Structural BMP Rooftop/Downspout Disconnection is applied.

** Pre- and Post-development areas shall match. Post development conditions shall reflect non-structural BMPs applied on WS 3

Worksheet Comments: This shows that the post-development runoff will increase, volume is then transferred to Worksheet 5.

WORKSHEET 4B. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (Some LID BMPs)

1-Year, 24-Hour Rainfall): 2.03 **in**

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.25**	**403**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**1.80**	**3,274**
Other:		**19166**	0.44	74	3.51	**0.36**	**581**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**0.85**	**4,258**

Post-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	36154.8	0.83	98	0.2	**1.80**	**5,436**
Grassland	C	10890	0.25	79	2.7	**0.54**	**490**
Woods	C	7840.8	0.18	73	3.7	**0.33**	**218**
Min soil compaction	C	1306.8	0.03	74	3.5	**0.36**	**40**
Protect ex. Trees	C	3920.4	0.09	70	4.3	**0.25**	**82**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.25**	**6,266**

Runoff Volume Increase (ft^3): 2,008

PEAK FLOW RATE ANALYSIS

(Use detailed information to complete Worksheets 4C & 4D, or use simplified Graphical Method below)

Storm Event	Duration (Hr)	Pre-Settlement Peak Discharge[A]	Post-Settlement Peak Discharge Rate	Difference (Post - Pre)	Are the criteria met? (Y/N)**
1-year	24	0.054	0.219	0.165	N
2-year	24	0.073	0.283	0.210	N

[A] Graphical Peak Discharge method = Qp = qu*A*Q

Where: Qp = Peak Discharge (cfs)

Qu = Unit Peak Discharge (csm/in)

A = Drainage Area (mi) Q = Runoff

*To determine Qu through graphical methods see Worksheets 4C & D, and attached figure assuming a minimum Time of Concentration of 6 minutes to fill out the table below for the peak flow table above.

Ia = 0.2*(1000/CN-10) Where : CN = weighted curve number P = Rainfall

	Weighted CN	I_a	I_a/P 1-yr, 24Hr	I_a/P 2-yr, 24Hr	qu 1-yr	qu 2-yr
Pre	81.4	0.4564	0.2248	0.1886	**353**	**366**
Post	88.9	0.2485	0.1224	0.1027	**975**	**1005**

** If the peak flow rate increases after development, then BMPs must be designed to address the increase.

Worksheet Comments: The peak flow rate for this site increases, requiring the installation of BMPs.

WORKSHEET 4C. Time of Concentration

PROJECT NAME: Bob's Tire (Some LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Pre-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1 overland flow	0.24	300	0.01	0.87
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.87*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved				0.00
	Paved				0.00
				Shallow Concentrated Subtotal	*0.00*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Time of Concentration (hr)	**0.87**
				Adjusted Time of Concentration (hr)**	**0.87**

Post-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1	0.011	50	0.01	0.02
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.02*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved		0	0.01	0.00
	Paved		250	0.01	0.03
				Shallow Concentrated Subtotal	*0.03*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Total Time of Concentration (hr)	**0.05**
				Adjusted Time of Concentration (hr)**	**0.10**

*** minimum allowed Tc is 0.1hr; maximum allowable is 10 hrs*

Roughness Coefficient (Manning's n) for sheet flow

Surface Description	**n**
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	

Residue cover <= 20%	0.06
Residue cover > 20%	0.17
Grass	
Short grass prairie	0.15
Dense grassess	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods	
Light underbrush	0.4
Dense underbrush	0.8

WORKSHEET 4D. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (Some LID BMPs)

PEAK FLOW RATE ANALYSIS

Storm Event	P (in)	Develop-ment	Tc (hr)[1]	Weighted Avg CN[2]	Ia/P[3]	Peak Unit qu (csm/in)[4]	Peak Runoff (cfs)[5]	Peak Runoff (cfs/ac)[6]
1-year 24-hour	2.03	Pre-	0.87	81.4	0.22	353	0.054	0.039
	2.03	Post-	0.10	88.9	0.12	975	0.219	0.159
2-year 24-hour	2.42	Pre-	0.87	81.4	0.19	366	0.073	0.053
	2.42	Post-	0.10	88.9	0.10	1005	0.283	0.205

1. From Worksheet 4C
2. From Worksheet 4B
3. From Worksheet 4B

4. Peak Unit qu (csm/in) =

10^((-2.744*(Ia/P)^3)+(0.312*(Ia/P)^2-(0.212*(Ia/P))+2.574)
+((5.5616*(Ia/P)^3)-(3.6065*(Ia/P)^2)+(0.686*(Ia/P))-0.6533)*LOG(Tc)
+((-6.2705*(Ia/P)^3)+(6.424*(Ia/P)^2)-(1.5281*(Ia/P))-0.00691)*(LOG(Tc)^2)

Where:
Ia/P = From Table above

5. Peak Runoff (cfs) =

$$\frac{(qu*A)}{640} * Q$$

Where:
qu = From Table above
A = Total site area, pre/post
Q = Total site runoff pre/post
(A & Q from Worksheet 4B)

6. Peak Runoff (cfs/ac) =

$$\frac{\text{Peak Runoff}}{A}$$

Where:
A = Total site area, pre/post
(A from Worksheet 4B)

Worksheet Comments:
Using the attached sheets and equations on worksheets 4C & 4D, the same conclusion that peak flow rate increases for the site after development.

WORKSHEET 5. STRUCTURAL BMP VOLUME REDUCTION**

PROJECT: Bob's Tire (Some LID BMPs)

This worksheet is to be used to tabulate the volume reduction as a result of the installation of structural BMPs. To meet Channel Protection Criteria for volume reduction, the Permanently Removed Storage Volume will be considered as sufficient support documentation. The Infiltration Volume During Storm calculations may be provided in addition at the developer's discretion.

Runoff Volume Increase (cubic feet) *from Worksheet 4A* : 2,310

Proposed BMP[A]	Area (ft^2)	Permanently Removed Storage Volume[B] (ft^3)	*Ave. Design Infiltration Rate (in./hr.)	*Infiltration Volume During Storm[C] (ft^3)	Total Volume Reduction[D] (ft^3)
Porous Pavement					0
Infiltration Basin					0
Subsurface Infiltration Bed					0
Infiltration Trench					0
Bioretention	200	180			180
Dry Well					0
Vegetated Swale	1360	1031			1031
Retentive Grading					0
Vegetated Roof			N/A	N/A	0
Capture and Re-use			N/A	N/A	0

Total Volume Reduction Credit by Proposed Structural BMPs (ft^3): 1,211

Runoff Volume Increase (cubic feet): 1,099

* Optional information

**** FOR PERMANENTLY REMOVED VOLUME ONLY, TEMPORARY DETENTION VOLUMES ARE NOT INCLUDED HERE. PERMANENTLY REMOVED STORAGE NOT TO BE INCLUDED IN PEAK DISCHARGE DETENTION CALCULATIONS**

[A] Follow design guidance and Protocols from Manual for each Structural BMP type

[B] Storage volume as defined in individual BMP writeups found in the Low Impact Development for Michigan- this represents permanently removed volume, not detention storage

[C] Can be approximated as the average design infiltration rate over 6 hours multiplied by the BMP area:

Design Infiltration Rate x 6 hours x BMP Area x Unit Conversions = Infiltration Volume (ft^3)

[D] Total Volume Reduction is sum of Storage Volume and Infiltration Volume During Storm.

Other Proposed BMPs *Not Volume Reducing*	Area (ft^2)
Constructed Filter	
Constructed Wetlands	
Wet Detention Pond	
Dry Extended Detention Basin	
Water Quality Devices	
Level Spreader	

Worksheet Comments: This example provides some BMP storage, but not enough to meet the criteria.

WORKSHEET 6. WATER QUALITY WORKSHEET

PROJECT: Bob's Tire (Some LID BMPs)

This worksheet calculates water quality volume based on the criteria of 1 inch of runoff from the entire site pervious and impervious.

A	~~B~~ B		C	D	E	F
BMP Tributary Area[A]	**Total Disturbed Area (ft^2)**	**Impervious Area (ft^2)**	**Disturbed Pervious Area (ft^2)**	**Water Quality Volume for Impervious Area (ft^3)**	**Water Quality Volume for Pervious (ft^3)**	**Total Water Quality Volume to BMPs (ft^3)**
				Col B x 1 inch/12	**Col C x 1 inch/12**	**Col D + Col E**
A	12380	9280	3100	773	258	1032
B	10750	7150	3600	596	300	896
C				0	0	0
D				0	0	0
E				0	0	0
Totals:	23130	16430	6700	1369	558	**1928**

Total area: 0.53 acres Total Site: 1.38 acres (From WS 3)

A - Only indicate the areas tributary to a particular BMP. The sum of all areas shall equal the total site area used to calculate channel protection and flood control criteria.

If only 1 water quality BMP is proposed for a given area, then it must be rated "High" for TSS Removal **. A TSS removal of "High" indicates a minimum of 80% TSS removal.

Indicate below which areas are treated by

Tributary Areas Passing Through BMP	BMP	TSS Removal Rating
B	**Bioretention**	High
	Capture/Reuse	Medium
A	**Constructed Wetlands**	High
	Wet Ponds	High
	Dry Ponds	Medium
	Constructed Filters	High
	Porous Pavement*	High
	Infiltration Systems*	High

Fill in other if not listed

If 2 or more water quality BMPs are proposed in series, any that are rated "Low/Medium" or better for TSS Removal are acceptable. List proposed BMPs here:

* Requires appropriate pretreatment to prevent clogging

** Proprietary, manufactured water quality devices are not acceptable unless they have been field tested by a third-party according to approved testing protocols.

Worksheet Comments:

This example has BMPs, but runoff from only .53 out of the total 1.38 acres of the site passes through a BMP, meaning the site doesn't meet the water quality criteria.

WORKSHEET 7. Maximum Allowable Discharge and Detention Calculations

The Runoff Detention calculation is required for non-residential construction that results in an increase of impervious area greater than 1000 square feet

Purpose: Development typically includes impervious parking lots and roofs. Rain water that used to soak into the ground immediately runs off into storm sewers that were originally designed and installed to accommodate storm runoff from residential property. To assure that storm sewers are not overloaded, runoff from new development is limited.

PROJECT NAME: Bob's Tire (Some LID BMPs)

SITE LOCATION: 1603 Wiseman

Maximum Allowable Discharge[B]: **1.4352** **ft^3/s**

Post-Development Conditions

Total Site Drainage Area[A]: **1.38** **acres** **Impervious :** **0.83** **acres**

Existing "C": **0.4** **Pervious :** **0.55** **acres**

DURATION (min)	Rainfall Intensity 100-year Storm[C] t(hr)	I(in/hr)	R(in)	Average Coefficient[D]	100-year Runoff[E] (ft^3)	Permitted Outflow[F] (ft^3)	Required Storage[G] (ft^3)
20	0.33	4.9 =	1.62	0.60109	4878.0	**1705.0176**	**3172.9**
30	0.5	3.85 =	1.93	0.60109	5811.4	**2583.36**	**3228.0**
40	0.67	3.33 =	2.23	0.60109	6714.7	**3461.7024**	**3253.0**
50	0.83	2.83 =	2.35	0.60109	7076.0	**4288.3776**	**2787.7**
60	1	2.52 =	2.52	0.60109	7587.9	**5166.72**	**2421.2**
90	1.5	1.92 =	2.88	0.60109	8671.9	**7750.08**	**921.8**
120	2	1.58 =	3.16	0.60109	9515.0	**10333.44**	**-818.4**
24 hrs	24	0.23 =	5.52	0.60109	16621.2	**124001.28**	**-107380.1**

Pond Size Required (ft^3): **3,253.02**

INSTRUCTIONS

A) SITE DRAINAGE AREAS shall be calculated in acres and divided into impervious and pervious areas.

B) MAXIMUM ALLOWABLE DISCHARGE (Q) (ft^3) shall be for a 2 yr, 24-hr storm

Q = C*I*A — C = 0.40 for Previously Develped areas

I=2.60 inches/hr — C = 0.15 for Previously Unevelped areas

A = Site Area in acres — or C = Design Value for storm system

C) Inches of rainfall, given for a 100 year storm, source: Rainfall Frequency Atlas of the Midwest by Floyd A. Huff and James R. Angel. Bulletin 71 (MCC Research Report 92-03). Midwestern Climate Center and Illinois State Water Survey. 1992.

D) AVERAGE COEFFICIENT for runoff, used for all durations, is calculated by the weighted average of pervious and impervious areas, using a pervious coefficient of 0.15 and an impervious coefficient of 0.90.

(ie: AVE COEF = (Impervious*0.90)+(Pervious*0.15)/Total Site Area)

E) Runoff: multiply the total site drainage area by the average coefficient then by inches of rainfall converted into feet, then by 43,560 to convert acres into square feet, result will be in cubic feet.

(ie: RUNOFF = DRAIN AREA*AVE COEF*(RAINFALL/12)*43560)

F) Permitted Outflow: Multiply maximum allowable outflow by time in hours, then by 3600

(ie: PERMITTED OUTFLOW = MAX ALLOWABLE DISCHARGE (FT^3/SEC)*TIME(HR)*3600(SEC/HR))

G) REQUIRED STORAGE: Subtract Permitted Outflow from 100-Year Runoff. Storage volume will increase to a peak and then decrease.

H) The Pond Size Required is the peak volume from the Required Storage column.

Worksheet Comments: Sheet calculates amount of detention storage required on the site, same for all examples. BMP storage in excess of what is required for channel protection on sheet 5 may be counted towards this volume.

City of Jackson
Department of Engineering

WORKSHEET 8. Criteria Summary Sheet

PROJECT: Bob's Tire (Some LID BMPs)

Total Site Area	**1.38**	acres	
Impervious	**0.5**	acres	Pre-Development
	0.88	acres	Post-Development
Pervious	**0.83**	acres	Pre-Development
	0.55	acres	Post-Development

Channel Protection Criteria

Criteria Satisfied?

Maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event.

Volume:

Pre-Development Volume	**5545**	ft^3	(From Worksheet 4A)
Post-Development Volume	**7854**	ft^3	(From Worksheet 4A)
Difference	**2309**	~~ft^4~~ ft3	
BMP Storage	**1211**	ft^3	(From Worksheet 5)

***Criteria for channel protection volume may be satisfied if the site provides adequate BMP storage to handle the increase in runoff from pre- to post-development conditions.** **No**

Peak Flow Rate:

Pre-Development Peak Flow Rate	0.07 ~~**0.19**~~	ft^3/s	(From Worksheet 4B)
Post-Development Peak Flow Rate	0.28 ~~**0.281**~~	ft^3/s	(From Worksheet 4B)

*** Criteria for channel protection peak rate analysis may be satisfied if the post-development rate is less than the pre-development rate. If not, the criteria can be achieved if the development has included BMPs in the site plan.** **Yes**

Flood Control Criteria

Structures are to be sized to accommodate a twenty-four-hour, fifty-year storm. Maximum allowable discharge is based on a thirty-minute, ten-year storm

Maximum Allowable Discharge	**0.14**	ft^3 /sec	(From Worksheet 7)
Required Storage - Flood Control	**3253**	ft^3	(From Worksheet 7)
Excess BMP Storage	**(-1098)**	ft^3	(BMP Storage-Ch. Pro. Vol)
On-Site Detention/Retention	**1821****	ft^3	Provide separate calculations.**
Volume Provided - Volume Required	**(-2530)**	ft^3	(Excess BMP Storage+On-site storage-Flood Control volume requirements)

***Criteria for flood control may be satisfied if the site provides for enough storage to retain the post development runoff and to detain/retain the volume of water required to maintain the maximum allowable discharge. This may be completed through utilization of available BMP storage , including storage provided by any on-site re-/detention ponds.** **No**

(Detention and discharge calculations should be submitted based upon selected detention method.

** Volume provided in sewer system through oversized piping, or non-BMP storage. Cannot apply towards channel protection.

Water Quality Criteria

Minimum of 80% removal of Total Suspended Solids (TSS), compared with uncontrolled runoff - or - Discharge concentrations of TSS not to exceed 80 (mg/l).

Water Quality Volume **0** ft^3 (From Worksheet 6) **No**

Maintenance Criteria

All BMPs installed require a plan for maintaining maximum design performance through long-term operation and maintenance (O&M). An easment is necessary to perform periodic assessment of BMP condition.

O&M Plans Provided? **Y** / N

Easement Agreement? (Attach Signed Agreement) **Y** / N

Soil Erosion Control

Has a soil erosion control plan been developed and submitted? **Y** / N

Wetland Protection

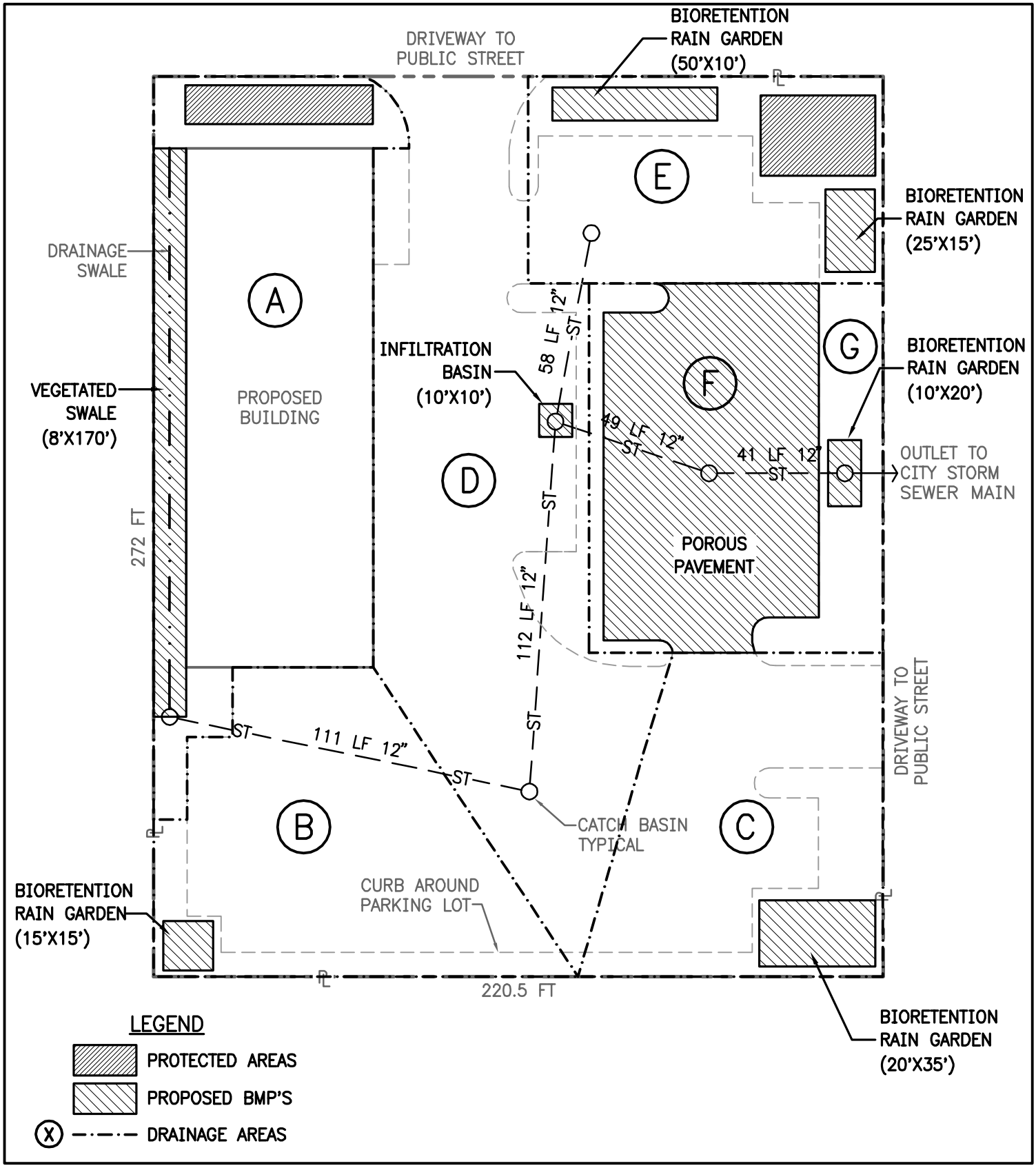
Have acceptable wetland protection measures been taken? **Y** / N

Worksheet Comments:

The site as designed will not meet the criteria for Channel Protection, Volume or Peak Flow Rate, or the Criteria for Water Quality.

The site does meet the Criteria for Flood Control based on the availability of storage within the oversized piping system.

The site does not meet the Water Quality Criteria, because all site runoff must br directed through a BMP.



N W E S	CITY OF JACKSON DEPARTMENT OF ENGINEERING	EXAMPLE 2C – FULL LID BMP'S SITE PLAN FOR 1603 WISEMAN STREET

Worksheet 1. General Watershed/ Site Information

NOTE: If the project extends over more than 1 Watershed, fill out Worksheet 1 for each Watershed

Date: 8/18/2011

Project Name: Bob's Tire (Full LID BMPs)

Municipality: City of Jackson

County: Jackson County

Total Area (acres): 1.38

Major Watershed: Upper Grand Watershed 04050004

http://cfpub.epa.gov/surf/state.cfm?statepostal=MI

Subwatershed:

Nearest Surface Water(s) to Receive Runoff: Grand River

Part 4 - Designated Water Use:

http://www.michigan.gov/deq/0,4561,7-135-3313_3682_3714---,00.html

Michigan Natural Rivers watershed?

http://www.michigan.gov/dnr/0,1607,7-153-30301_31431_31442-95823--,00.html

Yes	
No	X

Impaired according to Chapter 303(d) List?

http://www.deq.state.mi.us/documents/deq-wb-intreport-appendixj.pdf

Yes	X
No	

List Causes of Impairment:

Areas of impairment not local to project

Is project subject to, or part of:

Phase I or Phase II Municipal Separate Storm Sewer System (MS4) Requirements? (Is the site greater than 1 acre?)

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3716-24366--,00.html

Yes	X
No	

Existing or planned drinking water supply?

Yes	
No	X

If yes, distance from proposed discharge (miles):

Approved Watershed Management Plan?

http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714_4012-95955--,00.html

Yes	X
No	

Worksheet 2. Sensitive Natural Resources

Project: Bob's Tire (Full LID BMPs)

INSTRUCTIONS:

1. Provide Sensitive Resources Map for the site. This map should identify waterbodies, floodplains, riparian areas, wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural features.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres).

Small wooded area identified on the site to be protected.

3. Summarize total proposed Protected/Undisturbed Area. Use the following BMPs to define Protected/Undisturbed Area; protect sensitive areas, protect riparian buffers, protect natural flow pathways, cluster development, and minimize disturbed area.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once (include as either floodplain or wetland, not both).

EXISTING NATURAL SENSITIVE RESOURCE	MAPPED? (yes, no, n/a)	TOTAL AREA (Ac.)	PROTECTED/ UNDISTURBED AREA (Ac.)
Waterbodies			
Floodplains			
Riparian Areas			
Wetlands			
Woodlands	Yes	0.06	0.05
Natural Drainage Ways			
Steep Slopes, 15% - 25%			
Steep Slopes, over 25%			
Special Habitat Areas			
Other:			
TOTAL EXISTING:		0.06	0.05

Worksheet Comments: This sheet indicates that the developer has identified 0.06 acres of the site to be an existing woodland, of which they intend to protect 0.05 acres. That area will be exempt from the site storm water calculations.

Worksheet 3. Runoff Reduction Credits

PROTECTED/ UNDISTURBED AREA

Protected/Undisturbed Area* (from WS 2) **0.03** **Ac.**

TOTAL PROPOSED PROTECTED/UNDISTURBED AREA **0.03** **Ac.**

Total Site Area	*minus*	Protected/ Undisturbed Area	*equals*	Disturbed Area (To be managed)
1.38	-	0.05	=	1.33

This is the area that requires stormwater management

Transfer to WS 4

NON STRUCTURAL BMP CREDITS**

BMP: Minimize Soil Compaction Area: 0.05 **Ac.**

Soil Type C Existing CN 79 Credited CN 74

BMP: Soil Amendment and Restoration Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Areas complying with the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a "Good" condition instead of "Fair" as required for other disturbed pervious areas. For example, lawn areas with B soils would be given a CN of 61 instead of 69; lawns with C soils a CN of 74 instead of 79.

Protect Existing Trees within Disturbed Area (part of Minimize Disturbed Area)

Number of Trees: 6

Total Area: 0.11 **Ac.**

Soil Type C Existing CN 73 Credited CN 70

Trees protected under the requirements of this BMP can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 800 SF per tree or the entire area of the tree canopies protected, whichever is greater.

BMPS: Native Revegetation and Riparian Corridor Restoration

Number of Trees: -

Number of Shrubs: -

Total Area: - **Ac.**

Soil Type - Existing CN - Credited CN -

Proposed trees and shrubs to be planted under the requirements of these BMPs can be assigned a Curve Number (CN) reflecting a Woods in "Good" condition for an area of 200 SF per tree or the estimated tree canopy, whichever is greater. For shrubs, an area of 25 SF per shrub.

** *A checklist is provided for each BMP in chapter 6 and 7 to ensure certain criteria is being met and credit can be given.*

Worksheet Comments: This worksheet shows that the developer is employing the non-structural BMPs of minimal soil compaction and protecting existing trees to improve the site CN used on Worksheet 4.

City of Jackson
Department of Engineering

WORKSHEET 4A. Calculations for Channel Protection Volume

PROJECT NAME: Bob's Tire (Full LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Total Site Area: 1.38 **acres**
Disturbed Area to be managed: 1.38 **acres** (From WS 3)

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.42**	**667**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**2.19**	**3,977**
Other:		**19166**	0.44	74	3.51	**0.56**	**900**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.11**	**5,545**

Post-Development Conditions**

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	**36154.8**	0.83	98	0.2	**2.19**	**6,602**
Grassland	C	**9583.2**	0.22	79	2.7	**0.78**	**626**
Woods	C	**7405.2**	0.17	73	3.7	**0.52**	**324**
Min soil compaction	C	**2178**	0.05	74	3.5	**0.56**	**102**
Protect ex. Trees	C	**4791.6**	0.11	70	4.3	**0.42**	**167**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.56**	**7,821**

Runoff Volume Increase (ft^3): **2,277** ***Transfer to WS 5***

Runoff Volume Increase = (Post-Dev. Runoff Volume) MINUS (Pre-Dev. Runoff Volume)

1. **Runoff (in)** = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where:
   - P = 2-Year, 24-Hour Rainfall (in)
   - S = 1000/ CN - 10
   - CN = Curve Number
   - Q = Runoff (in)
2. **Runoff Volume (ft^3)** = Q x 1/12 x Area — Area = Area of specific land cover (ft^2)

* Runoff Volume must be calculated separately for pervious and impervious areas (without using a weighted CN), unless Non-Structural BMP Rooftop/Downspout Disconnection is applied.

** Pre- and Post-development areas shall match. Post development conditions shall reflect non-structural BMPs applied on WS 3

Worksheet Comments: This shows that the post-development runoff will increase, volume is then transferred to Worksheet 5.

WORKSHEET 4B. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (Full LID BMPs)

1-Year, 24-Hour Rainfall): 2.03 **in**

Pre-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN (from TR-55)	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Woods / Meadow	A	**0**		30	23.3	**0.00**	**0**
Woods	B	**0**		55	8.2	**0.00**	**0**
Meadow	B	**0**		58	7.2	**0.00**	**0**
Woods	C	**19166**	**0.44**	70	4.3	**0.25**	**403**
Meadow	C	**0**		71	4.1	**0.00**	**0**
Woods	D	**0**		77	3.0	**0.00**	**0**
Meadow	D	**0**		78	2.8	**0.00**	**0**
Impervious	N/A	**21780**	**0.5**	98	0.20	**1.80**	**3,274**
Other:		**19166**	0.44	74	3.51	**0.36**	**581**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**0.85**	**4,258**

Post-Development Conditions

Cover Type	Soil Type	Area (sf)	Area (ac)	CN*	S	Q Runoff[1] (in)	Runoff Volume[2] (ft^3)
Impervious	C	**36154.8**	0.83	98	0.2	**1.80**	**5,436**
Grassland	C	**9583.2**	0.22	79	2.7	**0.54**	**431**
Woods	C	**7405.2**	0.17	73	3.7	**0.33**	**206**
Min soil compaction	C	**2178**	0.05	74	3.5	**0.36**	**66**
Protect ex. Trees	C	**4791.6**	0.11	70	4.3	**0.25**	**101**
TOTAL:	**N/A**	**60,113**	**1.38**	**N/A**	**N/A**	**1.25**	**6,239**

Runoff Volume Increase (ft^3): 1,981

PEAK FLOW RATE ANALYSIS

(Use detailed information to complete Worksheets 4C & 4D, or use simplified Graphical Method below)

Storm Event	Duration (Hr)	Pre-Settlement Peak Discharge[A]	Post-Settlement Peak Discharge Rate	Difference (Post - Pre)	Are the criteria met? (Y/N)**
1-year	24	0.054	0.218	0.164	N
2-year	24	0.073	0.281	0.208	N

[A] Graphical Peak Discharge method = Qp = qu*A*Q

Where: Qp = Peak Discharge (cfs)

Qu = Unit Peak Discharge (csm/in)

A = Drainage Area (mi) Q = Runoff

*To determine Qu through graphical methods see Worksheets 4C & D, and attached figure assuming a minimum Time of Concentration of 6 minutes to fill out the table below for the peak flow table above.

Ia = 0.2*(1000/CN-10) Where : CN = weighted curve number P = Rainfall

	Weighted CN	I_a	I_a/P 1-yr, 24Hr	I_a/P 2-yr, 24Hr	qu 1-yr	qu 2-yr
Pre	81.4	0.4564	0.2248	0.1886	**353**	**366**
Post	88.8	0.2525	0.1244	0.1043	**973**	**1002**

** If the peak flow rate increases after development, then BMPs must be designed to address the increase.

Worksheet Comments: The peak flow rate for this site increases, requiring the installation of BMPs.

WORKSHEET 4C. Time of Concentration

PROJECT NAME: Bob's Tire (Full LID BMPs)

2-Year, 24-Hour Rainfall): 2.42 **in**

Pre-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1 overland flow	0.24	300	0.01	0.87
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.87*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved				0.00
	Paved				0.00
				Shallow Concentrated Subtotal	*0.00*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Time of Concentration (hr)	**0.87**
				Adjusted Time of Concentration (hr)**	**0.87**

Post-Development Conditions

Sheet Flow	Surface Description	Manning	Flow length (ft)	Slope (ft/ft)	Tc (hr)
	1	0.011	50	0.01	0.02
	2				0.00
	3				0.00
				Sheet Flow Subtotal	*0.02*
Shallow Concentrated Flow	Surface Description		Flow length (ft)	Slope (ft/ft)	
	Unpaved		0	0.01	0.00
	Paved		250	0.01	0.03
				Shallow Concentrated Subtotal	*0.03*
Channel Flow	Surface Description	Velocity (fps)	Flow length (ft)		
	1				0.00
	2				0.00
	3				0.00
				Channel Flow Subtotal	*0.00*
				Total Time of Concentration (hr)	**0.05**
				Adjusted Time of Concentration (hr)**	**0.10**

*** minimum allowed Tc is 0.1hr; maximum allowable is 10 hrs*

Roughness Coefficient (Manning's n) for sheet flow

Surface Description	n
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover <= 20%	0.06
Residue cover > 20%	0.17
Grass	
Short grass prairie	0.15
Dense grassess	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods	
Light underbrush	0.4
Dense underbrush	0.8

WORKSHEET 4D. Calculations for Channel Protection Peak Flow Rate

PROJECT NAME: Bob's Tire (Full LID BMPs)

PEAK FLOW RATE ANALYSIS

Storm Event	P (in)	Develop-ment	Tc (hr)[1]	Weighted Avg CN[2]	Ia/P[3]	Peak Unit qu (csm/in)[4]	Peak Runoff (cfs)[5]	Peak Runoff (cfs/ac)[6]
1-year 24-hour	2.03	Pre-	0.87	81.4	0.22	353	0.054	0.039
	2.03	Post-	0.10	88.8	0.12	973	0.218	0.158
2-year 24-hour	2.42	Pre-	0.87	81.4	0.19	366	0.073	0.053
	2.42	Post-	0.10	88.8	0.10	1002	0.281	0.204

1. From Worksheet 4C
2. From Worksheet 4B
3. From Worksheet 4B

4. Peak Unit qu (csm/in) =

10^((-2.744*(Ia/P)^3)+(0.312*(Ia/P)^2-(0.212*(Ia/P))+2.574)
+((5.5616*(Ia/P)^3)-(3.6065*(Ia/P)^2)+(0.686*(Ia/P))-0.6533)*LOG(Tc)
+((-6.2705*(Ia/P)^3)+(6.424*(Ia/P)^2)-(1.5281*(Ia/P))-0.00691)*(LOG(Tc)^2)

Where:
Ia/P = From Table above

5. Peak Runoff (cfs) =

$$\frac{(qu*A)}{640} * Q$$

Where:
qu = From Table above
A = Total site area, pre/post
Q = Total site runoff pre/post
(A & Q from Worksheet 4B)

6. Peak Runoff (cfs/ac) =

$$\frac{\text{Peak Runoff}}{A}$$

Where:
A = Total site area, pre/post
(A from Worksheet 4B)

Worksheet Comments:

Using the attached sheets and equations on worksheets 4C & 4D, the same conclusion that peak flow rate increases for the site after development.

WORKSHEET 5. STRUCTURAL BMP VOLUME REDUCTION**

PROJECT: Bob's Tire (Full LID BMPs)

This worksheet is to be used to tabulate the volume reduction as a result of the installation of structural BMPs. To meet Channel Protection Criteria for volume reduction, the Permanently Removed Storage Volume will be considered as sufficient support documentation. The Infiltration Volume During Storm calculations may be provided in addition at the developer's discretion.

Runoff Volume Increase (cubic feet) *from Worksheet 4A* : 2,310

Proposed BMP[A]	Area (ft^2)	Permanently Removed Storage Volume[B] (ft^3)	*Ave. Design Infiltration Rate (in./hr.)	*Infiltration Volume During Storm[C] (ft^3)	Total Volume Reduction[D] (ft^3)
Porous Pavement	7150	2860			2860
Infiltration Basin	100	500			500
Subsurface Infiltration Bed					0
Infiltration Trench					0
Bioretention	2350	2115			2115
Dry Well					0
Vegetated Swale	1360	1031			1031
Retentive Grading					0
Vegetated Roof			N/A	N/A	0
Capture and Re-use			N/A	N/A	0

Total Volume Reduction Credit by Proposed Structural BMPs (ft^3): 6,506

Runoff Volume Increase (cubic feet): (4,196)

* Optional information

**** FOR PERMANENTLY REMOVED VOLUME ONLY, TEMPORARY DETENTION VOLUMES ARE NOT INCLUDED HERE. PERMANENTLY REMOVED STORAGE NOT TO BE INCLUDED IN PEAK DISCHARGE DETENTION CALCULATIONS**

[A] Follow design guidance and Protocols from Manual for each Structural BMP type

[B] Storage volume as defined in individual BMP writeups found in the Low Impact Development for Michigan- this represents permanently removed volume, not detention storage

[C] Can be approximated as the average design infiltration rate over 6 hours multiplied by the BMP area:
Design Infiltration Rate x 6 hours x BMP Area x Unit Conversions = Infiltration Volume (ft^3)

[D] Total Volume Reduction is sum of Storage Volume and Infiltration Volume During Storm.

Other Proposed BMPs *Not Volume Reducing*	Area (ft^2)
Constructed Filter	
Constructed Wetlands	
Wet Detention Pond	
Dry Extended Detention Basin	
Water Quality Devices	
Level Spreader	

Worksheet Comments: This example completely satisfies the criteria by supplying ample storage volume.

WORKSHEET 6. WATER QUALITY WORKSHEET

PROJECT: Bob's Tire (Full LID BMPs)

This worksheet calculates water quality volume based on the criteria of 1 inch of runoff from the entire site pervious and impervious.

A	-B- B	C	D	E	F
BMP Tributary Area[A]	**Total Disturbed Area (ft^2)**	**Impervious Area (ft^2)**	**Disturbed Pervious Area (ft^2)**	**Water Quality Volume for Impervious Area (ft^3)**	**Water Quality Volume for Pervious (ft^3)**	**Total Water Quality Volume to BMPs (ft^3)**
				Col B x 1 inch/12	**Col C x 1 inch/12**	**Col D + Col E**
A	12380	9280	3100	773	258	1032
B	8400	6400	2000	533	167	700
C	5700	3800	1900	317	158	475
D	16850	15500	1350	1292	113	1404
E	6825	3950	2875	329	240	569
F	7150	7150	0	596	0	596
G	2600	0	2600	0	217	217
Totals:	59905	46080	13825	3840	1152	**4992**

Total area: 1.38 acres Total Site: 1.38 acres (From WS 3)

A - Only indicate the areas tributary to a particular BMP. The sum of all areas shall equal the total site area used to calculate channel protection and flood control criteria.

If only 1 water quality BMP is proposed for a given area, then it must be rated "High" for TSS Removal **. A TSS removal of "High" indicates a minimum of 80% TSS removal.

Indicate below which areas are treated by

Tributary Areas Passing	BMP	TSS Removal Rating
B, C, E, G	**Bioretention**	High
	Capture/Reuse	Medium
A	**Constructed Wetlands**	High
	Wet Ponds	High
	Dry Ponds	Medium
	Constructed Filters	High
F	**Porous Pavement***	High
D	**Infiltration Systems***	High

Fill in other if not listed

If 2 or more water quality BMPs are proposed in series, any that are rated "Low/Medium" or better for TSS Removal are acceptable. List proposed BMPs here:

* Requires appropriate pretreatment to prevent clogging

** Proprietary, manufactured water quality devices are not acceptable unless they have been field tested by a third-party according to approved testing protocols.

Worksheet Comments:

This example demonstrates that all of the runoff generated on the site passes through a BMP rated "High", meaning that the water quality criteria has been achieved.

WORKSHEET 7. Maximum Allowable Discharge and Detention Calculations

The Runoff Detention calculation is required for non-residential construction that results in an increase of impervious area greater than 1000 square feet

Purpose: Development typically includes impervious parking lots and roofs. Rain water that used to soak into the ground immediately runs off into storm sewers that were originally designed and installed to accommodate storm runoff from residential property. To assure that storm sewers are not overloaded, runoff from new development is limited.

PROJECT NAME: Bob's Tire (Full LID BMPs)

SITE LOCATION: 1603 Wiseman

Maximum Allowable Discharge[B]: **1.4352** **ft^3/s**

Post-Development Conditions

Total Site Drainage Area[A]: **1.38** **acres** **Impervious :** **0.83** **acres**

Existing "C": **0.4** **Pervious :** **0.55** **acres**

DURATION (min)	Rainfall Intensity 100-year Storm[C] t(hr)	I(in/hr)	R(in)	Average Coefficient[D]	100-year Runoff[E] (ft^3)	Permitted Outflow[F] (ft^3)	Required Storage[G] (ft^3)
20	0.33	4.9 =	1.62	0.60109	4878.0	**1705.0176**	**3172.9**
30	0.5	3.85 =	1.93	0.60109	5811.4	**2583.36**	**3228.0**
40	0.67	3.33 =	2.23	0.60109	6714.7	**3461.7024**	**3253.0**
50	0.83	2.83 =	2.35	0.60109	7076.0	**4288.3776**	**2787.7**
60	1	2.52 =	2.52	0.60109	7587.9	**5166.72**	**2421.2**
90	1.5	1.92 =	2.88	0.60109	8671.9	**7750.08**	**921.8**
120	2	1.58 =	3.16	0.60109	9515.0	**10333.44**	**-818.4**
24 hrs	24	0.23 =	5.52	0.60109	16621.2	**124001.28**	**-107380.1**

Pond Size Required (ft^3): **3,253.02**

INSTRUCTIONS

A) SITE DRAINAGE AREAS shall be calculated in acres and divided into impervious and pervious areas.

B) MAXIMUM ALLOWABLE DISCHARGE (Q) (ft^3) shall be for a 2 yr, 24-hr storm

Q = C*I*A — C = 0.40 for Previously Develped areas

I=2.60 inches/hr — C = 0.15 for Previously Unevelped areas

A = Site Area in acres — or C = Design Value for storm system

C) Inches of rainfall, given for a 100 year storm, source: Rainfall Frequency Atlas of the Midwest by Floyd A. Huff and James R. Angel. Bulletin 71 (MCC Research Report 92-03). Midwestern Climate Center and Illinois State Water Survey. 1992.

D) AVERAGE COEFFICIENT for runoff, used for all durations, is calculated by the weighted average of pervious and impervious areas, using a pervious coefficient of 0.15 and an impervious coefficient of 0.90.

(ie: AVE COEF = (Impervious*0.90)+(Pervious*0.15)/Total Site Area)

E) Runoff: multiply the total site drainage area by the average coefficient then by inches of rainfall converted into feet, then by 43,560 to convert acres into square feet, result will be in cubic feet.

(ie: RUNOFF = DRAIN AREA*AVE COEF*(RAINFALL/12)*43560)

F) Permitted Outflow: Multiply maximum allowable outflow by time in hours, then by 3600

(ie: PERMITTED OUTFLOW = MAX ALLOWABLE DISCHARGE (FT^3/SEC)*TIME(HR)*3600(SEC/HR))

G) REQUIRED STORAGE: Subtract Permitted Outflow from 100-Year Runoff. Storage volume will increase to a peak and then decrease.

H) The Pond Size Required is the peak volume from the Required Storage column.

Worksheet Comments: Sheet calculates amount of detention storage required on the site, same for all examples. BMP storage in excess of what is required for channel protection on sheet 5 may be counted towards this volume.

City of Jackson
Department of Engineering

WORKSHEET 8. Criteria Summary Sheet

PROJECT: Bob's Tire (Full LID BMPs)

Total Site Area	**1.38**	acres	
Impervious	**0.5**	acres	Pre-Development
	0.88	acres	Post-Development
Pervious	**0.83**	acres	Pre-Development
	0.55	acres	Post-Development

Channel Protection Criteria

Criteria Satisfied?

Maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event.

Volume:

Pre-Development Volume	**5545**	ft^3		(From Worksheet 4A)
Post-Development Volume	**7821**	ft^3		(From Worksheet 4A)
Difference	2276 ~~**2369**~~	~~ft^4~~ ft3	B	
BMP Storage	**6506**	ft^3	A	(From Worksheet 5)

***Criteria for channel protection volume may be satisfied if the site provides adequate BMP storage to handle the increase in runoff from pre- to post-development conditions.** **Yes**

Peak Flow Rate:

Pre-Development Peak Flow Rate	0.07 ~~**0.19**~~	ft^3/s	(From Worksheet 4B)
Post-Development Peak Flow Rate	**0.28**	ft^3/s	(From Worksheet 4B)

*** Criteria for channel protection peak rate analysis may be satisfied if the post-development rate is less than the pre-development rate. If not, the criteria can be achieved if the development has included BMPs in the site plan.** **Yes**

Flood Control Criteria

Structures are to be sized to accommodate a twenty-four-hour, fifty-year storm. Maximum allowable discharge is based on a thirty-minute, ten-year storm

Maximum Allowable Discharge	**1.4**	ft^3 /sec		(From Worksheet 7)
Required Storage - Flood Control	**3253**	ft^3	E	(From Worksheet 7)
Excess BMP Storage	4230 ~~**4137**~~	ft^3	C	(BMP Storage-Ch. Pro. Vol) (A - B above)
On-Site Detention/Retention	**291****	ft^3	D	Provide separate calculations.**
Volume Provided - Volume Required	1268 ~~**1175**~~	ft^3		(Excess BMP Storage+On-site storage-Flood Control volume requirements) (C + D - E) more vol provided than req'd

***Criteria for flood control may be satisfied if the site provides for enough storage to retain the post development runoff and to detain/retain the volume of water required to maintain the maximum allowable discharge. This may be completed through utilization of available BMP storage , including storage provided by any on-site re-/detention ponds.** **Yes**

(Detention and discharge calculations should be submitted based upon selected detention method.

** Volume provided in sewer system through oversized piping, or non-BMP storage. Cannot apply towards channel protection.

Water Quality Criteria

Minimum of 80% removal of Total Suspended Solids (TSS), compared with uncontrolled runoff - or - Discharge concentrations of TSS not to exceed 80 (mg/l).

Water Quality Volume **4992** ft^3 (From Worksheet 6) **Yes**

must be greater than 1" over entire site

Maintenance Criteria

All BMPs installed require a plan for maintaining maximum design performance through long-term operation and maintenance (O&M). An easment is necessary to perform periodic assessment of BMP condition.

O&M Plans Provided? **Y** / N

Easement Agreement? (Attach Signed Agreement) **Y** / N

Soil Erosion Control

Has a soil erosion control plan been developed and submitted? **Y** / N

Wetland Protection

Have acceptable wetland protection measures been taken? **Y** / N

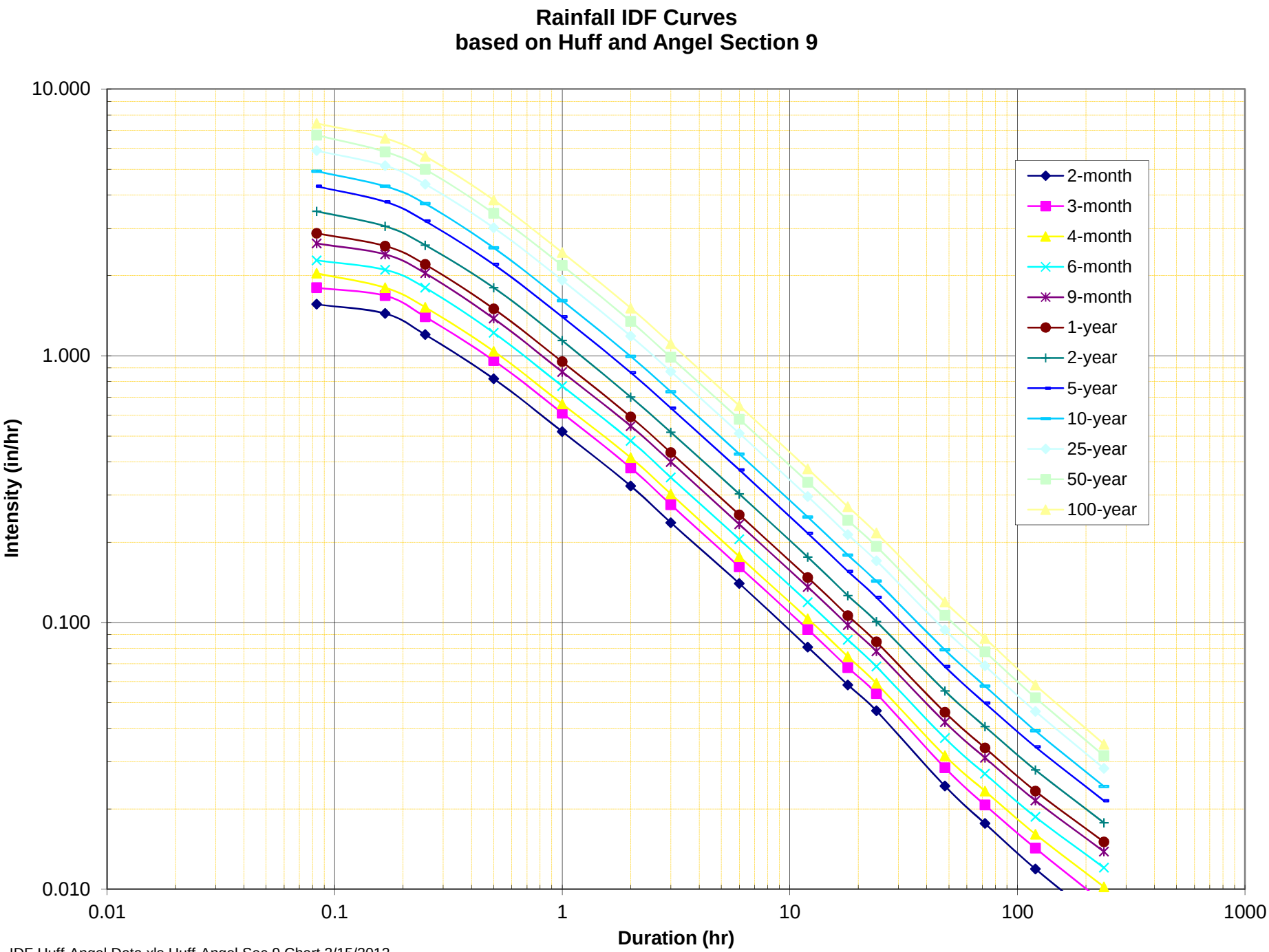
Worksheet Comments:

The site as designed will meet all criteria for Channel Protection, Flood Control and Water Quality.

The site utilizes extra storage available in the BMPs to demonstrate that there is enough volume available to account for both the Channel Protection and Flood Control Criteria.

FIGURE 1

Huff & Angel
Rainfall IDF Curves



IDF Huff-Angel Data.xls Huff-Angel Sec 9 Chart 2/15/2012

CITY OF JACKSON DEPARTMENT OF PUBLIC WORKS

APPLICATION AND PERMIT FOR CONSTRUCTION AND OPERATION OF A STORMWATER MANAGEMENT SYSTEM

_____
Permit No.

The applicant hereby applies for a permit to CONSTRUCT, OPERATE and MAINTAIN a Stormwater Management System within the City of Jackson at the location listed below and agrees to abide by the conditions set forth below:

LOCATION ADDRESS: _____

PARCEL ID NUMBER(S) _____

APPLICANT (PROPERTY OWNER) INFORMATION:		AUTHORIZED REPRESENTATIVE INFORMATION:	
Business Name:		Business Name	
Contact Name/Title:		Contact Name/Title:	
Address:		Address:	
City, State, ZIP:		City, State, ZIP:	
Phone:		Phone:	
Email:		Email:	
Signature:		Signature:	
Date:		Date:	

Will the proposed project disturb one (1) acre of land or more? ❒ No ❒ Yes

If no, is it a part or a phase of a larger project that, upon future completion, will have disturbed one (1) acre of land or more? ❒ No ❒ Yes

If yes to either of above, has a pre-application conference between the applicant and the City Engineer/Director of Public Works been held? ❒ No ❒ Yes If yes, on what date? _____

ATTACHED TO THE APPLICATION:

- ❒ Stormwater Management Plan
  Prepared by: _____ Dated: _____
- ❒ $_____ check payable to 'CITY OF JACKSON' for application review fee
- ❒ Copy of executed and recorded stormwater management easements
- ❒ Copies of recorded Operation and Maintenance (OM) plan for Stormwater Management System
- ❒ Certificate of Insurance in accordance with section 27-13b.b.12 of the City of Jackson Code of Ordinances
- ❒ Performance Bond in the amount of City Engineer/Dir. of Public Works approved estimated construction costs
- ❒ Copy of executed escrow fee acknowledgement form

APPLICANT (PROPERTY OWNER) PRE-CONSTRUCTION CERTIFICATION STATEMENT:

I, the undersigned, do hereby certify that all land disturbance activities, construction and drainage will be conducted in full compliance with the attached stormwater management plan.

_____ _____
Signature Date

OVER PLEASE

CITY OF JACKSON DEPARTMENT OF PUBLIC WORKS

APPLICATION AND PERMIT FOR CONSTRUCTION AND OPERATION OF A STORMWATER MANAGEMENT SYSTEM continued

_____
Permit No.

PERMIT APPROVAL (FOR CITY OF JACKSON USE ONLY)

CONDITIONS OF PERMIT:

1. If construction of the approved Stormwater Management System does not commence within one (1) year of the approval date or an extension is not approved by the City Engineer, the permit shall lapse and become invalid. All extensions shall expire within one (1) year.

2. This permit does not waive the necessity for obtaining other required federal, state and local permits.

3. The permittee shall provide written notice to the City Engineer one week prior to the commencement of earth disturbing activities on the subject property.

Other: _____

_____

_____

APPROVAL SIGNATURE: _____ **DATE:** _____

PRINTED NAME AND TITLE: _____

EXTENSION APPROVAL SIGNATURE: _____ **DATE:** _____

PRINTED NAME AND TITLE: _____

“SAMPLE ONLY”

ESCROW ACCOUNT FORM LETTER

(on banking institution stationary)

(Date)

City Engineer
City of Jackson Department of Engineering
521 Water Street
Jackson, MI 49201

Re: (Project Name/Phase)
(Project Address and Parcel ID Number)
(Escrow Account Number)

Dear (Sir or Madam):

Please be advised that $(Amount of Money) has been set aside in escrow to pay for the estimated costs and expenses of services by any City of Jackson personnel and/or any professional consultant deemed necessary by the City Engineer to adequately review the application for the construction and operation of a stormwater management system for the above referenced project. This money has been placed in the name of (Developer) under the account number (Account Number) as held by (Banking Institution Name).

This is to further advise that withdrawals will be allowed from this escrow account based on Section 27-133 of the City of Jackson Code of Ordinances. The City Engineer shall base withdrawals on the actual total costs of the services provided by City of Jackson personnel and professional consultants.

Sincerely,

By: _____ By: _____
(Bank Official and Title) (Developer & Title)

BOND _____

PERFORMANCE BOND
FOR
STORMWATER MANAGEMENT SYSTEM CONSTRUCTION)

KNOW ALL MEN BY THESE PRESENTS, that _____

Permittee, (hereinafter "Principal"), and _____,

(hereinafter "Surety"), are held and firmly bound unto THE CITY OF JACKSON, MICHIGAN, 161 West Michigan Avenue,

Jackson, MI 49201, (hereinafter "City"), in the sum of _____ to be paid to said City, its legal representatives and assigns, for which payment well and truly be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, and each and every one of them jointly, firmly by these presents.

Sealed with our seals and dated this _____ day of _____, 20_____.

WHEREAS, pursuant to Jackson City Code 27, Article 127 et. Seq., the above named Principal has obtained a Permit for the Construction of a Stormwater Management System from the City of Jackson, (hereinafter "Permit"), from the City

Engineer, dated this _____ day of _____, 20_____,

which authorized the said Principal to make excavations and construct a stormwater management system on certain properties located within the City of Jackson referenced in said Permit.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION IS SUCH that by and under said permit, the above named Principal has agreed to well and faithfully on all things fulfill the Permit according to the terms and conditions stipulated therein and comply with all applicable laws, regulations and guidelines and all directives of the City Engineer.

This obligation shall remain in full force and effect until the work and obligations required by the Permit have been satisfactorily completed and approved in writing by the City Engineer or his designee, at which time this obligation shall be null and void.

In case of failure to full fulfill the Permit within one (1) year of the Permit expiration date, then the City shall have the right to purchase such materials and employ such labor and equipment as may be necessary for the purpose, and to undertake, the construction of the permitted stormwater management system and/or stabilize the earth disturbance to the satisfaction of the City Engineer and charge the expense thereof to, and receive the same from said Principal and Surety, or either of them.

If, during the permitted construction, any repair or corrective action is necessary at once to the property referenced in the Permit to protect life and property, then and in that case, the said City may take immediate steps to repair or barricade such defects without notice to the Principal or Surety. In such accounting, the said City shall not be held to obtain the lowest figures for the doing of the work, or any part thereof, but all sums actually paid therefore shall be charged to the Principal and Surety, or either of them. In this connection, the judgment of the City is final and conclusive.

AND PROVIDED, that any alterations which may be made in the terms of said Permit, or in the work to be done under it, or in the event that the City shall grant any extension of time for the performance of said Permit or otherwise modify any elements of the Permit, or any forbearance on the part of either party to the other shall not in any way release the Principal and Surety, or either of them, from any liability hereunder, notice to the Surety of any such alterations, modifications, extension or forbearance being herby waived.

Said Principal and Surety, or either of them, shall fully indemnify, defend and save harmless said City from all suits and actions for damages of every name and description brought or claimed against it for or on account of any injury or damage to person or property received or sustained by any party or parties, by or from any of the acts or omissions or through negligence of said Principal, servants, agents, or employees in the prosecution of the work included in said Permit, and from any and all claims arising under the Workers' Compensation act, so-called, of the State of Michigan.

IN WITNESS THEREOF, the parties hereto have caused this instrument to be executed by their respective authorized officers, this _____ day of _____, 20 _____.

WITNESS:

_____ _____
Principal

By: _____

Its: _____

WITNESS:

_____ _____
Surety

By: _____
Attorney-in-fact

By: _____

Its: _____

_____
Address of Surety

_____
City State Zip

ATTACH POWER OF ATTORNEY

CITY OF JACKSON DEPARTMENT OF PUBLIC WORKS

POST CONSTRUCTION CERTIFICATION AND ACCEPTANCE OF A PERMITTED STORMWATER MANAGEMENT SYSTEM

_____
Permit No.

LOCATION ADDRESS: _____

PARCEL ID NUMBER(S) _____

PERMIT HOLDER (PROPERTY OWNER) INFORMATION	
Business Name:	
Contact Name/Title:	
Address:	
City, State, ZIP:	
Phone Number:	
Email Address:	

POST-CONSTRUCTION CERTIFICATION STATEMENT
(To be completed by a Professional Engineer registered in the State of Michigan)

Affix Licensed Professional Engineer seal here:

I, the undersigned, do hereby certify that

- All land disturbance activities and the construction of the stormwater management system including permanent turf establishment was completed on _____ (date); and
- Said construction was completed in full compliance with the approved permit and the Stormwater Management Plan attached thereto; and
- Stormwater management system as-built plans containing my signature and professional seal have been submitted to the City Engineer.

Signature: _____ Date: _____

Printed Name and Title: _____

Business Name: _____

Address: _____

City, State, ZIP _____

Phone Number: _____

ACCEPTANCE OF COMPLETED WORK (FOR CITY OF JACKSON USE ONLY):

- I have completed an inspection of the permitted stormwater management system and found that it conforms to an acceptable level with the approved plans.
- I have completed a review of the as-built plans for the permitted stormwater management and found them to be complete and accept them as final.
- I authorize the release of all performance guarantees associated with this stormwater management system.

Approval Signature: _____ Date: _____

Printed Name and Title: _____

STORMWATER MANAGEMENT AGREEMENT AND DECLARATION OF EASEMENT

THIS Stormwater Management Agreement and Declaration of Easement ("Agreement") is made _____ __, 2012, between _____, whose address is _____ (herein referred to as "Owner"), and the **CITY OF JACKSON**, a Michigan municipal corporation, with offices located at 161 West Michigan Ave., Jackson, Michigan 49201 (herein referred to as the "City"),

WHEREAS, the Owner has acquired property in the City which is described as follows:

Legal Description (herein referred to as the "Real Property")

Commonly known as _____, and Tax Parcel No._____,

WHEREAS, the Real Property is a "Covered Development Project" under Article V ("Post-Construction Stormwater Management for New Development and Redevelopment") of Chapter 27 ("Water and Sewers") of the City of Jackson Code of Ordinances, as amended ("Article V of Chapter 27 of the City Code").

WHEREAS, as a Covered Development Project, Owner must obtain a Stormwater Management Permit and have an approved Final Stormwater Management Plan as provided by Article V of Chapter 27 of the City Code.

WHEREAS, Article V of Chapter 27 of the City Code requires that the Owner provide such easements as determined necessary by the City to implement an approved Final Stormwater Management Plan and to otherwise comply with Article V of Chapter 27.

WHEREAS, this Agreement is being entered into between the parties to provide the easements required to implement the proposed Final Stormwater Management Plan for the Real Property and to accomplish such other objectives as stated by this Agreement.

NOW THEREFORE, it is agreed by the parties as follows:

1. This Agreement is entered by the parties to establish easements as determined necessary by the City to implement the Owner's proposed Final Stormwater Management Plan for the Real Property and to accomplish such other objectives as stated by this Agreement and required by Article V of Chapter 27 of the City Code.

2. Owner has agreed to install and maintain stormwater management practices, methods, and facilities on the Real Property in accordance with the proposed Final Stormwater Management Plan and Article V of Chapter 27 of the City Code. The Owner further agrees to the terms stated in this document to ensure that the stormwater management practices, methods, and facilities continue to comply with the approved Final Stormwater Management Plan, any associated Stormwater Management Permit, and other applicable standards, conditions, and requirements, in perpetuity.

3. Owner shall be solely responsible, in perpetuity, for the installation, maintenance and repair of the stormwater management practices, methods, and facilities required by the approved Final Stormwater Management Plan and Article V of Chapter 27 of the City Code.

4. Owner hereby conveys to the City an easement over, on, and in the Real Property for all of the following purposes, as determined applicable by the City:

   a. To provide entry and access for stormwater management facility inspections and maintenance.

b. To preserve stormwater runoff conveyance, infiltration, and detention areas and facilities, including flood routes for storm events.

c. To preserve primary and secondary drainage ways that are needed to serve stormwater management needs of other properties.

d. To accomplish purposes such as those listed above for all areas used for off-site stormwater control, including undeveloped or undisturbed lands.

e. To serve other purposes and objectives determined necessary by the City to achieve the purposes of this Agreement and Article V of Chapter 27 of the City Code.

5. The City is authorized to access the Real Property as determined necessary by the City to conduct inspections of the stormwater management practices, methods, and facilities to ascertain compliance with the approved Final Stormwater Management Plan and for any other purpose as provided by Article V of Chapter 27 of the City Code.

6. If the City determines that the stormwater management system required for the Real Property has not been properly operated or maintained, or has become a danger to public safety, health, or the environment, the City shall notify Owner by first-class mail and also by certified mail. The notice shall specify the measures needed to comply with applicable requirements and shall specify the time within which such measures must be completed. If Owner fails or refuses to complete the measures needed to comply with the applicable requirements within the specified time, the City may (but is not required to) enter the property and perform, or cause to be performed, the necessary work to return the stormwater management system to full compliance, and bill Owner for the full cost of any such work.

7. Costs and expenses incurred by the City in implementing and enforcing the provisions of this Agreement, including, but not limited to, costs and expenses incurred by the City in responding to, correcting violations, and/or performing work pursuant to Sections 27.152, 27.158, 27.163, 27.165, 27.167, 27.168 Article V of Chapter 27 of the City Code, shall be a lien on the premises which shall be enforceable in accordance with Act No. 94 of the Public Acts of 1933 (MCL 141.101 et seq.), as amended from time to time. Any such costs and expenses which are unpaid for 6 months or more may be certified by the City Manager on April 30 and September 30 of each year to the City Assessor who shall enter the lien on the next tax roll against the premises and the costs and expenses shall be collected and the lien shall be enforced in the same manner as provided for in the collection of taxes assessed upon the roll and the enforcement of a lien for taxes. In addition to any other lawful enforcement methods, the City shall have all remedies authorized by Act No. 94 of the Public Acts of 1933, as amended. If the City elects to pursue collection of unpaid costs and expenses through the courts, Owner shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

8. For purposes of this Agreement, "Owner" means and includes _____ as the current owner, and all future owners of the Real Property, as defined by Article V of Chapter 27 of the City Code. For purposes of this Agreement, "City" means the City of Jackson and any of its designees.

9. Nothing in this Agreement shall be construed to conflict with or limit in any way the City's power or authority under Article V of Chapter 27 of the City Code or other applicable laws and regulations.

10. This Agreement shall be governed by and construed in accordance with the laws of the State of Michigan, except that it is the express intention of the parties hereto that this

Agreement shall not be construed to be a requirements contract within the purview of the Uniform Commercial Code.

11. Nothing under this Agreement and no action taken pursuant hereto shall cause the City and Owner to be treated as a partnership, joint venture, association, or other common entity.

12. If any part of this Agreement is held by a Court of competent jurisdiction to be illegal or unenforceable, such event shall not be deemed to affect the validity of any other portion hereof. Any such holding materially affecting the commitments herein may be the subject of further negotiations for purpose of legally revising the consideration involved.

13. This Agreement shall become effective on the date that it has been signed by authorized representatives of both the City and Owner as set forth below.

14. This Agreement constitutes the final, entire and exclusive agreement of the parties with respect to the subject matter addressed, and supersedes all prior communications, understandings and agreements relating to the subject matter, whether oral or written. Nothing in this Agreement shall limit the ability of the parties to negotiate amendments to this Agreement, provided that except as expressly provided in this Agreement, no amendment or waiver of this Agreement shall be binding unless executed in writing by the party to be bound thereby. No waiver of any provision of this Agreement shall constitute a waiver of any other provision nor shall any waiver of any provision of this Agreement constitute a continuing waiver unless otherwise expressly provided. Nothing in this Agreement is intended to nor should it be construed to create any rights in any persons or entities that are not a party to this Agreement.

15. Owner agrees that this Agreement shall be recorded in the Jackson County Register of Deeds, and that the Real Property shall be subject to the covenants and obligations

contained herein, and this Agreement shall bind all current and future owners of the Real Property, including their administrators, executors, successors, heirs, or assigns.

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

IN WITNESS WHEREOF, the parties have executed this Agreement effective on the date set forth in the first paragraph.

(OWNER)	CITY OF JACKSON
By: _____	By: _____
_____	Martin J. Griffin
its: (authorized member)	its: Mayor

STATE OF MICHIGAN)
)ss
COUNTY OF JACKSON)

On _____, 2012, before me, a Notary Public, in and for said County, personally appeared _____, by and through _____, its authorized member, to me known to be the same party described in and who executed the within instrument, who personally acknowledged the same to be his own free act and deed.

_____
, Notary Public
Acting in Jackson County, Michigan
My commission expires: _____

STATE OF MICHIGAN)
)ss.
COUNTY OF JACKSON)

On _____, 2012, before me, a Notary Public, in and for said County, personally appeared the City of Jackson, by and through _____, its authorized officer, to me known to be the same party described in and who executed the within instrument, who personally acknowledged the same to be his own free act and deed.

_____
, Notary Public
Acting in Jackson County, Michigan
My commission expires: _____

After recording, return to _____ and Julius A. Giglio, at the addresses below.

Julius A. Giglio
161 West Michigan Avenue, 12th Floor
Jackson, MI 49201

deposit shall bear interest and such deposit, or any remaining balance thereof, shall be returned to the customer making the same when the customer shall discontinue receiving water and wastewater service. The customer shall notify the city, in writing, of the forwarding address where the deposit, or any remaining balance thereof, shall be mailed. The failure of a customer to notify the city of their forwarding address within six (6) months of termination of service shall result in the deposit, or other remaining balance thereof, being forfeited by the customer.
(Code 1977, § 2.78)

Sec. 27-113. Billing disputes.

(a) Customers of water and/or sewer service may contest their water and/or sewer bills by contacting a customer service representative at the water department at least ten (10) days before the due date of the bill. If a resolution of the dispute is not resolved from that contact, a customer wishing to further contest a bill must, not more than ten (10) days after the due date of the bill, request a personal hearing with the billing supervisor.

(b) This hearing shall be scheduled as soon as is practicable after the request is made; shall be informal; and shall consist of a review of the amount of the bill, the recent usage history of the premises, and any other relevant matter which, in the opinion of the billing supervisor, may assist in the resolution of the dispute.

(c) At the close of the hearing, the billing supervisor, based upon the information reviewed at the informal hearing, shall either find the bill to be proper or adjust the bill.
(Code 1977, § 2.85)

Secs. 27-114—27-119. Reserved.

ARTICLE V. POST-CONSTRUCTION STORMWATER MANAGEMENT FOR NEW DEVELOPMENT AND REDEVELOPMENT

DIVISION 1. TITLE, DESCRIPTION, PURPOSE, AND FINDINGS

Sec. 27-120. Title.

This article may be officially referred to as the "City of Jackson Post-Construction Stormwater Management Ordinance."
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-121. Description.

This article requires that a stormwater management permit be obtained prior to commencing any land disturbance activities in connection with new development and redevelopment projects, as defined by this article. The permitting process includes review and approval of a stormwater management plan that sets forth, among other things, how a project developer will implement stormwater management practices, methods, and facilities to address post-construction stormwater runoff quality and quantity impacts resulting from land disturbance activities associated with the development. This article also addresses long-term operation, maintenance, and inspection requirements for stormwater management practices, methods, and facilities; specifies a minimum water quality treatment volume standard to address water quality impacts of storm runoff; specifies channel protection criteria to maintain and control runoff volume and peak flow rates; and contains enforcement mechanisms and recordkeeping requirements.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-122. Findings.

The city hereby finds and determines as follows:

(a) State and federal laws and the phase II stormwater rules and regulations promulgated thereunder compel local public bodies in certain urbanized areas, including the city, to adopt an ordinance with certain minimum provisions and require-

ments applicable to post-construction stormwater runoff from development and redevelopment sites.

(b) Implementation of the minimum provisions and requirements provided by this article will meet the applicable state and federal stormwater laws and regulations, and minimize or prevent the adverse effects of stormwater runoff from post-construction stormwater runoff from development and redevelopment sites.

(c) Development and redevelopment activities alter the hydrologic response of watersheds, resulting in increased stormwater runoff rates and volumes, increased flooding, increased soil erosion, increased stream channel erosion, increased nonpoint and point source pollution, increased sediment transport and deposition, reduced groundwater recharge, and other adverse effects.

(d) The adverse effects of stormwater runoff from development and redevelopment activities can be harmful to the public health, safety, and general welfare, the environment, and public and private property and infrastructure.

(e) The adverse effects of stormwater runoff from development and redevelopment activities can be minimized or prevented by requiring the use of appropriate stormwater management practices, methods, and facilities to manage and control runoff from development and redevelopment sites.

(f) Enactment of this article is necessary to protect, preserve, and enhance the public health, safety, and general welfare, the environment, and public and private property and infrastructure, and is necessary to meet the requirements of state and federal laws and regulations regarding post-construction stormwater runoff from new development and redevelopment sites.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-123. Purpose.

(a) This article is enacted to protect, maintain and enhance the public health, safety, environment, and general welfare, and public and private property and infrastructure, by establishing minimum requirements and procedures to manage and control the adverse effects of post-construction stormwater runoff from new development and redevelopment in the City of Jackson, as required by and in accordance with the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Federal Act"), Michigan Act 451, Public Acts of 1994, as amended (the "Michigan Act"), Parts 31 and 41, the city's MS4 watershed general permit, the city's certificate of coverage, and other applicable local, state and federal laws and regulations.

(b) Further, this article establishes minimum stormwater management provisions and requirements to accomplish purposes including, but not limited to, the following:

(1) Achieve compliance with state and federal stormwater laws and regulations.

(2) Establish a minimum treatment volume standard to minimize water quality impacts of post-construction stormwater runoff.

(3) Establish channel protection criteria to minimize excess sediment and channel instability caused by increased flow rate and volume from post-construction stormwater runoff.

(4) Protect natural infiltration and groundwater recharge rates in order to sustain ground water supplies and stream base flows.

(5) Maintain natural drainage patterns and encourage the use of natural drainage systems and low impact development techniques.

(6) Treat and release stormwater as close to the source of runoff as possible using minimal structures and maximizing reliance on natural processes.

(7) Prevent or minimize the adverse impacts on water quality and channel stability

caused by post-construction runoff by requiring implementation of appropriate stormwater management practices, methods, and facilities.

(8) Recognize private responsibility to incorporate stormwater management systems into the early stages of site planning and design.

(9) Provide requirements to ensure effective long-term operation and maintenance of stormwater management practices, methods, and facilities.

(10) Establish recordkeeping requirements to document the implementation of and compliance with the post-construction stormwater runoff program established by this article, including documentation of stormwater management plans, operation and maintenance plans and agreements, and enforcement actions.

(11) Facilitate achievement of the goals outlined in the Upper Grand River Watershed Master Plan.

(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 2. DEFINITIONS

Sec. 27-124. Definitions.

Unless the context specifically indicates otherwise, the following terms shall have the following meanings as used in this article:

Applicant means a property owner or authorized agent of a property owner who has filed an application for a stormwater management permit.

Best management practice or *BMP* means any practice, program, procedure, control, technique or measure (used singularly or in combination), designed to prevent pollutants from entering into stormwater flows, to direct the flow of stormwater, or to treat polluted stormwater flows. BMPs include, but are not limited to: schedules of activities; pollution treatment practices or devices; prohibitions of practices; good housekeeping practices; pollution prevention, minimization and reduction measures; educational practices and programs; maintenance procedures; other management programs, practices, or devices; treatment requirements; notice, reporting, and record-keeping requirements; and operating procedures and practices to control or contain site runoff, spillage, or leaks, batch discharges, sludge or water disposal, or drainage from product and raw materials storage. BMPs may be structural, non-structural, or both.

BOD or *biochemical oxygen demand* means the quantity of oxygen used in the biochemical oxidation of a given amount of organic matter under standard laboratory procedures in five (5) days at twenty (20) degrees centigrade, expressed in milligrams per liter.

Certificate of coverage or *COC* means certificate of coverage issued to the city by the MDNRE under MS4 watershed general permit.

City means the City of Jackson, Michigan, or the city's authorized representatives.

City Code means the Code of Ordinances, City of Jackson, Michigan, as amended from time to time.

City engineer means the city engineer of the City of Jackson or the city engineer's designees.

COD or *chemical oxygen demand* means a measure of oxygen-consuming capacity of inorganic and organic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specified test. It does not differentiate between stable and unstable organic matter and thus does not necessarily correlate with biochemical oxygen demand. Also known as oxygen consumed (OCR) and dichromate oxygen consumed (DO), respectively.

Cost, costs, or *costs and expenses,* and similar terms, as used generically in the context of payments or amounts that must be paid by any person to the city, must be reimbursed to the city, or are due and payable to the city under this article, "cost," "costs," "costs and expenses," and similar terms shall be construed to mean and include, but shall not be limited to, all costs, expenses, fines, fees, charges, surcharges, penalties, assessments, claims, losses, liabilities, and damages (direct or indirect), including natural

resource damages, and other amounts, and the full value of any city staff time (including any required overtime), consultant and engineering fees, testing fees, and actual attorney fees and defense costs, as applicable to the circumstances and relevant to stormwater management matters.

Covered development project means a development or redevelopment project that meets the applicability requirements of subsection 27-126(a) of this article.

Developer means a person who undertakes or proposes to undertake land disturbance activities. The developer may be the property owner or the property owner's authorized representative.

Discharge means the introduction of stormwater into the MS4, whether intentional or unintentional, and whether directly (such as through an approved sewer connection or other approved discharge point or point source or in form of diffuse non-point runoff) or indirectly (including, but not limited to, sources such as inflow and infiltration).

Hazardous waste means any substance discharged or proposed to be discharged into the MS4, that:

(1) If otherwise disposed of would be a hazardous waste under 40 CFR Part 261 or under the rules promulgated under the state hazardous waste management act (Part 111 of Act 451 of the Public Acts of Michigan of 1994, MCL §§ 324.11101 et seq., as amended); or

(2) Is otherwise a waste or a combination of waste and other discarded material including solid, liquid, semisolid, or contained gaseous material that because of its quantity, quality, concentration, or physical, chemical, or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious irreversible illness or serious incapacitating but reversible illness, or may pose a substantial present or potential hazard to human health or the environment if improperly treated, stored, transported, disposed of, or otherwise managed.

Hotspot means a land use or activities that generate concentrations of pollutants in excess of those typically found in stormwater runoff, and/or present a higher potential risk for spills, leaks or illicit discharges, as determined by the city engineer. Hotspots may include, but are not limited to: vehicle salvage yards; vehicle fueling stations; vehicle service and maintenance facilities; vehicle and equipment cleaning facilities; fleet storage areas; industrial sites (based on SIC or NAICS codes); marinas with service and maintenance; outdoor liquid container storage; outdoor loading/unloading facilities; public works storage areas; facilities that generate or store hazardous materials; commercial container nurseries; recycling facilities (including, but not limited to, vehicle, glass, paper, and battery recycling facilities); and other land uses and activities as determined by the city engineer.

Infiltration means any waters entering the MS4 from the ground through such means as, but not limited to, defective pipes, pipe joints, connections or manhole walls. Infiltration does not include, and is distinguished from, inflow.

Inflow means any waters entering the MS4 from sources such as, but not limited to, building downspouts; roof leaders; cellar, yard, and area drains; foundation and footing drains; cooling water discharges; drains from springs and swampy areas; manhole covers; cross connections from storm sewers and combined sewers; catch basins; stormwaters; surface runoff; street wash waters; or drainage.

Land disturbance activity means any action that causes any land change, including, but not limited to, a change in the position, location, or arrangement of soil, sand, rock, gravel, or similar earth material, and any clearing, digging, grubbing, stripping, removal of vegetation, dredging, grading, excavation, transporting and filling of land, construction, paving, and any other installation of impervious cover.

Larger common plan of development or sale means a contiguous area where multiple separate and distinct construction activities may be taking place at different schedules under one plan.

Medical waste means isolation wastes, infectious agents, human blood and blood products, pathological wastes, sharps, body parts, contaminated bedding, surgical wastes, potentially contaminated laboratory wastes, or dialysis wastes, and includes any medical or infectious wastes as defined by the MDNRE.

MDNRE means the Michigan Department of Natural Resources and Environment and its successor departments (or the MDNRE's predecessor department as embodied by the Michigan Department of Environmental Quality).

MS4 watershed general permit means the NPDES watershed general permit issued to the city by the MDNRE as authorized by Michigan Act 451, Public Acts of 1994, as amended, Part 31, and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.).

Municipal separate storm sewer system or *MS4* means, in general, all separate storm sewers that are owned or operated by the United States, a state, city, village, township, county, district, association, or other public body created by or pursuant to state law, having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under state law, such as a sewer district, flood control district, or drainage district, or similar entity, or a designated or approved management agency under Section 208 of the Federal Act that discharges to the waters of the state. This term includes systems similar to separate storm sewer systems in municipalities, such as systems at military bases, large hospital or prison complexes, and highways and other thoroughfares. The term does not include separate storm sewers in very discrete areas, such as individual buildings. As used in this article, the term MS4 refers to MS4s located within the city.

NAICS or *North American Industrial Classification System* means the system of classification for business establishments adopted by the U.S. Office of Management and Budget.

New development means any land disturbance activities on previously unimproved premises.

NPDES means the "National Pollutant Discharge Elimination System" established pursuant to Section 402 of the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Federal Act").

Owner means the owner of record of the freehold of a premises or lesser estate therein, a mortgagee or vendee in possession, assignee of rents, receiver, executor, trustee, lessee, or other person, firm or corporation in control of a premises.

Permittee means any person issued a stormwater management permit under this article.

Person means any individual, partnership, copartnership, firm, company, association, society, corporation, joint stock company, trust, estate, governmental entity, or any other legal entity or their legal representatives, agents or assigns.

Pollutant includes, but is not limited to, any of the following:

(a) Any material that is discharged into water or other liquid, including, but not limited to, dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, medical wastes, chemical wastes, biological materials, radioactive materials, wrecked or discharged equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste.

(b) Properties of materials or characteristics of wastewater, including, but not limited to, pH, heat, TSS, turbidity, color, BOD, COD, toxicity, and odor.

(c) Substances regulated by, or that are required to be monitored, or that are limited in, the city's MS4 watershed general permit, the city's certificate of coverage, the Federal Water Pollution Control Act, as amended, Michigan Act 451, Public Acts of 1994, as amended, Parts 31 and 41, or relate local, state and federal laws and regulations.

(d) Hazardous wastes, toxic pollutants, and medical wastes.

Post-construction stormwater runoff means the stormwater that would flow from a development site to an MS4 or surface water of the state following (not during) the development or redevelopment of the site.

Predevelopment means runoff conditions that exist onsite immediately before the currently proposed land disturbance activities occur.

Premises means any building, lot, parcel of land, or portion of land, whether improved or unimproved, including adjacent sidewalks and parking strips, located within the city from which discharges into the MS4 are or may be created, initiated, originated, or maintained.

Pretreatment means reducing the amount of pollutants, eliminating pollutants, or altering the nature of pollutant properties to a less harmful state prior to discharge into the MS4. The reduction or alteration can be by physical, chemical, or biological processes, process changes, or by other means. Dilution is not considered pretreatment.

Redevelopment means land disturbance activity on premises already improved with buildings, structures or activities or uses, including, but not limited to, alterations that change the footprint of a building or that offer a new opportunity for stormwater controls. Redevelopment does not include ordinary maintenance activities such as exterior changes or improvements of buildings that do not alter or expand the existing building footprint; resurfacing and/or repaving of existing paved areas that does not expand the existing paved area; and other activities that do not materially increase or concentrate stormwater runoff or cause additional nonpoint source pollution, as determined by the city engineer. Paving of a previous unpaved area is specifically excluded from the definition of "ordinary maintenance activities" as used in this article.

Separate storm sewer means a conveyance or system of conveyances designed or used for collecting or conveying stormwater which is not a combined sewer and which is not part of a publicly-owned treatment works as defined in 40 CFR 122.2 of the Code of Federal Regulations.

SIC or *Standard Industrial Classification Code* means a classification pursuant to the Standard Industrial Classification Manual issued by the U.S. Office of Management and Budget.

Stormwater includes stormwater runoff, snowmelt runoff, and surface runoff and drainage.

Stormwater management system means stormwater management practices, methods, and facilities, including BMPs.

Surface waters of the state are defined consistent with Rules 323.1041 through 323.1117 of the Michigan Administrative Code to mean all of the following, but not including drainage ways and ponds used solely for wastewater conveyance, treatment, or control: the Great Lakes and their connecting waters; all inland lakes; rivers; streams; impoundments; open drains; and other surface bodies of water within the confines of the state.

Total suspended solids or *TSS* means solids that float on the surface of, or are suspended in, water, wastewater, or other liquids and which can be removed by laboratory filtering or other standard methods.

Toxic pollutant means any pollutant or combination of pollutants that is or can potentially be harmful to the public health, the MS4, or the environment, including, without limitation, those listed in 40 CFR 401.15 as toxic under the provisions of the Clean Water Act, or listed in the Critical Materials Register promulgated by the MDNRE, or as provided by local, state, or federal laws, rules, or regulations.

Treatment means the removal of pollutants through settling, filtration, infiltration, or the equivalent.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 3. ADMINISTRATION

Sec. 27-125. City engineer.

The city engineer is hereby appointed to administer and implement the provisions of this article.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 4. APPLICABILITY

Sec. 27-126. Covered development projects; exemptions.

(a) *Covered development projects.* The requirements of this article shall apply to post-construction stormwater runoff from any of the following:

(1) Any new development project or redevelopment project that:

a. Disturbs one (1) acre or more; or disturbs less than one (1) acre, if the project is part of a larger common plan of development or sale that would disturb one (1) acre or more; and

b. Discharges to a surface water of the state, either directly or via a separate storm sewer system.

(2) Any new development project or redevelopment project that would change, alter, or convert the use of land to a stormwater hotspot as defined by this article.

The requirements of this article shall apply to development projects as provided above whether or not the project is owned, operated, managed, or controlled by a private or public person or entity, and whether or not the project would otherwise be subject to site plan review and approval requirements under other provisions of this Code.

(b) *Exemptions.* The following activities shall not be considered covered development projects for purposes of this article, even if the activity would otherwise qualify as a covered development project under subsection (a) of this section based on the amount of land disturbed:

(1) Normal maintenance and improvement of land in bona fide agricultural use as defined and protected by the Michigan Right to Farm Act (Public Act 93 of 1981, MCL 286.471, et seq.) as determined by the city engineer.

(2) Routine single-family residential landscaping and/or gardening that does not materially alter stormwater flow from the property in terms of quality, quantity, and/or rate, as determined by the city engineer.

(3) Development that is not part of a larger common plan of development on one (1) single-family lot, parcel, or condominium unit where the city engineer determines that, due to the size of the site, or due to other circumstances, the quality, quantity, and/or rate of stormwater leaving the site will not be materially altered.

(4) The construction of any fence that will not alter existing terrain or drainage patterns, as determined by the city engineer.

(5) Construction of utilities (gas, water, electric, telephone, etc.) other than drainage, which will not alter terrain, ground cover, or drainage patterns, as determined by the city engineer.

(6) Emergency repairs to any stormwater management facility or practice that poses a threat to public health or safety, or as deemed necessary by the city engineer.

(7) The installation or removal of individual mobile homes within a mobile home park that does not materially alter stormwater flow from the property in terms of quality, quantity, and/or rate, as determined by the city engineer. This exemption shall not be construed to apply to the construction, expansion, or modification of a mobile home park.

(8) Developments that have received final site plan or final plat approval prior to the effective date of this article, unless the approval expires prior to the commencement of construction. If a plat has received only preliminary plat approval prior to the effective date of this article, then the development shall not be exempt and the development shall comply with the requirements of this article to the maximum extent feasible without requiring the development to be redesigned in a way that would reduce the number, size and density of buildings. For phased developments, this exemption shall apply only to the phases that have been constructed prior to the effective date of this article.

(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 5. STORMWATER MANAGEMENT PERMITS

Sec. 27-127. Permit required for covered development projects.

(a) No person shall commence or engage in any land disturbance activity for a proposed covered development project without first obtaining a stormwater management permit as provided by this division.

(b) Further, notwithstanding any other provision of this Code, the city shall not grant to any person any final permits or final approvals required under other provisions of this Code for land disturbance activities that are required for a proposed covered development project unless the permit or approval under those other provisions is expressly conditioned upon the requirement to also obtain a stormwater management permit for the covered development project as provided by this division.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-128. Permit application submission schedule.

The city engineer shall establish a submission schedule for permit applications. The schedule shall establish deadlines by which complete permit applications must be submitted with the goal of ensuring, to the extent practicable, that there is adequate time to review stormwater management permit applications, accommodate the various stages of the stormwater management permit review process, and coordinate the stormwater management permit review process with the reviews of any other public bodies that may also be required for the development.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-129. Pre-application conference.

Before an application for a stormwater management permit is submitted, the developer shall meet with the city engineer to:

(a) Discuss the permit application process, stormwater management plan submittal requirements, and potential stormwater management measures that may be required to meet the requirements of this article;

(b) Review and assess potential stormwater management designs before formal site design engineering is commenced;

(c) Determine stormwater impacts of the proposed development on local watershed plans and other relevant resource protection plans;

(d) Review requirements that may apply to the proposed covered development project under other local and state laws and regulations; and

(e) Review and discuss any related matters as determined appropriate by the city engineer.

To the extent possible, the pre-application conference shall be held before the developer has applied for permits or approvals required under other provisions of this Code for land disturbance activities that may also be required for the proposed covered development project. Following the initial pre-application conference, additional pre-application conferences may be required as determined necessary by the city engineer.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-130. Preliminary stormwater management plan.

(a) To maximize the efficiency and effectiveness of the pre-application conference, the city engineer may require the developer to submit a preliminary stormwater management plan prior to the conference.

(b) The preliminary plan may be used by the city engineer to evaluate the type of stormwater management measures that may be necessary and appropriate for the proposed development and to ensure adequate planning for stormwater management on the site consistent with the requirements of this article.

(c) The preliminary stormwater management plan shall include all of the information and shall meet all of the requirements for final stormwater management plans as provided by section [27-

137] of this article, unless any such information or requirements are determined unnecessary by the city engineer for the development in question.

(d) All required elements of the preliminary plan, such as maps, plans, easements, details, and calculations may be preliminary rather than final, and detailed construction drawings shall not be required, unless determined necessary by the city engineer for the development in question.

(e) In all cases, the preliminary plan shall include all information, documents, items, and materials, in the form and at the level of detail, as determined necessary by the city engineer to adequately evaluate, before the permit application is submitted, the environmental characteristics of the project site, the potential impacts of the proposed development of the site on water resources, and the effectiveness of any measures proposed by the applicant to manage stormwater generated at the project site as required by this article.

(f) If a preliminary stormwater management plan is required, approval of the preliminary plan by the city engineer shall be required before the city engineer will proceed with review of a final stormwater management plan. The city engineer shall review the submitted preliminary plan and specify any modifications that must be made to the preliminary plan for purposes of preparing a final stormwater management plan that meets the requirements of section 27-137 of this article. The applicant shall prepare and submit to the city engineer a final stormwater management plan that incorporates any modifications required to the preliminary plan as specified by the city engineer and that meets the requirements of section 27-137 of this article.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-131. Permit application.

The developer of a proposed covered development project shall be required to submit a stormwater management permit application and all required accompanying submittals and shall meet the other requirements provided by this article.

(a) An application for a stormwater management permit shall be submitted by the applicant to the city engineer on the form provided by the city engineer.

(b) The applicant may be the property owner or the property owner's authorized representative. The permittee, however, shall be the property owner.

(c) The submitted application shall include all information, documents, items, and materials as specified by the application form. In addition to what is required by the application form, the city engineer may require the applicant to submit any other materials as determined necessary by the city engineer to fully and adequately review and evaluate the application for purposes of this article.

(d) All of the required application materials shall be submitted in as many copies, and shall be prepared in the form, manner, and level of detail, as specified by the application form or as otherwise required by the city engineer.

(e) A permit application shall not be deemed complete until the city engineer has determined that all required information, documents, items and materials have been provided, along with the fully paid stormwater management permit review fee, and, if requested, the fully paid escrow fee and completed escrow fee acknowledgement form.

(f) If the city engineer determines that an application is not complete, the city engineer shall specify in writing to the applicant what the applicant must do to complete the application.

(g) Any period for approving, denying, or modifying an application as specified by this article shall not begin to run until the city engineer has determined that the application is complete as provided by this section.

(h) An application may be considered withdrawn and the application file may be closed by the city engineer if an applicant fails to respond to any written request from the city engineer for information, documents, items, or materials regarding the application within thirty (30) days of

the request, or within any longer period of time if the city engineer and the applicant agree in writing that an extension of time is appropriate and the amount of additional time is set forth in the agreement.

(i) At any time during the permit application review and approval process, the city engineer may forward copies of the application to other city departments and other public bodies for their information, review and input, and to coordinate, to the extent possible, the stormwater management permit review process with other public reviews and approvals that may also be required for the development.

(j) Filing an application for a stormwater management permit grants the city permission to enter the site to verify information in the application and to inspect for compliance with any permit that may be issued.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-132. Permit application fee.

A non-refundable application fee shall be submitted to the city engineer with the initial submittal of the permit application form. The application fee shall be in an amount sufficient to cover reasonable costs and expenses generally associated with the review by the city engineer of stormwater management permit applications, including routine administrative and technical reviews and on-site inspections. The amount of the application fee shall be established from time to time by resolution of the city council.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-133. Escrow fee.

In addition to the application fee, based on the size, complexity, or other aspects of a proposed development, the city engineer may determine that the applicant must submit to the city as part of the permit application an escrow fee in an amount sufficient, as determined by the city engineer, to pay for the estimated reasonable costs and expenses of any city personnel and any professional consultants whose services are deemed necessary by the city engineer to adequately review the application for purposes of compliance with the requirements of this article.

(a) If the city engineer requires payment of an escrow fee, the applicant must complete and submit an escrow fee acknowledgment form provided by the city engineer.

(b) The amount of the escrow fee shall be determined at the time of project review based on a specific scope of work, and shall be calculated at the rates determined by the city engineer.

(c) The services for which an escrow fee may be used may include, but shall not be limited to, hydrologic and drainage analysis, wildlife evaluation, stormwater quality analysis, wetland survey and delineation, site inspections, as-built plan review, analysis of legal issues, and any other city personnel and professional consultant services deemed necessary by the city engineer.

(d) If the actual total cost of the services of the city personnel and consultants is less than the escrow fee submitted, the city shall refund the balance to the applicant.

(e) If the actual total cost of the services of the city personnel and consultants exceeds the amount of the escrow fee submitted, the applicant shall provide to the city an additional escrow amount equal to no less than one-half (½) the original escrow amount. All review by the city of the stormwater management permit application shall cease until such additional escrow amount is deposited with the city, and the number of days that review of the stormwater management permit application ceases shall be deducted from the period within which the city engineer may otherwise be required to act upon the application.

(f) Payment of an escrow fee as provided by this section may be required by the city engineer at any point during the

stormwater management permit review process, as determined necessary by the city engineer.

(g) A denial of an application for a stormwater management permit shall not affect in any way the applicant's obligation to pay the escrow fees required by this section.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-134. Payment of fees.

All fees required by this article shall be paid by cash, check, or money order. All forms of payment other than cash shall be made payable to the City of Jackson.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-135. Post-application conferences.

The city engineer may require one or more post-application conferences and consultations with the applicant at any time during the stormwater management permit review process for any purpose as determined necessary by the city engineer to meet the requirements of this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-136. Permit application review and approval procedures.

(a) The city engineer shall review an application for a stormwater management permit as provided by this article and shall approve, approve with conditions, deny, or request a modification to the application within ninety (90) days after receipt of the completed application. The ninety-day review period as provided by this section may be extended for any additional period of time as agreed upon in writing by the city and the applicant.

(b) The city engineer shall not approve a stormwater management permit application or issue the stormwater management permit unless the city engineer determines that all of the following requirements are met:

(1) The applicant has submitted a final stormwater management plan complying with section 27-137 of this article.

(2) The final stormwater management plan contains a description and design of a stormwater management system adequate to control post-construction stormwater runoff from the development consistent with the requirements of this article.

(3) The combination of stormwater management facilities, practices, methods, and procedures proposed by the applicant to control post-construction stormwater runoff from the development site will meet the minimum water quality treatment volume standard, the channel protection criteria, and any other stormwater management design standards and criteria applicable to the development as determined by the city engineer consistent with the requirements of division 7 of this article.

(4) The final stormwater management plan provides protection for water quality and quantity management adequate to ensure protection of property owners and watercourses both within the proposed development and downstream.

(5) The final stormwater management plan complies with all other applicable local, state, and federal laws and regulations.

(6) The applicant has paid or deposited the stormwater management permit review fee pursuant to section 27-132 of this article.

(7) The applicant has paid or deposited the escrow fee pursuant to section 27-133 of this article, if required.

(8) The applicant has paid or posted the performance guarantee pursuant to subsection 27-137(d)(8) of this article, if required.

(9) The applicant has provided all stormwater management easements as determined necessary by the city engineer to implement the approved final stormwater management plan and to otherwise comply with this article, and the easements have been recorded with the county register of deeds.

(10) The applicant has provided an operation and maintenance plan and agreement to implement the approved final stormwater management plan and as otherwise required by this article, and the operation and maintenance plan and agreement has been recorded with the county register of deeds.

(11) The applicant has certified in writing that all land disturbance activities, construction, and drainage will be conducted in full compliance with the approved stormwater management plan.

(12) The applicant has obtained and has provided evidence of a commercial general liability insurance policy that will be in full effect prior to the commencement of any land disturbance activities covered by the proposed permit and that is otherwise acceptable to the city attorney. The policy shall name the city, its agents, representatives, officers and employees as additional insureds to protect their interests. Both bodily injury and property damage insurance must be on an occurrence basis; and the policy shall provide that the coverage afforded thereby shall be primary coverage to the full limits of liability stated in the declarations, and if said city, agents, representatives, officers or employees have other insurance against the loss covered by said policies, that such other insurance shall be excess insurance only. The policy certificate shall reference the projects or contracts to which it applies. Upon request by the city engineer, the applicant shall submit all insurance policies to the city attorney for review. The amounts and types of such insurance shall be not less than the following:

Comprehensive commercial general liability of at least:

a. Bodily injury, each occurrence: $2,000,000.00

b. Bodily injury, aggregate: $2,000,000.00

c. Property damage, each occurrence: $2,000,000.00

d. Property damage, aggregate: $2,000,000.00

e. Or in the alternative to subsections (b)(12)a—d.: Bodily injury and property damage combined single limit, each occurrence: $2,000,000.00; and aggregate: $2,000,000.00.

The property damage liability coverage shall include standard explosion, collapse and underground coverage (XCU) for property damage and bodily injury liability coverage with limits of $2,000,000.00 each occurrence and $2,000,000.00 aggregate; additionally, the policy shall provide third party pollution liability insurance coverage with minimum limits of $2,000,000.00 per occurrence and $2,000,000.00 aggregate.

(13) The application includes all required submittals and is otherwise complete.

(c) If the city engineer determines that all of the requirements of subsection (b) of this section have been met, the city engineer shall approve the permit. The approval shall provide in writing that all of the determinations required by subsection (b) of this section have been made.

(d) The city engineer's approval of a stormwater management permit shall be subject to any conditions determined necessary by the city engineer to implement the purposes and requirements of this article. If the approval is subject to any conditions, the conditions shall be specified in writing. The applicant shall fully comply with all such conditions.

(e) The failure or refusal to fully comply with any requirement of a stormwater management permit or a stormwater management plan constitutes a separate and independent violation of this article.

(f) Notwithstanding the issuance of a stormwater management permit, in conducting the development project, the permittee (including the permittee's representatives any other responsible persons) shall be subject to all of the following requirements:

(1) The permittee shall comply with all requirements of the permit, the stormwater management plan, and this article.

(2) The development project shall be conducted only within the area or areas specified in the approved stormwater management plan.

(3) The city engineer shall be allowed to conduct unscheduled, periodic inspections of the development project as provided by this article.

(4) No changes may be made to any aspect of the approved stormwater management plan without review and written approval by the city engineer and subject to the requirements of this article.

(5) Upon completion of the project, the permittee shall submit the engineer's certification and as-built plans required by section 27-151 of this article.

(g) If the city engineer determines that any of the requirements of subsection (b) have not been met, the city engineer shall deny the permit and shall specify in writing why the permit was denied. The applicant may revise the application to address any matters specified by the city engineer in the denial, and may resubmit the application for review by the city engineer. Alternatively, instead of denying the permit, the city engineer may request that the application be modified and resubmitted. All resubmittals shall be subject to all of the requirements of this article that applied to the original submittals.

(h) If the land disturbance activity for which a stormwater management permit has been issued has not been commenced within one (1) year from the date of issuance of the permit, the permit shall lapse, provided that the city engineer may extend the time for commencement of the land disturbance activity if the permittee requests an extension prior to the expiration of the initial period and the city engineer determines that no material change of circumstances has occurred. If an extension is granted, the city engineer may require the permittee to submit additional or updated information as determined necessary by the city engineer, and the city engineer may require revisions to the stormwater management plan as determined necessary by the city engineer based on the additional or updated information.

(i) After a stormwater management permit has been approved, no change shall be made to the development unless and until the change is approved by the city engineer. If any change in the development is proposed, the permittee must notify the city engineer in writing of the proposed change before any such change is made. If the city engineer determines that the proposed change would affect the information and criteria considered in approving the permit, the city engineer may revoke or suspend the permit, require that a new permit application be filed, require submittal of a revised stormwater management plan, or take such other action that the city engineer determines appropriate under the circumstances.

(j) A stormwater management permit approved under this article may also be revoked or suspended by the city engineer for any of the following reasons:

(1) A violation of any requirement or condition of the permit or the stormwater management plan.

(2) Misrepresentation or failure to fully disclose any relevant fact in the permit application or in subsequent notices, reports, or communications to the city engineer.

(k) The issuance of a stormwater management permit under this article shall not relieve any person of the obligation to comply with any other applicable regulations, standards or requirements under local, state, or federal laws, including any regulations, standards, requirements, or laws that may become effective during the term of the permit.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 6. STORMWATER MANAGEMENT PLAN

Sec. 27-137. Final stormwater management plan requirements.

This section sets forth the requirements that shall apply to final stormwater management plans for proposed covered development projects as required by this article.

(a) *General.*

(1) The stormwater management plan shall display and present the infor-

mation required by this section through the use of maps, illustrations, reports, and calculations.

(2) The stormwater management plan shall specify the type, location, and size of stormwater management system to be provided, using final calculations and detailed construction drawings.

(3) If the development will be completed in phases, the stormwater management plan shall be prepared and submitted for the total project and for all phases. Further, upon completion of each phase, the stormwater management plan for the project shall be fully functional for the phases already completed and its functionality shall not be reliant in any way upon the completion of future phases. Final approval of one or more phases shall not ensure approval of subsequent phases.

(b) *Plan preparation.* The stormwater management plan shall be prepared, signed, and sealed by a professional civil engineer registered in the State of Michigan.

(c) *Scale for mapping.* The stormwater management plan shall be drawn to a scale not less than 1" = 50', or as otherwise required by the civil engineer.

(d) *Required elements and information.* A stormwater management permit shall not be approved unless the applicant has provided a final stormwater management plan that contains all of the submittals required by this subsection (d). (The city engineer may require the same or similar requirements for a preliminary stormwater management plan submitted by an applicant during earlier stages of the stormwater management permit review process, but using preliminary calculations and without requiring detailed construction drawings, as determined appropriate by the city engineer.) A final stormwater management plan shall include all of the following elements and information:

(1) *Location and size.* The location of the development by means of a small location map, drawn to a scale no less than 1" = 2000', and the size of the development in acres.

(2) *Zoning.* The zoning classification of the development site and all abutting parcels.

(3) *On-site and off-site features.* The location and description of all on-site features and all adjacent off-site features within fifty (50) feet (unless another distance is specified by the city engineer based on the circumstances at the site), and all other off-site features that may be impacted in determining the overall requirements for the development.

This shall include:

a. Property lines of the development and of adjoining developments.

b. Existing site topography with contours at two-foot intervals or less based on the NAVD88 datum.

c. On-site public and private streets and street right-of-way lines; and adjoining public and private streets and street right-of-way lines.

d. Railroads.

e. High-tension power lines or underground transmission lines.

f. Cemeteries.

g. Parks.

h. Natural and artificial watercourses, wetlands and wetland boundaries, environmental feature boundaries, floodplains, lakes, bays, existing stormwater storage facilities, conveyance

swales (natural or artificial) with identification of permanent water elevations.

i. Location of woodlands.

j. Designated natural areas.

k. Any proposed environmental mitigation features.

l. Existing and proposed public and private drains, storm sewers, sanitary sewers, and water mains, and any related easements.

m. A map, at the U.S.G.S. scale, showing the drainage boundary of the proposed development and its relationship with existing drainage patterns.

n. Boundaries of any off-site drainage area contributing flow to the development.

o. All watercourses passing through the development, along with the following:

1. Area of upstream watershed and current zoning.

2. Final calculations of runoff from the upstream area for both the one hundred-year and two-year 24-hour design storms, for fully developed conditions according to the current land use plan for the area.

p. Soil borings at the sites of proposed retention/detention and infiltration facilities, and as needed in areas where high groundwater tables or bedrock near the surface exist, and at any other locations as required by the city engineer.

q. Proposed development site improvements including lot divisions and building footprints.

r. Drinking water wells, public wellheads, wellhead protection areas (WHPAs), underground storage tanks, and brownfields.

s. Any areas of unique geological formations (e.g., karst areas).

t. Any other on-site or off-site features as determined necessary by the city engineer.

(4) *Stormwater BMP construction plans.* The stormwater management plan shall include final stormwater BMP construction plans. The BMP construction plans shall be drawn to a scale not less than 1" = 50', and on sheets no larger than 24" × 36". The scales used shall be standard engineering scales and shall be consistent throughout the plans. When plans have been completed with computer aided design technology, locations should be geo-referenced and a copy of the electronic file shall also be provided. The construction plans and related documents shall, at a minimum, include:

a. Location and specifications of all proposed stormwater management practices, methods, and facilities (plan and profile).

b. Proposed storm drains, including rim elevations, invert elevations, pipe sizes, and pipe materials.

c. Calculations of runoff from upstream areas for both the one hundred-year and two-year, 24-hour design storms for fully developed conditions according to the current land use plan for the area.

d. Identification of stormwater quality and quantity treatment facilities and method of stormwater conveyance.

e. Calculation of runoff volume captured by BMPs for treatment facilities.

f. Proposed open channel facilities including slope, cross-section detail, bottom elevations, and surface material.

g. Final sizing calculations for stormwater quality and quantity treatment facilities and stormwater conveyance facilities.

h. Storage provided by one-foot elevation increments.

i. Tributary area map for the stormwater management system and all components thereof indicating total size and average runoff coefficient for each sub-area.

j. Analysis of existing soil conditions and groundwater elevation (including submission of soil boring logs) as required for proposed retention and infiltration facilities.

k. Plans and details of proposed soil erosion and sedimentation control measures, both during construction (as required by Part 91 of the Public Acts of 1994) and permanent measures.

l. Details of all stormwater BMPs, including but not limited to:

1. Outlet structures.
2. Overflow structures and spillways.
3. Riprap.
4. Manufactured treatment systems.
5. Underground detention cross-section and product details.
6. Cross section of infiltration and/or bio-retention facilities.

m. Location of proposed stormwater management facility easements (consistent with subsection (d)(6) of this section.)

n. Final landscaping plans and details.

(5) *Operation and maintenance plans and agreements.* The applicant shall provide a stormwater operation and maintenance (O&M) plan and agreement.

a. The O&M plan and agreement shall be provided by the applicant in such form and substance as required by the city attorney.

b. The O&M plan and agreement shall contain provisions to ensure that the maximum design performance of stormwater BMPs is maintained on a long-term basis and that the city's standards for stormwater quality and quantity are met.

c. At a minimum, the O&M plans and agreements shall include all of the following information and contents:

1. The names and addresses of the property owners, and, the owners of all components of the stormwater system.
2. The names and addresses of the persons responsible for operation and maintenance.
3. The names and addresses of the persons responsible for financing operation and maintenance and emergency repairs.
4. The signatures of the owners and any other persons to be bound by the agreement.
5. A detailed annual estimated budget for the expected life of the BMPs; and a demonstrated means

of financing operation and maintenance and emergency repairs.

6. A map showing the location of the stormwater systems and facilities, including catch basins, manholes/access lids, main, and stormwater devices.

7. A schedule for routine, nonroutine, emergency, and long-term inspection and maintenance of all structural and vegetative stormwater BMPs, with detailed tasks to be performed, and detailed inspection and maintenance checklists.

8. Operating instructions for stormwater outlet components.

9. Vegetation maintenance schedule.

10. Recordkeeping, tracking, inspection, and notice checklists and requirements.

11. A statement recognizing the city's right to enter the property for the purpose of inspections.

12. Provisions regarding the city's right to perform, or cause to be performed, any required operation and maintenance if the responsible persons fail or refuse to do so, and the obligation of property owner to fully reimburse the city for the costs and expenses incurred by the city in connection with such activity.

d. The O&M plan and agreement shall be binding on all current and subsequent owners of land served by the stormwater BMPs and shall be recorded in the county register of deeds as directed by the city attorney.

e. Any person responsible for the operation and maintenance of a stormwater management facility shall provide records of all maintenance and repairs to the city engineer upon request.

(6) *Easements for stormwater management system.* The applicant shall provide all stormwater management easements as determined necessary by the city engineer to implement the approved final stormwater management plan and to otherwise comply with this article.

a. Stormwater management easements may be required for any of the following purposes:

1. To provide access for stormwater management facility inspections and maintenance.

2. To preserve stormwater runoff conveyance, infiltration, and detention areas and facilities, including flood routes for storm events.

3. To preserve primary and secondary drainage ways that are needed to serve stormwater management needs of other properties.

4. To accomplish purposes such as those listed above for all areas used for offsite stormwater control, including undeveloped or undisturbed lands, as applicable.

5. To serve other purposes and objectives as necessary to achieve the purposes of this article as determined by the city engineer.

b. All stormwater management easements shall meet the following requirements:

1. The purpose of each easement shall be specified in writing.

2. The easements shall be acceptable to the city attorney in form and substance and shall be recorded with the county register of deeds.

(7) *Implementation plan.* The applicant shall provide an implementation plan for construction and inspection during and after construction of all stormwater management system components required by the final stormwater management plan, including a schedule of the estimated dates of completing construction of the stormwater management system shown on the plan; identification of the proposed inspection procedures to ensure that the stormwater management system components are constructed and operating in accordance with the final stormwater management plan; and recordkeeping requirements. The implementation plan will include arrangements acceptable to the city engineer for notification by the applicant to the city engineer before the commencement of construction of the stormwater management system (and before construction of critical components of the system) and for final verification of construction by a registered professional engineer.

(8) *Performance guarantee.* The applicant shall provide a performance guarantee in a form and amount satisfactory to the city engineer and the city attorney as provided by this section.

a. The applicant shall submit a performance bond (or other financial guarantee acceptable to the city) for the timely and satisfactory construction of all stormwater management system components in accordance with the final stormwater management plan. The performance bond or other financial guarantee shall be accompanied by a detailed cost estimate provided by the applicant. Upon written certification by a registered professional engineer that all components of the required stormwater management system have been completed in accordance with the final stormwater management plan, including, but not limited to, the provisions contained in subsection (d)(7) of this section (implementation plan) and section 27-151 (as-built certification and final inspection), and subject to final acceptance and approval by the city engineer, the city may release the performance bond or other financial guarantee.

b. Except as provided in subsection (d)(8)c. of this section, the amount of the financial guarantee shall be in the amount of the cost estimate for the work provided by the applicant, unless the city engineer determines that a greater amount is appropriate, in which case the basis for such determination shall be provided to the applicant in writing. In determining whether a greater amount is appropriate, the city engineer shall consider the size and type of the development, the size and type of the on-site stormwater system, and the nature of the off-site stormwater management system the development will use.

c. The city engineer may, but shall not be required to, waive or reduce the amount of the financial guarantee for a development that will not increase the impervious surface of the development site by more than two thousand (2,000) square feet.

d. Nothing in this section or this article shall be construed or interpreted as relieving any person of their obligation to pay all costs associated with on-site private stormwater management systems, as well as those costs arising from the need to make other drainage improvements to reduce a development's impact on a drain consistent with adopted design standards.

(9) *Other information and materials.* The stormwater management plan shall include any other information, documents, items, and materials determined necessary by the city engineer to verify that the stormwater management plan complies with the city's design and performance standards for drains and stormwater management systems, and that the plan otherwise complies with the requirements of this article and other applicable laws and regulations.

(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 7. MINIMUM PERFORMANCE STANDARDS AND CRITERIA

Sec. 27-138. General.

Unless a waiver is granted pursuant to section 27-148 of this article, all stormwater management facilities, practices, methods, and procedures for a covered development shall be designed, constructed, and maintained in accordance with the minimum performance standards and criteria provided by this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-139. Stormwater management manual.

(a) The city engineer shall adopt a stormwater management manual to be used by the city engineer as a guide in reviewing, evaluating, and approving stormwater management permit applications, stormwater management plans, and associated stormwater management facilities, practices, methods, and procedures, and as otherwise determined appropriate by the city engineer to implement requirements of this article.

(b) The city engineer may revise and update the stormwater management manual from time to time based on improvements in engineering, science, monitoring, and local maintenance experience or to comply with changes in federal, state, and local stormwater laws and regulations, or as otherwise determined necessary and appropriate by the city engineer.

(c) The stormwater management manual adopted by the city engineer may include and incorporate by reference such other stormwater management manuals, guidebooks, and reference materials as determined appropriate by the city engineer, including, but not limited to, the "Guidebook of Best Management Practices for Michigan Watersheds," (MDEQ, 1998), and the "Low Impact Development Manual for Michigan" (SEMCOG 2008), as those manuals and reference materials may be updated and revised from time to time.

(d) The stormwater management manual shall list and include minimum design criteria, specifications, and performance standards for acceptable stormwater management facilities, practices, methods, and procedures as determined necessary and appropriate by the city engineer to meet the objectives of managing the quantity and quality of stormwater runoff from development sites, and provide flexibility to accommodate local conditions, consistent with the purposes and requirements of this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-140. Stormwater management system components.

An applicant for a stormwater management permit may select and propose any combination of

stormwater management facilities, practices, methods, and procedures, that meet the minimum design criteria, specifications, and performance standards specified by the city's stormwater management manual, provided that the selected stormwater management facilities, practices, methods, and procedures, shall also meet all of the following requirements, as determined by the city engineer:

(a) Take into consideration the natural features, upland areas, wetlands, and watercourses on the site; the potential for onsite and offsite adverse stormwater impacts, water pollution, and erosion; and the size of the site;

(b) Maintain, at a minimum, predevelopment runoff conditions on the site, and to the maximum extent feasible, attempt to improve upon predevelopment runoff conditions;

(c) Are appropriate for conditions on the site, near the site, and within the watershed;

(d) Do not conflict with the existing local stormwater management and watershed plans;

(e) Are designed, constructed, and completed in a manner to protect the public health and safety, and to minimize the need for maintenance and reduce the chances of failure;

(f) Are designed, constructed, and completed in a manner to meet the general standards for on-site and off-site stormwater management as provided by section 27-141 of this article;

(g) Are designed, constructed, and completed in a manner to meet the soil erosion control requirements as provided by section 27-142 of this article;

(h) Are designed, constructed, and completed in a manner to meet the requirements applicable to the discharge of stormwater runoff to wetlands as provided by section 27-143 of this article;

(i) Comply with the minimum treatment volume standard as provided by section 27-144 of this article;

(j) Comply with the channel protection criteria as provided by section 27-145 of this article;

(k) Comply with all other applicable requirements as provided by this article; and

(l) Comply with all other applicable local, county, state, and federal requirements.

In determining what stormwater management facilities, practices, methods, and procedures will be required in a particular case, the city engineer may consider all technological, economic, practical, and institutional considerations as determined relevant and appropriate by the city engineer, consistent with achieving and maintaining compliance with the requirements of this article and other applicable laws and regulations.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-141. General standards for on-site and off-site stormwater management.

(a) Stormwater management conveyance, storage and infiltration measures and facilities shall be designed to prevent flood hazards and water pollution related to stormwater runoff, to prevent accelerated soil erosion from the proposed development, and shall conform with requirements specified in the stormwater management manual.

(b) Natural topography and site drainage shall be preserved and site grading shall be minimized to the maximum extent reasonably achievable considering the nature of the development.

(c) Unless otherwise approved by the city engineer, stormwater runoff shall be conveyed through swales and vegetated buffer strips so as to decrease runoff velocity, allow for natural infiltration, allow suspended sediment particles to settle, and to remove pollutants. To the fullest extent possible, impervious surfaces should be disconnected from other impervious surfaces.

(d) Runoff rates from detention basins shall conform to the requirements specified in the stormwater management manual for the first flush, bankfull, and one-hundred-year storm.

(e) Watercourses shall not be deepened, widened, dredged, cleared of vegetation, straightened, stabilized or otherwise altered without applicable permits or approvals from the city, relevant county agencies, and the MDNRE.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-142. Soil erosion control.

(a) Cutting, filling and grading shall conform with the requirements specified in the stormwater management manual.

(b) All development and other land disturbance activities shall be designed, constructed, and completed in such a manner that the exposed area of any disturbed land is limited to the shortest practical period of time. Proposed erosion control measures shall be submitted to Jackson County for determination that such measures comply with the county's soil erosion and sedimentation control requirements.

(c) Approved soil erosion control measures shall be installed and maintained between the disturbed area and any down-gradient watercourses (including rivers, streams, creeks, lakes, ponds, and other watercourses), wetlands, roadways, and property lines.

(d) Sediment resulting from accelerated soil erosion shall be removed from runoff water before it leaves the site of the development.

(e) Temporary and permanent soil measures designed and constructed for the conveyance of water around, through, or away from the development or land disturbance activity area shall be designed to limit the water flow to a non-erosive velocity.

(f) Temporary soil measures shall be removed after permanent soil measures have been implemented and stabilized. All developments and land disturbance activity areas shall be stabilized with permanent soil measures.

(g) If inland lakes, ponds, rivers, creeks, streams, or other watercourses and wetlands are located on or near the site, measures that trap sediment shall be provided. The use of temporary sediment basins, sediment traps, filter fabric, and rock filters shall be employed as required by the city engineer. Other measures may be required if reasonably determined to be necessary by the city engineer to protect a watercourse or wetland.

(h) If it is not possible to permanently stabilize a disturbed area after an earth change has been completed or where significant land disturbance activity ceases, temporary soil erosion control measures shall be implemented within two (2) calendar days.

(i) Permanent soil measures for all slopes, channels, ditches, or any disturbed land area shall be completed within fifteen (15) calendar days after final grading or the final land disturbance activity has been completed. All temporary soil measures shall be maintained until permanent soil measures are implemented and stabilized.

(j) Vegetated filter strips, twenty-five (25) feet in width, preferably vegetated with native plant species, shall be created or retained along the edges of all lakes, creeks, streams, wetlands, and other watercourses. The width of a particular filter strip may be reduced to the extent it is demonstrated to the city engineer's satisfaction that a portion of the width will serve no useful function, e.g., to the extent the grade is such that water flow will be away from the watercourse and the filter strip does not serve to protect wildlife habitat or other useful function.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-143. Discharge of stormwater runoff to wetlands.

(a) Wetlands shall be protected from damaging modification and adverse changes in runoff quality and quantity associated with land disturbance activities. Before approval of a final plat or site plan, all necessary wetland permits from the MDNRE and/or the city must first be obtained.

(b) Wetlands shall be protected during development by appropriate soil erosion and sedimentation control measures that are continuously maintained throughout the construction phase.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-144. Minimum treatment volume standard.

To address water quality impacts of storm runoff, all stormwater management plans shall comply with the minimum treatment volume standard provided by this section.

(a) The minimum treatment volume standard shall be one (1) inch of runoff from the entire site.

(b) Treatment methods shall be designed on a site-specific basis to achieve either of the following:

(1) A minimum of eighty (80) percent removal of total suspended solids (TSS), as compared with uncontrolled runoff; or

(2) Discharge concentrations of TSS not to exceed eighty (80) milligrams per liter (mg/l).

(c) A minimum treatment volume standard is not required where site conditions are such that TSS concentrations in stormwater discharges will not exceed eighty (80) mg/l.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-145. Channel protection criteria.

All stormwater management plans shall comply with the channel protection criteria provided by this section to address post-development site runoff volume and peak flow rates.

(a) A stormwater management plan shall require such stormwater management practices, methods, and facilities as necessary to maintain post-development site runoff volume and peak flow rates at or below existing levels for all storms up to the two-year, twenty-four-hour event, as determined adequate by the city engineer. "Existing levels" means the runoff flow volume and rate for the last land use prior to the proposed development. The city engineer may specify more restrictive criteria if determined necessary by the city engineer to meet the goals of reducing runoff volume and peak flows to less than existing levels on the property to be developed.

(b) To ensure that the required channel protection criteria are met, the city engineer shall use the procedures, methods, techniques, formulas, and data sources as contained in the city's stormwater management manual or as otherwise determined appropriate by the city engineer.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-146. Hotspots.

The city engineer may require the use of specific structural stormwater management practices and pollution prevention practices for stormwater discharges from hotspots. In addition, stormwater discharges from a hotspot land use or activity shall be properly pretreated prior to infiltration to remove potential pollutants (including, but not limited to, heavy metals, nutrients, dissolved pollutants, and total petroleum hydrocarbons) from entering either groundwater or surface waters, as determined necessary by the city engineer.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-147. Off-site stormwater management.

(a) In lieu of on-site stormwater detention, the use of off-site stormwater conveyance, infiltration, and/or detention areas may be proposed. Off-site stormwater management systems shall be designed, constructed, completed, and maintained to comply with the standards and requirements specified in the stormwater management manual and all other standards and requirements provided by this article that are applicable to onsite facilities. Further, all provisions of this article, including, but not limited to, provisions regarding performance guarantees, inspections, O&M plans and agreements, and easements, shall also apply to off-site stormwater management systems.

(b) Off-site stormwater management areas may be shared with other landowners, provided that the terms of the agreement are approved by the city engineer and city attorney.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-148. Waivers; application; conditions for grant.

Unless a waiver is granted pursuant to this section, all stormwater management facilities, practices, methods, and procedures for a covered development shall be designed, constructed, and maintained in accordance with the minimum performance standards and criteria provided by this division.

(a) The applicant for stormwater management permit may apply to the city engineer for a full or partial waiver from strict compliance with the minimum performance standards and criteria provided by this division. All waiver requests shall be submitted in writing and accompanied by the applicable waiver fee as established from time to time by the city engineer.

(b) Each request for a waiver shall be considered on a case-by-case basis. After considering the request, the city engineer shall respond in writing by granting or denying the waiver in full, in part, or granting the waiver with any necessary conditions or mitigation measures to protect public health, safety, welfare, and the environment, or as otherwise determined necessary to meet the purposes and intent of this article. If granted, the waiver provisions and any conditions imposed shall be incorporated as a part of an approved final stormwater management plan.

(c) The city engineer shall not grant a waiver unless the applicant demonstrates to the city engineer's satisfaction that at least one (1) of the following conditions exist:

(1) Alternative, equally effective, minimum requirements for on-site management of stormwater discharges are available to be used in place of the requirement for which the waiver is requested.

(2) The applicant has made provisions to manage stormwater using an off-site facility; the off-site facility is designed and adequately sized to provide a level of stormwater control that is equal to or better than that which would be afforded by on-site practices; and there is a legally obligated entity responsible for long-term operation and maintenance of the off-site facility.

(3) Full compliance with the otherwise applicable minimum on-site stormwater management requirements is not technologically or economically feasible due to the natural or existing physical characteristics of a site (including pre-existing development).

(4) New non-structural practices will be implemented on the site that will meaningfully reduce the generation of stormwater from the site; the size and cost of stormwater storage; and the pollutants generated at the site.

(d) Notwithstanding the existence of one (1) or more conditions under subsection (c) of this section that would otherwise support the grant of a waiver, the city engineer shall not grant a waiver if the city engineer determines that any of the following conditions apply:

(1) The waiver, if granted, might (by itself or considering its cumulative effect along with other waivers previously granted) result in any of the following impacts on downstream waterways:

a. Deterioration of existing culverts, bridges, dams, and other structures;

b. Degradation of biological functions or aquatic habitat;

c. Accelerated streambank or streambed erosion or siltation;

d. Adverse impacts on channel stability; or

e. An increase in the extent, frequency, or duration of flooding at downstream properties and structures.

(2) The waiver, if granted, would (by itself or considering its cumulative effect along with other waivers previously granted) impair attainment of the purposes and objectives of this article; and/or interfere with achieving the goals outlined in the Upper Grand River Watershed Master Plan.

(3) The need for the waiver was self-created by the prior actions of the applicant.

(4) The need for the waiver is caused by the applicant's unwillingness to incur reasonable costs necessary to comply with the minimum performance standards and criteria provided by this division.

(5) The applicant has not demonstrated that all reasonable options to comply with the minimum performance standards and criteria provided by this division have been exhausted.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-149. Mitigation measures.

(a) If a waiver is granted pursuant to section 27-148 of this article, and the city engineer determines that as a result of the waiver the level of stormwater control provided will be less than what would have been achieved without the waiver, then the applicant must implement mitigation measures to provide the same level of stormwater control that would have achieved without the waiver, as determined sufficient and appropriate by the city engineer.

(b) Mitigation measures may include, but are not limited to, one (1) or more of the following:

(1) *Fee in lieu.* If the city engineer waives all or part of the minimum stormwater management requirements, or if the waiver is based on the provision of adequate stormwater facilities provided downstream of the proposed development, the applicant may be required to pay a fee in lieu of stormwater management practices. The amount of the fee shall be determined by the city engineer, and based on the cubic feet of storage required for stormwater management of the development in question. All of the monetary contributions shall be credited to a dedicated fund for stormwater management activities within the watershed, and shall be paid by the applicant prior to the issuance of the stormwater management permit for the development.

(2) *Dedication of land; grant of easement.* An applicant may enter into an agreement with the owner of other property that currently lacks adequate stormwater management facilities for the granting of an easement or the dedication of land by the applicant to be used for the construction of stormwater management facilities on the other property. The other property shall be located within the watershed and, if possible, shall be located adjacent to the same stream corridor as the applicant's development. Both the applicant and the owner of the other property shall obtain stormwater management permits as provided by this article. The agreement shall be entered into between the applicant and the other property owner prior to the issuance of the stormwater management permits. The agreement shall contain adequate provisions to ensure that the off-site stormwater management facilities will be designed, constructed, completed, and maintained to comply with the standards and requirements specified in the stormwater management manual and all other standards and requirements provided by section 27-147 of this article for off-site stormwater management facilities.

(3) *Other.* The applicant may implement such other mitigation measures for application with the watershed as determined sufficient and appropriate by the city engineer.

(c) All stormwater mitigation measures shall be consistent with the city's stormwater management manual and other applicable requirements of this article.

(d) The city engineer shall not approve any mitigation measure that would require the city to incur any current or future cost or expense in connection with the mitigation measure (other than costs and expenses that must be reimbursed to the city or otherwise subject to recovery by the city as provided by this article).
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 8. INSPECTIONS OF STORMWATER MANAGEMENT SYSTEMS

Sec. 27-150. Inspections to ensure plan compliance during construction.

(a) Periodic inspections during construction of a stormwater management system shall be conducted by the city engineer, or conducted and certified by a professional engineer who has been approved by the city engineer. All inspections shall be at the sole cost of the permittee. The approved final stormwater management plan shall be used for determining compliance during construction inspections.

(b) All inspections shall be documented with written reports that contain the following information:

(1) The date and location of the inspection;

(2) The name and qualifications of the inspector;

(3) The specific components of the stormwater management system inspected;

(4) Whether construction of the a stormwater management system was determined to be in compliance with the approved final stormwater management plan;

(5) Any variations in the construction from the approved final stormwater management plan; and

(6) Any other variations or violations of the requirements or conditions of the approved final stormwater management plan.

(c) If the inspection is conducted by a professional engineer approved by the city engineer, the written report shall be submitted to the city engineer immediately upon completion of the inspection.

(d) If any variations or violations are found, the permittee shall be notified in writing of the nature of the variations or violations and the required corrective actions.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-151. As-built certification and final inspection.

(a) Within twenty (20) working days of the date of completion of construction of a stormwater management system (or discrete components thereof if the construction is phased), the permittee shall prepare and submit to the city engineer reproducible mylars and electronic files (in AutoCAD format) of the actual as-built plans for the system. The mylars shall be made of quality material and three (3) mils in thickness and shall otherwise be prepared at the same scale and level of detail as the approved final stormwater management plan.

(b) The as-built plans shall show the final design specifications for the stormwater management system (and all discrete components thereof) and any deviations from the approved final stormwater management plan, and shall be accompanied by a written certification that the construction has been completed in full accordance with the approved final stormwater management plan. The as-built plans and written certification shall be signed and sealed by a professional civil engineer registered in the State of Michigan.

(c) The city engineer shall conduct a final inspection of the stormwater management system. The stormwater management system must be approved by the city engineer before any performance guarantees may be released.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-152. Ongoing, long-term inspections.

(a) Stormwater management systems approved under this article shall be inspected on an ongoing basis to document proper operation and main-

tenance and the need for repairs, and to ensure compliance with the stormwater management permit, the approved final stormwater management plan (including the O&M plan and agreement and implementation plan), and other applicable requirements of this article.

(b) A stormwater management system shall be inspected on a periodic basis by the responsible person in accordance with the approved O&M plan and agreement.

(c) In addition to the inspections required by the O&M plan and agreement, the city engineer may establish an inspection program, including but not limited to: routine inspections; random inspections; inspections based upon complaints or other notice of possible violations; and joint inspections with other agencies inspecting under other environmental or safety laws. Inspections may include, but are not limited to: reviewing maintenance and repair records; sampling discharges, surface water, groundwater, and material or water in stormwater management facilities; and evaluating the condition of stormwater management facilities, practices, methods, and procedures.

(d) If the city engineer determines that a stormwater management system has not been properly operated or maintained, or has become a danger to public safety, health, or the environment, the city engineer shall notify the responsible person for carrying out the O&M plan and agreement by first-class mail and also by certified mail. The notice shall specify the measures needed to comply with the O&M plan and agreement and shall specify the time within which such measures shall be completed. If the responsible person fails or refuses to complete the measures needed to comply with the O&M plan and agreement within the specified time, the city engineer may enter the property and perform, or cause to be performed, the necessary work to return the stormwater management system to full compliance, and bill the property owner for the full cost of any such work.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-153. Right-of-entry.

(a) The discharge of stormwater runoff is a pervasively regulated activity under state and federal laws and this article. The city has the right and obligation to inspect discharges of post-construction stormwater runoff from development and redevelopment sites to ensure compliance with applicable local, state, and federal laws and regulations.

(b) Any person who discharges, or applies to discharge, post-construction stormwater runoff from a development or redevelopment site is hereby put on notice that inspections may be made in accordance with this article and the Michigan and United States Constitutions. Any such person who discharges, or applies to discharge, post-construction stormwater runoff from a development or redevelopment site does so with the knowledge that inspections provided for by this article will be made to ensure compliance with applicable requirements. Such a person shall have no reasonable expectation of privacy with respect to such discharges (or potential discharges) and announced and unannounced inspections may be conducted as authorized by this article and state and federal laws.

(c) The city engineer and other authorized representatives of the city bearing proper credentials and identification are authorized to enter the development site to conduct inspections as necessary to determine, independent of information supplied by or on behalf of applicants or permittees, compliance with stormwater management permits, stormwater management plans, the standards and requirements of this article and with other applicable laws and regulations. This authority shall include the right to observe, measure, monitor, sample, test, and photograph for purposes including, but not limited to, the following:

(1) To verify the completeness and accuracy of information submitted to the city engineer.

(2) To determine compliance with the terms, conditions and requirements of stormwater management permits and stormwater management plans.

(3) To assess the adequacy of required stormwater management practices, methods, and facilities.

(4) To determine if permittees have corrected problems identified in previous inspections.

(5) To correct a noncompliance or otherwise support enforcement actions taken by the city against non-compliant permittees.

(6) To obtain required records.

(7) To set up and maintain on the development site such devices as are necessary to conduct sampling, inspection, compliance monitoring and/or metering operations, or to require the permittee to do so, at the permittee's sole expense.

(8) To repair and maintain stormwater management systems (or portions thereof) that have not been properly repaired or maintained by the property owner or any other responsible persons and to recover from the property owner all associated costs and expenses thereby incurred by the city.

(9) To abate a public nuisance.

(d) Applicants, permittees, and other responsible persons shall allow the city engineer and other authorized city representatives ready access at all times to all parts of the development site where stormwater management systems required by this article are located for the purposes of inspection as provided by this division. If security measures are in force on the site that would require proper identification and clearance before entry by the city, the applicant, permittee, or other responsible person shall make necessary arrangements in advance with security guards so that upon presentation of suitable identification, authorized city representatives will be permitted to enter, without delay, for the purposes of performing their specific responsibilities. Upon arrival at the development site, city representatives shall inform the applicant, permittee, or other responsible person that inspections and associated activities are to be performed and that the applicant, permittee, or other responsible person has the right to accompany the city representative during the inspection. Entry shall be commenced and completed as expeditiously as practicable, consistent with the purposes for which the entry was made.

(e) The refusal to permit access (or causing an unreasonable delay in access) as provided by this section shall constitute a violation of this article. If an applicant, permittee, or other responsible person refuses to permit access (or unreasonably delays access) to an authorized city representative or to permit the representative to undertake authorized inspection activities as provided by this article, the city engineer may order the permittee to permit access within a time certain; issue a notice of violation of this section; or take other appropriate action as provided by this article and other applicable laws and regulations (including, but not limited to, seeking the issuance of a search warrant).
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 9. RECORDKEEPING

Sec. 27-154. Recordkeeping requirements.

Any person subject to the requirements of this article shall retain and preserve for no less than three (3) years any and all books, drawings, plans, prints, documents, memoranda, reports, correspondence and records, including records on magnetic or electronic media and any and all summaries of such records, related to the discharge of stormwater runoff and stormwater management systems governed by this article.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 10. ACCIDENTAL DISCHARGES

Sec. 27-155. Notice requirements; affirmative defense.

(a) Any person who accidentally discharges into the MS4 any substance other than stormwater shall upon becoming aware of the discharge immediately inform the city of the discharge. If the accidental discharge occurs during normal weekday business hours, the discharger shall immediately notify the city engineer. At all other times, the discharger shall immediately notify the city police department.

(b) If notice of the accidental discharge is given orally, a written report concerning the discharge shall be filed with the city engineer within five (5) days. The written report shall specify:

(1) The composition of the discharge and the cause thereof.

(2) The exact date, time, duration, and estimated volume of the discharge.

(3) All measures taken to clean up the accidental discharge, and all measures proposed to be taken to reduce and prevent any recurrence.

(4) The name and telephone number of the person making the report, and the name and telephone number of a person who may be contacted for additional information on the matter.

A discharge shall be considered properly reported only if the discharger complies with all the requirements of this subsection (b).

(c) A properly-reported accidental discharge that also meets the requirements of this subsection (c) shall be an affirmative defense to a municipal civil infraction proceeding brought under this article against a person for the discharge. It shall not, however, be a defense to a legal action brought to obtain an injunction, to obtain recovery of costs, or to obtain other relief related to the discharge. In a municipal civil infraction proceeding, the person seeking to establish the affirmative defense for the accidental discharge shall have the burden of proof and must demonstrate, through properly signed, contemporaneous written records, or other relevant evidence, all of the following:

(1) An accidental discharge occurred and the person can identify the cause(s) of the accidental discharge;

(2) The facility was at the time being operated in a prudent and workmanlike manner and in compliance with applicable operation and maintenance procedures as provided by the O&M plan and agreement;

(3) The accidental discharge was not caused by operational error, improperly designed or inadequate stormwater management system, lack of preventative maintenance, or careless or improper operation.

(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 11. EXISTING COUNTY DRAINS

Sec. 27-156. Drains under the jurisdiction of the drain commissioner.

(a) Drainage districts shall not be altered when designing development drainage, except as provided under Section 433 of Act 40, Public Act 1956 as amended.

(b) Existing county or city drain easements shall be indicated on the plans as well as the final plan and will be designated as "Jackson County Drain" or "City of Jackson Drain", as applicable. It shall be the responsibility of the applicant for a stormwater management permit to check the permanent records of the drain office to determine if a drain easement is in existence on the subject property.

(c) A permit must be obtained from the county drain commissioner's office prior to tapping or crossing any county drain. The permit must be obtained prior to final approval of a stormwater management plan.

(d) Proposed relocations of county drains shall be processed through the office of the county drain commissioner.

(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 12. ENFORCEMENT

Sec. 27-157. Notice of violation.

(a) Any person found to be violating a provision of this article may be served with written notice stating the nature of the violation and providing a reasonable time limit for the satisfactory correction of the violation. The person shall, within the period of time stated in the notice, permanently cease and/or correct all violations. The notice of violation (NOV) shall be served and shall contain the information as provided by section 27-159 of this article.

(b) Unless otherwise specified by the NOV, the following provisions shall apply: Within thirty (30) days of the date of the NOV, the person shall submit to the city engineer a written explanation of the violation and a plan for the satisfactory correction and prevention thereof, to include specific required actions. Submission of the required plan shall not in any way relieve the person of liability for any violations occurring before or after receipt of the NOV.

(c) Nothing in this section shall limit the authority of the city or the city engineer to take any action, including emergency actions or any other enforcement action, without first issuing a NOV, or otherwise require the city or the city engineer to first issue a NOV before initiating a civil or criminal action against a person for violating this article.

(d) Failure or refusal to comply with any requirement of a NOV shall constitute a separate violation of this article.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-158. Orders and supplemental enforcement tools.

The city engineer may issue an order to any person as determined by the city engineer to be appropriate under the circumstances, as provided by this section. Multiple orders may be issued simultaneously or in combination as a single order with respect to a single person.

(a) *Service.* An order shall be served upon a person and shall contain the information as provided by section 27-159 of this article. However, orders to immediately cease and desist discharge or other emergency orders where delay might endanger human health, safety, welfare, or the environment may be oral and may be served by telephone (to be followed within five (5) days by written confirmation of the order by the city engineer).

(b) *Types of orders.* The city engineer may issue the following types of orders:

(1) *Order to immediately cease and desist discharge.* The city engineer may issue an order to cease and desist from discharging to the MS4 any stormwater not in compliance with this article. The order shall have immediate effect if the actual or threatened discharge to the MS4 presents, or may present, imminent or substantial endangerment to the health, safety, or welfare of persons, or to the environment. If the person fails or refuses to comply with the order to immediately suspend its discharge, the city engineer shall implement whatever action is determined necessary as authorized by this article, including, but not limited to, physical blockage of the discharge. The person shall be responsible for and shall be assessed for any penalties, fines, charges, costs, expenses, or losses incurred due to the actual or threatened discharge of stormwater as provided by this article.

If the city engineer determines that physical blockage is necessary, the city engineer shall make a reasonable attempt to deliver to the person who appears to be in control of the facility a written notice describing the reason for the physical blockage order. After delivery of the notice (or after a reasonable attempt to deliver the notice, even if delivery was unsuccessful), the city engineer may immediately install the physical blockage. No person shall remove or tamper with a physical blockage installed by the city engineer without prior written permission from the city engineer.

(2) *Order to cease discharge within a time certain.* The city engineer may issue an order to cease and desist from discharging any stormwater not in compliance with this article by a certain time and date. The proposed time for remedial action shall be specified in the order. In addition to any other circumstances as determined appropriate by the city engi-

neer, an order may be issued under this section for the failure or refusal to comply with any term of a stormwater management permit or stormwater management plan.

(3) *Order to repair or maintain stormwater management system.* The city engineer may issue an order to a person requiring the person to repair and/or maintain a stormwater management system (or component thereof) in accordance with a stormwater management permit or stormwater management plan. Any person subject to an order to repair or maintain shall prepare a plan to conduct the repairs or maintenance as necessary to comply with the requirements of the stormwater management permit or stormwater management plan. The plan shall be submitted to the city engineer within a reasonable period as specified in the order. The plan shall be prepared in accordance with good engineering practice and shall state whether construction is necessary, as well as identify measures that can be completed without construction. The plan shall contain a schedule of compliance for completion of each of the various phases necessary to implement full compliance. The schedule of compliance must be approved by the city engineer and shall consist of one (1) or more remedial measures, including enforceable timetables for a sequence of actions or operations leading to compliance with the stormwater management permit or stormwater management plan.

(4) *Stop work order.* Where there is work in progress that causes or constitutes in whole or in part, a violation of any provision of this article, the city engineer is authorized to issue a stop work order so to prevent further or continuing violations or adverse effects. All persons to whom the stop work order is directed, or who are involved in any way with the work or matter described in the stop work order shall fully and promptly comply therewith. The city engineer may also undertake or cause to be undertaken, any necessary or advisable protective measures so as to prevent violations of this article or to avoid or reduce the effects of noncompliance herewith. The cost of any such protective measures shall be the responsibility of the owner of the property upon which the work is being done and the responsibility of any person carrying out or participating in the work.

(5) *Order to affirmatively respond.* The city engineer may issue an order requiring a person to perform any other action required under this article, including, without limitation, requiring a person to install sampling, metering, and monitoring equipment; to submit reports; to permit access for inspection; or to pay fees or other applicable charges.

(c) *Amendment, suspension, and revocation of orders.* An order shall be subject to amendment, suspension, or revocation as determined appropriate by the city engineer. Notice of the amendment, suspension or revocation shall be served upon the person in the same manner as notice was provided for the original order. An amendment, suspension, or revocation of an order shall be subject to the same procedures for review and appeal as the original issuance of the order, as provided by this article.

(d) *Consent orders and agreements.* The city engineer may enter into a consent order or agreement with a person to resolve disputed claims and address identified and potential deficiencies in the person's compliance status. The order or agreement shall be in the form of a written agreement with the person and may contain appropriate provisions, including,

without limitation, compliance schedules, stipulated fines, and required remedial actions.

(e) *City engineer authority to require financial assurances.* The city engineer may require any person to post a performance bond (or other form of surety acceptable to the city engineer) sufficient to cover expenses (direct and/or indirect) that might reasonably be incurred by the city engineer as a result of the person's discharges to the MS4 (including, but not limited to, the costs to restore or repair any damage to the MS4) or sufficient to achieve consistent compliance with a stormwater management permit, stormwater management plan, and applicable laws and regulations, as determined necessary by the city engineer. Further, any person that has in the prior two (2) years been responsible for causing damage to the MS4 may be required to obtain additional liability insurance (over and above what is required by subsection 27-136(b)(12) as determined sufficient to cover the reasonable costs of responding or restoring the MS4 in the event of any subsequent incidents. These financial assurance requirements may also be made conditions of a stormwater management permit or stormwater management plan.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-159. Service of notices of violations, orders and notices of assessments.

Except as otherwise expressly provided by this article, all orders, notices of violations and notices of assessments shall be served upon persons and shall contain the information as provided by this section.

(a) *Service.* Service shall be by personal delivery or first-class mail, and by also by certified mail, to the person's last known address as shown by the city's tax assessor's records. (If the violator is different than the property owner, a copy of any order or notice shall also be served on the property owner shown in the current tax rolls of the city.) The person served shall sign and date the order or notice and shall return the signed original copy to the city engineer; provided, that the failure or refusal to do so shall not affect the person's obligation to comply with the order or notice. Further, a notice or order served by mail may not actually be received by a person, but this shall not nullify any enforcement action subsequently taken by the city engineer against the person under authority of this article.

(b) *Content.* All orders and notices shall contain at least the following information, to the extent then known by the city engineer and as determined by the city engineer to be applicable to the situation:

(1) The name and address of the violator;

(2) The location and time that the violation occurred or was observed, and the duration of the violation;

(3) The nature of the violation, including the provisions of this article or of any permit, plan, order, decision, determination or agreement violated;

(4) The basis for determining that a violation has occurred (personal observation, report, etc.);

(5) The amount of the fine, penalty, costs, or charges assessed or due, if any;

(6) The manner in which, and time and date by which, any fine, penalty, costs, or charge must be paid, including any penalty or charge for late payment;

(7) The remedial actions ordered, the time within which required actions must be taken, and any consequences for failure or refusal to do so.

(8) The right to appeal the issuance of the order or notice and a summary of the procedures for appeal, or other applicable administrative procedures.

(9) The date and time the order or notice was issued.

(c) *Request for additional information.* A person served may request additional information from the city engineer regarding the contents or requirements of any order or notice. However, a request for additional information shall not extend the time for compliance with an order or notice.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-160. Municipal civil infractions.

(a) *Violation; municipal civil infraction.* Except as provided by section 27-161 of this article, and notwithstanding any other provision of the city's laws, ordinances, and regulations to the contrary, a person who violates any provision of this article (including, without limitation, any notice, order, permit, plan, decision or determination promulgated, issued or made by the city engineer under this article) is responsible for a municipal civil infraction, subject to payment of a civil fine of not less than one thousand dollars ($1,000.00) per day for each infraction and not more than ten thousand dollars ($10,000.00) per day for each infraction, plus costs and other sanctions.

(b) *Repeat offenses; increased fines.* Increased fines may be imposed for repeat offenses. As used in this section, "repeat offense" means a second (or any subsequent) municipal civil infraction violation of the same requirement or provision of this article committed by a person within any ninety-day period and for which the person admits responsibility or is determined to be responsible. The increased fine for a repeat offense under this article shall be as follows:

(1) The fine for any offense that is a first repeat offense shall be not less than twenty-five hundred dollars ($2,500.00), plus costs.

(2) The fine for any offense that is a second repeat offense or any subsequent repeat offense shall be not less than five thousand dollars ($5,000.00), plus costs.

(c) *Amount of fines.* Subject to the minimum fine amounts specified in subsections (a) and (b) of this section, the following factors shall be considered by the court in determining the amount of a municipal civil infraction fine following the issuance of a municipal civil infraction citation for a violation of this article: the type, nature, severity, frequency, duration, preventability, potential and actual effect, and economic benefit to the violator (such as delayed or avoided costs or competitive advantage) of a violation; the violator's recalcitrance or efforts to comply; the economic impacts of the fine on the violator; and such other matters as justice may require. A violator shall bear the burden of demonstrating the presence and degree of any mitigating factors to be considered in determining the amount of a fine. However, mitigating factors shall not be considered unless it is determined that the violator has made all good faith efforts to correct and terminate all violations.

(d) *Authorized local official.* Notwithstanding any other provision of the city's laws, ordinances, and regulations to the contrary, the following persons are designated as the authorized local officials to issue municipal civil infraction citations directing alleged violators to appear in district court for violations of this article (or, if applicable, to issue municipal civil infraction notices directing alleged violators to appear at a municipal ordinance violations bureau): the city engineer, any sworn law enforcement officer, and any other persons so designated by the city.

(e) *Other requirements and procedures.* Except as otherwise provided by this section, the requirements and procedures for commencing municipal civil infraction actions; issuance and service of municipal civil infraction citations; determination and collection of court-ordered fines, costs, and expenses; appearances and payment of fines and costs; failure or refusal to answer, appear, or pay fines; disposition of fines, costs, and expenses paid; and other matters regarding municipal civil infractions shall be as set forth in Act No. 236 of the Public Acts of 1961, as amended.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-161. Criminal penalties; imprisonment.

Any person who meets the following criteria shall, upon conviction, be guilty of a misdemeanor punishable by a fine of five hundred dollars

($500.00) per violation, per day, or imprisonment for up to ninety-three (93) days, or both in the discretion of the court:

(a) At the time of a violation, the person knew or should have known that stormwater or a pollutant or substance was discharged contrary to any provision of this article, or contrary to any notice, order, permit, plan, decision, or determination promulgated, issued or made by the city engineer under this article; or

(b) The person intentionally makes a false statement, representation, or certification in an application for, or form pertaining to a permit, or in a notice, report, or record required by this article, or in any other correspondence or communication, written or oral, with the city engineer regarding matters regulated by this article; or

(c) The person intentionally falsifies, tampers with, or renders inaccurate any sampling or monitoring device or record required to be maintained by this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-162. Continuing violation.

Each act of violation, and each day or portion of a day that a violation of this article (or of any permit, plan, order, notice or agreement issued or entered into under this article) exists or occurs, constitutes a separate violation subject to the fines, penalties, and other sanctions and remedies as provided by this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-163. Responsibility for system; failure to maintain; abatement and cost recovery not a defense.

(a) The property owner is solely responsible to provide, repair, maintain, and pay all costs and expenses for a stormwater management system that is required by this article.

(b) The property owner (and other responsible persons, if designated) shall maintain in good operating condition and promptly repair and restore all elements of a required stormwater management system, including, but not limited to, grade surfaces, walls, drains, dams and structures, vegetation, erosion and sedimentation controls, and other protective devices. All repairs, restoration, and maintenance shall be in accordance with the O&M plan and agreement and approved final stormwater management plan and shall be at no cost or expense to the city.

(c) If the property owner (or other responsible person) fails or refuses to meet the requirements of the O&M plan and agreement, the city engineer may enter the property and perform, or cause to be performed, the necessary work to return the stormwater management system to full compliance, and bill the property owner for the full cost of any such work.

(d) The abatement by the city of any violation, or any failure or refusal to comply, with any requirement of this article and subsequent recovery by the city of all or a portion of the costs and expenses incurred by the city shall not be a defense to any action by the city against any person for the violation, including without limitation, any action by the city to collect civil fines, damages, costs or expenses as otherwise authorized by law.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-164. Review or approval by city.

The city's review or approval of a person's plans, specifications, or operating procedures shall not provide the person with relief from an enforcement action for the failure or refusal to comply with the standards and requirements of this article.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-165. Reimbursement of city.

(a) Any person who discharges to the MS4 (including, but not limited to, any person who causes or creates a discharge that violates any provision of this article or that damages, injures, or impairs the MS4, or causes or contributes to a violation of any federal, state, or local law governing the MS4, whether any such act is intentional or unintentional) shall be liable to and shall fully reimburse the city for all expenses, costs, losses, or damages (direct or indirect) payable or incurred by the city as a result of any such dis-

charge. The costs that must be reimbursed to the city shall include, but shall not be limited to, all of the following:

(1) All costs incurred by the city in responding to the discharge or noncompliance, including, expenses for any cleaning, repair or replacement work, and the costs of sampling, monitoring, analysis, and treatment, as a result of the discharge or noncompliance.

(2) All costs to the city of inspection and enforcement in connection with investigating, verifying, and prosecuting any discharge or noncompliance.

(3) The full amount of any fines, assessments, penalties, and claims, including natural resource damages, levied against the city, or any city representative, by any governmental agency or third party as a result of a violation of the city's MS4 watershed general permit, the city's certificate of coverage, or other applicable local, state, and federal laws and regulations that is caused by or contributed to by any discharge or noncompliance.

(4) The full value of any city staff time (including any administrative and overhead costs and any required overtime), consultant and engineering fees, and actual attorney fees and defense costs (including the city's legal counsel and any special legal counsel), associated with responding to, investigating, verifying, and prosecuting any discharge or noncompliance or otherwise incurred by the city in administering and enforcing the requirements of this article.

Further, the city is authorized to correct any violation of this article or damage or impairment to the MS4 caused by a discharge and to bill the person causing the violation or discharge for the amounts to be reimbursed. The costs reimbursable under this section shall be in addition to fees, amounts, or other costs and expenses required to be paid by persons under other sections of this article.

(b) Costs and expenses to be reimbursed to the city as provided by this section may be collected as provided by section 27-166 of this article, or as otherwise determined appropriate by the city engineer in conjunction with an enforcement action.

(c) The failure or refusal by any person to pay any amounts required to be reimbursed to the city as provided by this section shall constitute an additional violation of this article.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-166. Collection of costs and expenses; lien.

Costs and expenses incurred by the city in implementing and enforcing the provisions of this article, including, but not limited to, costs and expenses incurred by the city in responding to, correcting violations, and/or performing work pursuant to sections 27-152, 27-158, 27-163, 27-165, 27-167, 27-168, shall be a lien on the premises which shall be enforceable in accordance with Act No. 94 of the Public Acts of 1933 (MCL 141.101 et seq.), as amended from time to time. Any such costs and expenses which are unpaid for six (6) months or more shall be certified by the city manager on April 30 and September 30 of each year to the city assessor who shall enter the lien on the next tax roll against the premises and the costs and expenses shall be collected and the lien shall be enforced in the same manner as provided for in the collection of taxes assessed upon the roll and the enforcement of a lien for taxes. In addition to any other lawful enforcement methods, the city shall have all remedies authorized by Act No. 94 of the Public Acts of 1933, as amended.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-167. Nuisance.

A violation of this article, or of any permit, plan, order, notice, or agreement issued or entered into under this article, is deemed to be a public nuisance and shall be corrected or abated as directed by the city. In addition to any other legal or equitable remedies available under the law, any person creating a public nuisance shall be subject to the provisions of state law, this article, or other ordinance of the city governing

such nuisances, including reimbursing the city for any costs incurred in removing, abating, or remedying said nuisance, as applicable.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-168. Judicial relief.

With the approval of the city, in conjunction with the city's legal counsel, the city engineer may institute legal proceedings in a court of competent jurisdiction to seek all appropriate relief for violations of this article or of any permit, order, notice, or agreement issued or entered into under this article. The action may seek temporary or permanent injunctive relief, damages, penalties, costs, and any other relief, at law or equity, that a court may order. The city engineer may also seek collection of fines, penalties, and any other amounts due to the city that a person has not paid.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-169. Cumulative remedies.

The imposition of a single penalty, fine, order, damage, or surcharge upon any person for a violation of this article, or of any permit, plan, order, notice, or agreement issued or entered into under this article, shall not preclude the imposition by the city or a court of competent jurisdiction of a combination of any or all of those sanctions and remedies or additional sanctions and remedies with respect to the same violation, consistent with applicable limitations on penalty amounts under state or federal laws or regulations. A criminal citation and prosecution of a criminal action against a person shall not be dependent upon and need not be held in abeyance during any civil, judicial, or administrative proceeding, conference, or hearing regarding the person.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 13. ADMINISTRATIVE REVIEW AND APPEALS

Sec. 27-170. Appeal available.

Any person aggrieved by a notice of violation, order, or other action taken by the city engineer under this article may request review and reconsideration by the city engineer and/or may appeal to the stormwater board of appeals as provided by this division. If review and reconsideration or appeal is not properly and timely requested in connection with an action as provided by this division, the action shall be deemed final. The person requesting the appeal shall pay an appeal fee in the amount determined from time to time by the city council. The appeal fee shall be paid at the time that the appeal is requested.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-171. Review and reconsideration by the city engineer.

A request for a review and reconsideration by the city engineer must be made in writing within seven (7) days from the date of the city engineer's action in question. The request must state the reasons for the review and shall include all supporting documents and dates. A hearing on the request shall be scheduled at the earliest practicable date as determined by the city engineer. The hearing shall be conducted on an informal basis at the city engineer's offices or at another location designated by the city engineer. The city engineer shall conduct the hearing. Following the informal hearing, the city engineer may affirm or reverse, in whole or in part, the action appealed from, or may make any order, requirement, decision, or determination as, in the city engineer's opinion, ought to be made in the case under consideration. the city engineer shall notify the aggrieved person of the decision on the request in writing within fourteen (14) days of the hearing. The city engineer may request additional information and extend the time for his/her decision by an additional seven (7) days in writing following the submission of the additional information. The decision of the city engineer may be appealed to the stormwater board of appeals as provided by section [27-172]. All supporting documentation and information shall be provided by the person requesting the appeal at no cost to the city.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-172. Appeal to stormwater board of appeals.

(a) The building code board of examiners and appeals of the city shall serve as a stormwater board of appeals ("SWBA"). The SWBA shall

consider appeals from final decisions of the city engineer. The SWBA shall adopt its own rules of procedure, and keep a record of its proceedings, showing findings of fact, the action of the board, and the vote of each member upon each question considered. The presence of five (5) members of the SWBA shall be necessary to constitute a quorum.

(b) The following provisions shall govern appeals of final decision of the city engineer made to the SWBA under this article:

(1) An appeal from any final action of the city engineer must be made to the SWBA within seven (7) days from the date of the action appealed. The appeal may be taken by any person aggrieved by the action. The appellant shall file a written notice of appeal with the city engineer and with the SWBA. The notice of appeal shall specify the grounds for the appeal and shall be accompanied by a non-refundable appeal fee. Failure to file a timely notice of appeal shall be deemed to be a waiver of the right to appeal.

(2) Prior to a hearing before the SWBA regarding an appeal, the city engineer shall transmit to the SWBA a written summary of all previous action taken in connection with the action being appealed. The SWBA may, at the SWBA's discretion, request the city engineer to provide further information regarding the action that is the subject of the appeal.

(3) The SWBA shall fix a reasonable time for the hearing of the appeal. Notice of the hearing shall be provided at least ten (10) days in advance of the hearing to require the attendance and testimony of witnesses and the production of evidence relevant to any matter involved in the hearing. The appellant must submit an exhibit and witness list to the SWBA at least five (5) days before the hearing or as directed by the SWBA.

(4) The SWBA shall conduct the hearing. At the hearing, attorneys may represent the parties and they may file briefs, present evidence, and call, examine and cross-examine witnesses. Any testimony taken at the hearing shall be under oath and recorded. A copy of the transcript of the hearing shall be made available at cost to any person upon payment of applicable charges for the transcript.

(5) The SWBA shall admit all testimony having reasonable probative value and shall exclude irrelevant or unduly repetitious testimony, as determined by the SWBA The SWBA shall not be bound by common law or statutory rules of evidence. The appellant shall have the burden of proof and persuasion for showing that the city engineer's decision was clearly erroneous.

(6) If the action of the city engineer subject to the appeal involves the city engineer's grant or denial of a waiver as authorized by section 27-148 of this article, the SWBA's decision to grant or deny the appeal shall be based on the standards and conditions provided by subsection 27-148(c) and (d) of this article.

(7) Within thirty (30) days after the completion of the hearing, the SWBA shall mail or otherwise deliver to all of the parties a written decision granting, denying or modifying the decision appealed and/or relief being sought.

(8) The decision of the SWBA on the matter shall be final, and shall be a final determination for purposes of judicial review.

(9) If the city engineer or his or her designee sits on the building code board of examiners and appeals because of additional responsibilities as the director or public works, the city engineer shall abstain from any decision before the SWBA.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-173. Payment of charges and fees pending outcome of appeal.

All charges, penalties, fines, fees, surcharges, costs, or expenses outstanding during any appeal process shall be due and payable to the city. Upon resolution of any appeal, the amounts due and payable shall be adjusted accordingly. The city

may suspend discharges to the MS4 if a corrective course of action is not taken or if service charges, penalties, fines, fees, surcharges, costs, or expenses are not timely paid in full.
(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-174. Finality of action; emergency orders; permit appeals.

(a) If an appeal is not demanded as provided by this division within the periods specified by this division, the city engineer's action shall be deemed final.

(b) If an appeal is properly demanded, the action appealed shall be suspended until a final determination has been made by the SWBA, except for emergency orders or actions where a suspension or delay might endanger human health, safety, welfare, the environment, or the MS4; and as otherwise expressly provided by this section regarding permit appeals.

(c) If an appeal involves a final decision made by the city engineer in connection with issuing or implementing a stormwater management permit, the following provisions shall apply:

(1) The person appealing the decision must specify in its notice of appeal the action of the city engineer being appealed and the grounds for the appeal. If a particular permit provision is objected to, the notice of appeal must specify in detail the reasons for the objection, and the specific alternative provision, if any, sought to be placed in the permit.

(2) If, after considering the record on appeal including any statements provided by the city engineer in response to the appeal, the SWBA determines that a permit or any provision of a permit should be reconsidered, the SWBA shall remand the matter to the city engineer for further action as determined appropriate by the SWBA. Only the specific provisions of a permit that are remanded by the SWBA for reconsideration by the city engineer shall be stayed pending further final action taken by the city engineer as required by the decision of the SWBA.

(3) A decision of the SWBA not to remand any matter shall be considered final administrative action for purposes of judicial review.

(4) Except as otherwise expressly provided by subsection (c) of this section, no action taken or request filed by any permittee shall operate to stay the effect of any permit or of any provision, term or condition of any permit.

(Ord. No. 2011.01, § 1, 1-11-11)

Sec. 27-175. Appeals from determination of SWBA.

Appeals from a final determination of the SWBA may be made to the county circuit court as provided by law. All findings of fact made by the SWBA, if supported by the evidence, shall be deemed conclusive.
(Ord. No. 2011.01, § 1, 1-11-11)

DIVISION 14. CONSTRUCTION AND CONFLICTS

Sec. 27-176. Liberal construction; most restrictive provisions control.

(a) In their interpretation and application, the provisions of this article shall be held to be minimum requirements and shall be liberally construed in favor of achieving the purposes of this article, and shall not be deemed a limitation or repeal of any other powers granted by state and federal statutes and regulations.

(b) Notwithstanding any provision of this article to the contrary, the most stringent or restrictive stormwater standard or requirement applicable to a development or redevelopment shall control, whether established by this article, by a stormwater management permit, stormwater management plan, by state laws or regulations, including the city's MS4 watershed general permit or certificate of coverage, or by federal laws or regulations. Further, if state or federal stormwater laws or regulations provide for standards and requirements not covered by this article that are otherwise applicable to a development or redevelopment, those standards and requirements shall apply to the development or redevelopment in