LIVINGSTON COUNTY

Procedures and Design Criteria for Stormwater Management Systems

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ACKNOWLEDGEMENTS

The Environmental Protection Agency (EPA) through the Michigan Department of Environment, Great Lakes, and Energy (EGLE) requires the County of Livingston and other regulated entities to comply with the National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System (MS4) permit requirements. The purpose of these standards is to address Post-Construction Stormwater Runoff Controls required under this permit.

These standards are a result of ongoing regional collaboration between Oakland, Wayne, Macomb, and Livingston Counties with the following overall objectives:

1. Provide a comprehensive framework for managing stormwater that achieves improved surface water quality, channel and infrastructure protection, localized flood control and long-term operations and maintenance.
2. Incorporate design standards that control both the quantity and quality of stormwater runoff.
3. Require volume reducing Low Impact Development (LID) design measures, or Best Management Practices (BMPs), such as infiltration, preservation of natural areas, enhanced vegetation and reduced imperviousness to control runoff volume to the Maximum Extent Practicable (MEP).
4. Strengthen the protection of natural features.
5. Protect public health, safety and welfare.
6. Promote economic development using straightforward and uniform drainage standards for site development throughout Livingston County, as well as across Southeast Michigan.
7. Provide guidelines and additional resources for the selection of effective structural and vegetative stormwater BMP's for development sites.
8. Enhance the sustainability of stormwater management practices in Livingston County including performance, longevity, safety, maintenance, community acceptance, and environmental benefits.
9. Emphasize long-term operation and maintenance of the stormwater management practices.
10. Use current rainfall data based on NOAA Atlas 14.
11. Promote a consistent design process by using a set of simple equations to determine runoff rates, detention volumes, water quality treatment and infiltration requirements.

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INTRODUCTION

The Livingston County Drain Commissioner Procedures and Design Criteria for Stormwater Management Systems apply only to stormwater management systems within new development projects (1.0 acre or larger), and redevelopment projects (1.0 acre or larger). The following discussion applies to all aspects of managing land and stormwater.

A. The Role of the Livingston County Drain Commissioner

The Office of the Livingston County Drain Commissioner (Drain Commissioner) exercises authority over the design and construction of structural facilities (when directly connected to a county drain) that convey and treat stormwater runoff that will be generated from a site as a result of its development. The Drain Commissioner's Rules regulate the design of such management facilities with the following objectives:

- Incorporate design standards that address both water quantity and quality.
- Encourage innovative stormwater management practices that meet the criteria contained within these rules.
- Place an emphasis on the facility maintenance.
- Make the facility safety a priority.
- Incentivize the protection of natural features.
- Encourage effective soil erosion and sedimentation control measures.

Regardless of Drain Commissioner or Local Unit review, the developer is responsible for both on-site and off-site impacts associated with earth disturbance activities. The developer should take all precautions necessary to prevent downstream damage due to concentration of flow.

i. Local Unit Review

Typically, the Local Unit of Government (Local Unit), such as a Township, City, or Village retains an engineer to perform plan review of the proposed development. The purpose of such a review is to ensure conformance with engineering and design standards as codified in local ordinances applicable to the proposed development. In many cases, this review by the Local Unit does include an analysis of the drainage system.

The following conditions are provided as a precursor to the Drain Commissioner's acceptance of a drainage review from a Local Unit:

- The drainage system for the development is not proposed to be dedicated to the Drain Commissioner under the applicable provisions of the Drain Code.
- The drainage system for the development does not directly outlet to a county drain.

- The road system in the development is intended to be private.
- The Local Unit must have a stormwater management ordinance and said ordinance must require all developments within the Local Unit be designed to the standards outlined herein.
- The engineering review letter prepared on behalf of the Local Unit and submitted to this office must state that a professional engineer reviewed the plans for conformance with these standards, and that the proposed design meets all standards herein.
- Exceptions to the above requirements may be granted for parcel divisions, if the median parcel size in the overall parcel split exceeds 2 acres, and the developers engineer certifies that:

    a. The proposed parcel division will not result in a concentration of flow sufficient to require detention, and

    b. The outlet for the proposed parcel division is adequate to accept design flows without detriment to other properties in the watershed.

    c. The Drain Commissioner may require a demonstration that the above 2 conditions are met as a condition of accepting the certification required above.

B. Authority of the Drain Commissioner

The Livingston County Drain Commissioner draws authority from the Land Division Act, the Michigan Drain Code, the Mobile Home Commission Act, and Part 91 of the Soil Erosion and Sedimentation Control of Natural Resources and Environmental Protection Act. This authority includes:

i. All plats recorded with the Register of Deeds must conform to Act 288 of the Public Acts of 1967, as amended. Under this Act, the Drain Commissioner is responsible for ensuring that the drainage or stormwater management system of a subdivision is adequate to address stormwater management needs within the proposed subdivision and for protecting downstream landowners. The procedures, standards, and recommendations set forth in these rules are designed for these purposes.

ii. In accordance with the provisions of Act 288, the Drain Commissioner has the authority, through the subdivision review process, to require that county drains, both inside and outside of a plat, be improved to the standards established by the Drain Commissioner when necessary for the proper drainage of a proposed subdivision.

iii. As specified in Act 288, the Drain Commissioner may acquire jurisdiction over the drainage systems within subdivisions as deemed necessary for adequate operation and maintenance. (See Appendix A.)

iv. The general standards set forth herein will be applied by the Drain Commissioner in review of site condominium plans prepared under Act 59, P.A. 1978, as amended.

v. The general standards set forth herein will be applied by the Drain Commissioner in review for plans for mobile home parks prepared under Act 96, P.A. 1987.

vi. All developments within an established drainage district, as established under Act 40 of P.A. of 1956, as amended, shall conform to all requirements herein.

vii. These rules provide minimum standards to be complied with by Owners and in no way limit the authority of the Local Unit in which the development is situated to adopt or publish and enforce higher standards as a condition of approval of the final plat or site plan.

viii. The Drain Commissioner reserves the right to determine site-specific requirements other than those herein, based upon his/her review of the plans.

ix. Approval of final lot grading is not under the jurisdiction of the Drain Commissioner. Some local municipalities have ordinances relating to final lot grades. The Drain Commissioner's office is not responsible for inspection of, or enforcing corrections to, final lot grading or landscaping.

C. Framework for the Design of Stormwater Management Systems

Thoughtful site planning can reduce the negative drainage impacts associated with development. Toward this end, communities, regulatory agencies, and designers must evaluate the impact of each individual development project over the long term and on a watershed scale. Such an approach requires the consideration of Best Management Practices (BMPs) that function together as a system to ensure that the volume, rate, and pollutant load of runoff remains similar to that which occurred under natural conditions. This can be achieved through a coordinated network of structural and nonstructural methods, designed to provide both source and site control. In such a system, each BMP by itself may not provide major benefits, but when combined with others becomes very effective.

i. Source Controls

Source controls reduce the volume of runoff generated on-site and reduce initial opportunities for pollutants to enter the drainage system. Source controls are the best option for mitigating stormwater impacts and include the following key practices:

- Preservation of existing natural features that perform stormwater management functions, such as depressions, wetlands and vegetation along stream banks.
- Direction of stormwater discharges to open, grassed areas such as swales rather than allowing stormwater to run off from impervious areas directly into the stormwater conveyance system. Careful design and installation of erosion control mechanisms and rigorous maintenance throughout the construction period.

ii. Site Controls

Site controls are the subject of this document. After the implementation of source controls, site controls are then required to convey, pre-treat, and treat (e.g., detain, retain, or infiltrate) the stormwater runoff generated by development. The range of engineering and design techniques

available to achieve these objectives is to some degree dictated by site configuration, soil type, and the receiving waterway. For example, flat or extremely steep topography may preclude the use of grassed swales, which are otherwise preferable to curb and gutter systems, depending on the density of development. Likewise, sites upstream of cold-water fisheries may not be suitable for permanent wet basins that discharge heated surface waters. But while each site will be unique, some universal guidelines for improving discharge quality and minimizing maximum flows can be stated. Preferred Hierarchy of Structural Site Controls

a. In general, the most effective stormwater quality controls are properly maintained infiltration practices, which reduce both the runoff peak and volume.

b. The next most effective stormwater site controls reduce the runoff peak and involve storage facilities such as retention and detention basins. In the selection of an appropriate stormwater basin design, wet basins are generally preferable to dry detention basins since they hold stormwater much longer, allowing more particulate to settle out. In addition, the aquatic plants and algae within wet basins take up soluble pollutants (nutrients) from the water column. These nutrients are then transformed into plant materials that settle to the basin floor, decay, and are consumed by bacteria. Since this biological process is dependent upon the presence of water, it does not occur in dry basins. It should be noted that the encouraged use of wet basins as defined in this manual is not intended to mandate the creation of regulated wetlands as defined by state law.

c. Where site conditions make the use of a wet basin infeasible, basins should be designed to provide extended detention of stormwater, again to promote as much settling of particulate as possible.

d. Once all possible methods of reducing and treating stormwater on-site have been implemented, excess runoff must be discharged into conveyance systems and carried off-site in a suitable outlet.

SECTION 1 - PROCEDURES FOR PLAN SUBMISSION AND REVIEW

1.1. Preliminary Plat or Plan Submission and Approval

1.1.1. Submission Requirements

1. A preliminary plat (or plan) showing the layout of the area intended to be developed will be submitted to the Drain Commissioner's Office by the Owner. This plat (or plan) will be prepared under the direction of, and sealed by, a registered professional engineer or a registered land surveyor and should fit on a sheet of paper that does not exceed 24 inches by 36 inches. The preliminary plat (or plan) shall be drawn to a standard engineering scale no smaller than 1" =100'.

2. Two (2) prints of the preliminary plat (or plan), prepared in accordance with the rules set forth in this section, will be submitted together with a letter of transmittal requesting that the preliminary plat be reviewed and, if found satisfactory, approved. The names of the Owner and engineering or surveying firm, with mailing addresses, emails and telephone numbers for each, will be included with the transmittal.

3. The preliminary plat (or plan) will include the following general information. A checklist including additional details is provided in Appendix B:

    a. The location of the proposed development by means of a small location map.

    b. The township, city, or village in which the parcel is situated.

    c. The section and part of section in which the parcel is situated.

    d. The proposed drainage system for the development.

    e. The proposed street, alley, and lot layouts and approximate dimensions.

    f. The location and description of all on-site and adjacent off-site features within 200 feet of the property boundary that may be relevant in determining the overall requirements for the development. For example:

        1) Adjoining roads and developments
        2) Railroads
        3) High tension power lines or underground transmission lines
        4) Cemeteries
        5) Parks
        6) Natural and artificial watercourses, wetlands and wetland boundaries, floodplains, lakes, bays, and lagoons
        7) Designated natural areas
        8) Any proposed environmental mitigation features
        9) Drains, sewers, water mains

10) Existing and proposed easements
11) Features greater than 200 feet from the property boundary may need to be shown depending on their relevancy to the drainage system design
12) Septic fields and wells
13) Wellhead protections areas

g. The number of acres to be developed.

h. Contours, at two-foot intervals or less, using the North American Vertical Datum (NAVD 88)

i. Test pits or soil borings indicating seasonally high groundwater elevations are required at the sites of proposed retention/detention/infiltration facilities, and as needed in areas where high ground water tables exist. Soil borings are only acceptable in areas where test pits are impractical due to basin depth as determined by the Drain Commissioner's Office.

4. Required Stormwater Management Information

a. A description of the off-site outlet, evidence of its adequacy, and a detailed description of the effects of said outlet on downstream properties.

b. Any natural watercourses, county and inter-county drains that traverse or abut the development.

c. Any watercourse passing through the development, along with the following:

1) Area of upstream watershed and current zoning.

2) Preliminary calculations of runoff from the upstream watershed area for the WQ, CPVC, CPRC, and Flood Control Volumes (link to page or section), for fully developed conditions according to the current land use plan for that area.

d. All calculations, including an electronic copy of any spreadsheets in Microsoft Excel format, used in the preliminary design of stormwater management systems must be submitted to the Drain Commissioner on the construction plans.

4. The Owner will describe the mechanism to be established to provide for long-term maintenance of the stormwater management system. The Drain Commissioner may require that a county drainage district be established pursuant to the Drain Code.

5. Should the Owner plan to develop a given area but wish to begin with only a portion of the total area, the original preliminary plat or plan will include the proposed general layout for the entire area. The first phase of the development will be clearly

superimposed upon the overall plat or plan in order to illustrate clearly the method of development that the Owner intends to follow. Each subsequent plat or plan will follow the same procedure until the entire area controlled by the Owner is developed.

6. Final acceptance by the Drain Commissioner of only 1 portion or phase of a development does not ensure final acceptance of any subsequent phases or the overall general plat or plan 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 Drain Commissioner are proposed.

7. Land Use Summary Table located in Appendix J shall be included with submittal.

1.1.2. Drainage Review Requirements

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

    a. Proposed drainage shall complement any local stormwater management plans that may exist and/or comply with any ordinance in effect in the municipalities where the development is located.

    b. The concentration of flow due to development of the site shall not create adverse impacts to downstream property owners and watercourses.

    c. Off-site drainage and/or flooding easements will not be required where the discharge is directly to a sufficient outlet (e.g., a lake, stream, wetland, or County drain) and the developer determines that no adverse impacts will occur to downstream property owners. Where the discharge is not directly to a sufficient outlet, off-site easements will be required unless the following conditions are met:

        1) Discharge does not exceed the pre-development peak flow rate for a series of rainfall events. At a minimum, analyses of the Water Quality Volume, Channel Protection Volume Control, Channel Protection Rate Control Volume, and Flood Control Volume are required. Definitions for these volumes can be found in section 2.2.1 beginning on page 19. Analysis of additional storms between the 10-year and 100-year may be required for larger developments or developments anticipated to have regional drainage impacts.
        2) An outlet assessment is performed which includes descriptions of the surrounding area, including nearby houses, that would be impacted by the concentration of flow.
        3) The developer and his/her Engineer determine that no adverse impact will occur to downstream property owners and stipulate this in writing.

    d. Discharge shall not exceed existing drain capacity. Both volume and rate of discharge from a development may be reduced to levels lower than stated (and as determined by the Drain Commissioner) in these guidelines if proposed discharge

levels exceed existing drain capacity. If sufficient downstream capacity exists, the variable release rate defined in Section 2.2.1 paragraph 4b may be applied.

2. In general, the Drain Commissioner will not accept responsibility for roadside ditches. The Livingston County Road Commission maintains these if located within the right-of-way of a public road.

1.1.3. Preliminary Plat or Site Plan Approval

1. The Drain Commissioner will approve or reject a preliminary plat or plan within 30 days of its submittal. If the proposed plat is not approved as originally submitted, the Commissioner will notify the Owner in writing, setting forth the reasons for withholding approval. If the proposed preliminary plat as submitted meets all requirements, one (1) approved copy of the preliminary plat will be returned to the Owner. Approval of the preliminary plat is required before the Drain Commissioner will proceed with review of final construction plans.

2. Payment of all fees is a prerequisite to approval (see Drain Commissioner's Office Fee Schedule on the Livingston County Website)

1.2. Construction Plan Approval

1.2.1. General Information

For all projects, the developer will submit a letter of transmittal requesting review. The names of the Owner and engineering firm, with mailing addresses, emails and telephone numbers for each, shall be included with the transmittal.

The Drain Commissioner will review construction plans to ensure that the design provides adequate storm drainage and that the stormwater management system provides adequate water quantity and quality management within the proposed development and downstream. In addition, the system must not impact upstream conveyance.

1.2.2. Submission Requirements

1. For all projects, the developer will submit two (2) complete sets of construction plans, drawn to a scale no smaller than 1" = 50' and on sheets no larger than 24" x 36". The plans shall be sealed by a registered professional engineer in the State of Michigan and drawn to standard engineering scales. When plans have been approved, copies of the electronic files, in accordance with the formats approved by the Livingston County Geographic Information Systems (GIS) Department, shall also be provided. Those items that specifically relate to the storm drainage facilities such as storm sewers, swales, basins, grading plans, etc., as well as all available information such as complete site layout, sanitary sewer and watermain plans, topographic surveys, etc., shall be included. Construction plans shall include all drainage information requirements listed in Section

II, as well as the following, where applicable (see Appendix C for Construction Plan Check List):

a. The property description including total acreage as well as the location of the proposed project by means of a small location map. If the project is to be completed in phases, the number of acres in each phase shall also be included.

b. The proposed project layout with all dimensions, including the proposed drainage system for the project.

c. A map, using a scale of 1 inch to 2,000 feet or greater (i.e. 1 inch to 1,000 feet), showing the drainage boundary of the proposed project and its relationship with existing drainage patterns.

d. The location and description of all on-site and adjacent off-site features including but not limited to: adjoining roads and subdivisions; railroads; high tension power lines and/or underground transmission lines; cemeteries; parks; natural and artificial watercourses; wetlands and wetland boundaries; floodplains, lakes, bays, and lagoons; designated natural areas; any proposed environmental mitigation features; drains, sewers, watermains, septic fields, and wells; existing and proposed easements.

e. Plans, profiles, and details of all roads and storm sewers. The storm sewer details will include type and class of pipe, length of run, percent of slope, invert elevations, rim elevations, depth of burial, backfill type, depth and compaction, and profile of the hydraulic gradient, as specified in Section II of these rules.

f. Storm sewer calculations, indicating the number of acres calculated to the nearest tenth of an acre, contributing to each specific inlet/outlet, the calculated hydraulic gradient elevation, maximum flow in cubic feet per second (cfs) and the flow velocities for enclosed systems.

g. Open ditch drains and drainage swales shall be shown with a typical ditch cross-section and matching contours.

h. Plans and details of the proposed soil erosion and sedimentation control measures, both temporary (during construction) and permanent.

i. Plans and details of proposed retention/detention facilities. Test pits and seasonally high groundwater elevations are required at the sites of these facilities and as needed in areas where high ground water tables exist.

j. A drainage area map overlaid onto a copy of the site grading plan, which clearly shows the areas tributary to each inlet and/or storage basin.

k. Topographic maps, at one-foot contour intervals or less using the North American Vertical Datum (NAVD 88), showing existing and proposed elevations, as well as off-site topography over at least 200 feet of the adjoining property. Maps will also show all existing watercourses, lakes and wetlands, and the extent of all off-site drainage areas contributing flow to the development. The Livingston County GIS

Department is a good resource for topographic maps within the county, for more information visit https://www.livgov.com/gis. These topographic maps are also available from SEMCOG. The designer assumes responsibility for topographic information used on the maps.

l. Locations of all drain fields and reserve areas as approved by the Livingston County Health Department. Drain fields shall not be located within drainage easements and shall also comply with isolation distance requirements as stated in the Livingston County Sanitary Code.

m. Locations of all drinking water wells, including the well record for each well. Wells shall not be located within drainage easements and shall also comply with the isolation distance requirements as state in the Livingston County Sanitary Code, and/or the Michigan Well Construction Code (Part 127 of Act 368 of 1978, as amended), and/or the Michigan Safe Drinking Water Act, (Act 399 of 1976, as amended).

n. Minimum basement opening elevations are required where walkout, daylight basements, or egress windows are proposed. Where walkout, daylight basements, or egress windows are proposed construction will be contingent on these elevations being matched or exceeded as certified by the Applicant's Surveyor or Engineer. Where finished grades indicate a substantial amount of drainage across adjoining lots, inlet structures and piped outlets shall be provided inside yards along lot lines. To ensure that property owners do not alter or fill drainage swales, easements in the developments governing documents (eg. deed restrictions or master deed) will be required over areas deemed necessary by the Drain Commissioner. Additional information regarding site grading can be found in Appendix I.

o. Benchmark locations and elevations using NAVD 88.

2. Specifications governing construction of stormwater management facilities.

a. Design data and criteria used for sizing all drainage structures, channels, and detention/retention basins including weighted runoff coefficient calculations. (Refer to Appendices.)

b. A stormwater facility maintenance plan, schedule, and budget estimating the costs that will be associated with system maintenance.

3. A soil erosion permit under Part 91 of the The Natural Resources and Environmental Protection Act, Act 451 of 1994, as amended, will be obtained from the Livingston County Drain Commissioner prior to any construction.

4. Review of construction plans by the Drain Commissioner will not proceed until preliminary plat or plan approval has been granted.

5. Approval of construction plans by the Drain Commissioner's office is valid for one (1) calendar year or up to two (2) calendar years if allowed by the local governing body. If an extension beyond this period is needed, the Owner will submit a written request to the

Drain Commissioner for an extension. The Drain Commissioner may grant one-year extensions of the approval and may require updated or additional information, if needed. Should modifications be made to the plans, a new review may be required subject to the appropriate review fees.

3. Payment of all fees is prerequisite to approval (see Drain Commissioner's Office Fee Schedule on the Livingston County Website)

1.3. Final Subdivision Plat Approval

1.3.1. General Requirements

Final subdivision plat review will be completed by the Drain Commissioner's office within ten (10) days of submission by the Owner. If the plat is not acceptable, written notice of rejection and the reasons therefore will be given to the Owner. If the Commissioner approves the plat, s/he will affix his/her signature to it and the plat will be executed.

1.3.2. Review Requirements

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

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

3. Before approval of the final plat or construction plans, it must be demonstrated that all necessary wetland, floodplain, inland lakes and streams, erosion control or other needed State, Federal, or local permits are in place.

4. If the stormwater management system is constructed before the Owner seeks final plat approval, the Developer's Engineer will submit certification of the stormwater system construction. This certification will state that the stormwater facilities were installed in an acceptable manner and according to construction plans approved by the Drain Commissioner.

1.4. Drains Under the Jurisdiction of the Drain Commissioner

The Drain Commissioner may require jurisdiction over developments with a direct connection to a county drain. The Drain Commissioner will only accept jurisdiction over other developments where the Livingston County Road Commission accepts the road system. For drains proposed to be under the jurisdiction of the Drain Commissioner, the following additional requirements apply:

1.4.1. Prior to Construction Plan Approval and Issuance of a Grading Permit

1. Developments proposed to have public drains must submit a completed Section 433 Agreement (see Appendix A).

2. A cash deposit must be made to provide for future maintenance. An additional administrative fee will be required as defined on the County's website, https://www.livgov.com/drain/Pages/drainage-review-fees.aspx.

3. Approval by the Drain Commissioner's Office of the master deed and/or land use and deed restriction language. The deed restriction language shall include the minimum finish floor and basement opening elevations from the approved plans.

4. Existing county drain easements will be indicated on the plans and designated as shown on the example in Appendix F. County drain easements prior to 1956 were not required by statute to be recorded; therefore, it may be necessary to check the permanent records of the Drain Commissioner's Office to see if a drain easement is in existence on the subject property. Related easement language will be depicted on final Mylar plats and/or exhibit B condominium drawings as follows:

"All drainage easements and detention (or retention) areas are under the jurisdiction of the Livingston County Drain Commissioner and the (Insert Drain Name) drainage district."

The placement of any utilities in a drainage easement is strongly discouraged and will require that a license be obtained from the Livingston County Drain Commissioner for the placement of any permanent structure within a drainage easement. Any utility shall be located such that it shall not significantly increase the expense of maintaining the drainage facility.

5. A permit will be obtained from the Drain Commissioner prior to tapping or crossing any county drain.

6. Agreements for any proposed relocations of county drains will be processed through the office of the Drain Commissioner and recorded prior to the issuance of a grading permit and/or the start of construction.

1.4.1. The Owner will follow the instructions on the County's website for posting financial guarantees. This deposit will be held for one (1) year after the date of final acceptance of the stormwater facilities.

1. This deposit will be returned to the Owner, as provided above, provided all stormwater facilities are clean, unobstructed, and in good working order.

2. The Owner shall make arrangements acceptable to the Drain Commissioner for inspection during construction, including submittal of inspection reports, and for final verification of the construction by a Michigan registered professional engineer prior to the approval of the final construction plans.

3. Prior to Final Acceptance by the Drain Commissioner

   a. Release of drainage easements to the drainage district, including a metes and bounds legal description and sketch or drawing. This must be executed and recorded prior to final acceptance of the drainage district.

   b. Public drainage systems shall be inspected and approved by the Office of the Livingston County Drain Commissioner prior to final acceptance.

   c. Digital files of the as-built stormwater management systems. Including both the DWG and PDF files for the stormwater management systems will be sent to the Drain Commissioner. These will be submitted by the Owner or his/her Engineer to the Commissioner along with the final plat or upon completion of system construction.

   d. A post-construction letter of volume certification from the professional engineer responsible for the design that certifies construction of the system in accordance with the approved plans and guarantees the as-built volume of any stormwater management basins to meet or exceed approved storage capacities shall be received.

   e. Copies of all documents recorded at the Register of Deeds shall be submitted to the Drain Commissioner.

SECTION 2 - DESIGN CRITERIA FOR STORMWATER MANAGEMENT SYSTEMS

This section sets forth specific design and construction standards that will be used by the Drain Commissioner in review of proposed stormwater management systems, in accordance with the objectives of managing both the quantity and quality of stormwater runoff.

2.1. Site Drainage - General Requirements

2.1.1. Stormwater Discharge

In no event shall the maximum design rate of discharge exceed that stated in Section 1.1.2.1.c, page 11.

It is the Owner's obligation to meet this standard. Should a stormwater system, as built, fail to comply with the rules herein, it is the Owner's responsibility to design and construct, or to have constructed at his/her expense, any necessary additional and/or alternative stormwater management facilities. Such additional facilities will be subject to the Drain Commissioner's review and approval. Additional volume controls will be required in such cases as will acquisition of rights-of-way from downstream property owners receiving the stormwater flow.

2.1.2. General Guidelines

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

1. In general, wet basins and stormwater marsh systems will be preferred to dry basins. Dry basins providing extended storage will be accepted when the development site's physical characteristics or other local circumstances make the use of a wet basin infeasible.

2. Providing safe retention/detention is the Owner's responsibility. Basin designs will incorporate gradual side slopes, topsoil, seeding and mulching, plantings per landscape plan if one is required, and safety shelves. Where further safety measures are required, the Owner is expected to include them within the proposed development plans. Additional information for basin design is found in Section 2.2.

3. For drainage systems proposed to be under the jurisdiction of the Drain Commissioner, detention and retention facilities shall be located on common-owned property (e.g., parks, outlots, etc.) in multi-ownership developments such as site condominiums and subdivisions and not on private lots or condominium units. For private drainage systems, the stormwater ordinance of the local unit will govern where these basins may be located.

4. Stormwater management systems incorporating pumps shall not be permitted. Variances from this rule will be considered only as a measure of last resort, subsequent to demonstration that no alternative system designs are technically feasible.

5. The development grading plan will be such that surface runoff is away from building envelopes and toward swales, ditches, or drainage structures, and designated natural retention/detention areas. Provision for drainage through properly graded stormwater conveyance systems will be made for all areas within the proposed development.

2.1.3. Floodplains

It is the responsibility of the Developer to demonstrate that any activity proposed within a 100-year floodplain will not diminish flood storage capacity. In certain instances, an analysis to determine the 100-year floodplain may be required. Where available, the community flood insurance study shall be used. Compensatory storage will be required for all lost floodplain storage.

The Livingston County Drain Commissioner reserves the right to require additional storage for all areas that directly connect to a drain under the Commissioner's jurisdiction.

2.1.4. Easements

1. Easement information shown on the plat or site plan is specifically required by the Drain Commissioner's office. The location and purpose of drainage easements should be clearly described in subdivision deed restrictions or condominium master deeds.

   Language will be included within the subdivision property deed restriction or condominium master deed that clearly notifies property owners of the presence of stormwater management facilities and accompanying easements, as well as restrictions on use or modification of these areas.

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

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

   a. Open channels and water courses (e.g., a definable stream bed): A minimum of 50 feet total width. Additional width may be required in some cases, including but not limited to water courses with floodplains delineated by FEMA, sandy soils, steep slopes, at access points from road crossings.

   b. Back lot drainage (open swales): A minimum of 30 feet total width.

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

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

d. Drain fields (septic areas) shall not be located within drainage easements.

2.2. Detention and Retention Systems

2.2.1. Minimum Volume Requirements

The Livingston County Drain Commissioner has partnered with Oakland County, Wayne County and Macomb County to unify the regional approach to stormwater volume management. This new approach looks at drainage from the perspectives of four requirements: Water Quality Control, Channel Protection Volume Control, Channel Protection Rate Control, and Flood Control Volume. A full breakdown of the way to apply these requirements can be shown in the examples of Appendix F**.**

1. Water Quality Volume Control (WQ)

$$V_{WQ} = 3{,}630 \times C \times A$$

Where:

C is the post-development runoff coefficient (Appendix G, Page 6.)
A is the contributing area in acres
V_{WQ} is the required volume in cubic feet.

a. Water Quality Volume Control is required for the runoff from the 1-inch rainfall event.

b. This requirement is considered met if the full CPVC can be met through infiltration onsite.

c. The requirement is also met by using a forebay with storage volume equal to 15% of the V_{WQ}, unless the infiltration requirement is being met within the detention basin, in which case the required forebay volume is equal to the full V_{WQ}.

d. Water Quality Rate Control, based on the 1 Year Frequency storm event, may be provided by a mechanical treatment device in lieu of the Water Quality Volume Control. The required 1 Year Frequency Storm Treatment rate equals: $R_{WQ} = CxAx(97/(Tc+30))$ where Tc = Storm Sewer flow time in minutes. The system must have an 80% reduction in Total Suspended Solids (TSS) or a maximum discharge concentration of 80 mg/L

2. Channel Protection Volume Control (CPVC)

a. The system will be designed to capture and infiltrate, the site runoff from the first 1.3 inch of rainfall. This is required for all sites to the Maximum Extent Practicable (MEP).

$$CPVC = 4{,}719 \times C \times A$$

Where:
C is the post-development runoff coefficient (Appendix G, Page 6)
A is the contributing area in acres
CPVC is the required volume in cubic feet

1. The Owner must submit evidence that a test pit has been used to determine soil infiltration. The minimum depth of this test pit is to be 10 feet below the proposed basin bottom elevation. This test pit is to be made in accordance with the standards detailed in Appendix E.

2. In instances that test pits are not possible, a geotechnical group can perform a core analysis, at the Drain Commissioner's discretion.

b. Provide adequate infiltration and/or storage/reuse BMPs, to the MEP, to provide the necessary CPVC. This may include (but is not limited to) bioretention, rain gardens, bio-swales, pervious pavement, cisterns, green roofs, and infiltration trenches.

1. When the in-situ infiltration rate is above 0.5 in/hr, supplemental measures are not required.

2. When in-situ infiltration rates are between 0.24 in/hr and 0.5 in/hr, soils are marginally suitable for infiltration BMP's, and supplemental measures are required. Supplemental measures may include subsoil amendment, or an underdrain located at the top of the storage bed layer to maximize infiltration. (The Drain Commissioner reserves the right to modify the infiltration requirement for sites with infiltration rates between 0.24 in/hr and 0.5 in/hr in the event of the site having excessive restrictions.)

3. When in-situ infiltration rates are less than 0.24 in/hr, infiltration is waived. When infiltration is waived, other volume reducing LID practices must be implemented to the MEP.

4. Infiltration BMP's shall completely dewater in less than 72-hours, consisting of 24-hour dewatering for the surface volume, and 48-hour dewatering of the void space (soil storage) volume. Water storage/reuse BMPs shall also be designed to fully dewater within 72-hours.

c. If infiltration is not feasible on the site, the system must still meet the WQ, CPRC and Flood Control requirements.

d. Infiltration testing results shall be shared with the Drain Commissioner prior to preliminary designs to determine if a predesign meeting is required.

3. Channel Protection Rate Control (CPRC)

CPRC = 6,897 x C x A

Where:
C is the post-development runoff coefficient (Appendix G)
A is the sites contributing area in acres
CPRC is the required extended detention volume in cubic feet

a. The system will capture and provide extended detention for the site runoff volume generated from a 1.9 in. rainfall event and release over 48 hours.

4. Detention and Flood Control Volume

a. The required detention and flood control volume shall be implemented to manage runoff from the 100-year frequency storm (see Atlas 14). Atlas 14 can be found on NOAA's Website. Additional information can also be found in Appendix J, page 1.

b. The allowable 100-year post-development peak flow rate (Q_{100P}) will be approved by LCDC and can be calculated one of two ways:

1. Using the Variable Release Rate (see following equations) in the limited situations where sufficient downstream capacity exists.

2. County determined peak flow rate based on known County Drain capacity limitations. A pre-design meeting is required for developments that discharge to County Drains. The typical maximum allowable discharge rate is 0.15 cfs/acre or less.

Q_{VRR}=1.1055-0.206ln (A)

Where:
Q_{VRR}=Allowable release rate in cfs/acre
A=Contributing area in acres

The variable release rate (cfs/acre) is capped at 1.0 cfs/acre for developments 2 acres or less. For all developments over 100 acres, the maximum allowable release rate is 0.15 cfs/acre.

$Q_{100P}=Q_{VRR} \times A$

Where:

Q_{100P}= Allowable 100-year post-development peak flow rate in cfs
A=Contributing area in acres

c. The required detention volume shall be calculated using all on-site contributing drainage areas. Volume stored within the forebay and extended detention area may be applied towards the required detention volume. Please refer to Appendix J, page 2 for typical detention basin profiles and stormwater design calculations.

The required 100-year detention volume (V_{100D}) is calculated as follows:

100-year peak runoff volume (V_{100R})

$V_{100R}=18985 \times C \times A$

Where:

C=Post-development runoff coefficient
A=Contributing area in acres
V_{100R}=Post-development 100-year runoff volume in cubic feet

100-year peak inflow rate (Q_{100IN})

$Q_{100IN} = C \times I_{100} \times A$

Where:

Q_{100IN}= 100-year post-development peak inflow rate in cfs
C= Post-development runoff coefficient
I_{100}= 100-year peak rainfall intensity in inches/hour
A= Contributing area in acres

100 -year peak rainfall intensity (I_{100})

$$\mathbf{I_{100}= 83.3 / (Tc + 9.17)^{0.81}}$$

Where:

I_{100} = 100-year peak rainfall intensity
Tc=Site-specific time of concentration for the development in minutes

Storage Curve Factor for the 100-year detention volume (R)

$R= [0.206 – 0.15 \ln (Q_{100P}/Q_{100IN})]$

Where:

R=Storage Curve Factor (dimensionless)
Q_{100P}= 100-year post-development peak flow rate in cfs

Q_{100IN}= 100-year post-development peak inflow rate in cfs

100-year detention basin size (V_{100D})

$V_{100D} = (V_{100R} \; x \; R) - V_{CP-P}$

Where:

V_{100D}= Required 100-year detention volume in cubic feet
V_{100R}= 100-year runoff volume in cubic feet
R= Storage Curve Factor (dimensionless)
V_{CP-P}= Provided CVPC volume in cubic feet

Key Rule: $V_{100D} \geq V_{ED}$

d. The adjusted 100-year detention basin volume shall be equal to or greater than the Extended Detention Volume (V_{ED}). The adjusted detention basin volume shall not be less than V_{ED}.

2.2.2. General Design Requirements

1. A minimum of one (1) foot of freeboard is required for all detention basins.

2. Basin Inlet / Outlet Design

a. Engineered velocity dissipation measures based on discharge flow rates and velocities will be incorporated into basin designs to minimize erosion at inlets and outlets, to minimize the re-suspension of pollutants, and to create sheet flow conditions where feasible.

b. To the extent feasible, the distance between inlets and outlets will be maximized. The length and depth of the flow path across basins and marsh systems can be maximized by:

1) increasing the length-to-width ratio of the entire design.

2) increasing the dry weather flow path within the system to attain maximum sinuosity. If possible, inlets and outlets should be offset at opposite longitudinal ends of the basin

c. The outlet will be well protected from clogging.

d. Sediment forebays (upper stage) will be provided at the inlet of all stormwater management facilities to provide energy dissipation and to trap and localize incoming sediments.

1) The forebay will be a separate basin, which can be formed by gabions or a compacted earthen berm and constructed with a minimum three (3) foot deep sediment sump.

2) For soils infiltrating greater than 0.5 inches per hour, any volume that is infiltrated or stored upstream of the forebay will count towards the Minimum Volume Requirements.

3) Direct maintenance access to the forebay for heavy equipment will be provided.

4) An adequate area for temporary staging of spoils, prior to ultimate disposal, shall be provided. This area shall be protected such that no runoff will be directed back into the stormwater management system or onto private property. For public drainage systems, an easement dedicated to the Drain Commissioner must be provided over the disposal area.

e. Riser Design

1) The use of a perforated standpipe-type riser structure (or a control structure with a weir and orifice plate/wall) is required to assure an appropriate detention time for all storm events.

2) Grates or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of four (4) inches.

3) When an orifice plate/wall is to be used to control discharge, the control structure will have a minimum diameter of four (4) feet.

4) The riser structure shall be placed near the basin embankment to provide for ready maintenance access.

5) The riser pipe shall be a minimum of 36 inches in diameter for riser pipes up to 4 feet in height. Riser pipes greater than 4 feet in height shall be a minimum of 48 inches in diameter. Riser pipes will be constructed with concrete bottoms.

f. Outlet Design

1) All outlets will be designed to be easily accessible for heavy equipment for maintenance purposes.

2) All outlets will be designed to discharge at an elevation within two (2) feet of the 100-year floodplain elevation for the receiving water body. Discharging at the “crest” of slopes will not be permitted.

3) Backwater on the outlet structure from the downstream drainage system shall be evaluated when designing the outlet.

4) Pumped outlets will not be permitted on public systems and discouraged on private systems. (Section 2.1.2 p. 19)

g. Overflow Spillway Design

1) All basins will have provisions for a defined overflow spillway, routed so that it can be picked up by the main outflow channel while not discharging directly over the outlet pipe. The overflow spillway will be set at an elevation at least 6 inches above the design high water elevation and shall convey the 10-year frequency storm flow from the basin.

2) The overflow spillway will be a minimum of 6 inches below the freeboard elevation of the basin.

3) If a standpipe is used to create the overflow spillway the standpipe will have a minimum diameter of 4 feet. No standpipe shall be less than 3 feet in diameter.

3. General Design Rules

a. Basin side slopes will be no steeper than one-foot-vertical to three-feet-horizontal (3:1). For basins proposed to be under the jurisdiction of the Drain Commissioner, slopes steeper than one-foot-vertical to five-feet-horizontal, will be permitted only with the installation of a four-foot-high chain link fence completely surrounding the detention facility. In such cases, a 12-foot-wide access gate shall be provided. Installation of fencing on private systems shall be governed by the stormwater ordinance of the local unit. In cases where the basins will not be designed to provide infiltration, a three-foot-deep permanent pool, or a minimum 0.5% slope from the basin inlets to the outlet structure pipe invert shall be provided.

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

c. Adequate maintenance access from public or private right-of-way to the basin will be reserved. The access will be on a slope of 5:1 or less, stabilized to withstand the passage of heavy equipment, and will provide direct access to both the forebay and the detention basin riser/outlet.

4. General Restrictions

a. The placement of retention/detention basins within a floodplain of a stream, creek, or lake is prohibited.

b. The use of underground retention/detention on new and existing developments is strongly discouraged, and prohibited on drains proposed to be under the jurisdiction of the Drain Commissioner. Exceptions may be granted if each of the following conditions exist:

1) A catastrophic property loss results in the need to rebuild an existing commercial facility that was not previously equipped with retention/detention, and the installation of an above-ground retention/detention facility would significantly reduce the available square footage for a replacement structure.

2) The provision of above-ground retention/detention on an existing commercial parcel less than 1 acres in size would preclude development of the property under its current zoning.

c. Retention/detention systems with designed underground infiltration chambers or galleries 10 ft or greater below the ground surface require review by the Livingston County Health Department prior to approval. The Livingston County Drain Commissioner's Office may prohibit any infiltration practice that is in a defined wellhead protection area or may negatively impact the quality of groundwater for existing wells in proximity to the site and/or the ability to construct new drinking wells in the future.

2.2.3. Retention Basin Design

A "no outlet" retention basin is only permissible subject to certain conditions that include, but are not limited to the following:

1. There is no other available positive outlet for the stormwater runoff from the property. Every effort should be made to provide a means to de-water the basin including downstream improvements.

2. The Volume of the Retention Basin is calculated either of the following two methods:

   a. Using the equation below, and providing twelve inches of freeboard over the design high water elevation:

      $V_{RB} = (18985 \times C \times A \times 2) - V_C$

      Where:
      V_{RB}= Total retention basin volume in cubic feet
      C= Composite runoff coefficient
      A= Contributing area in acres
      V_C= Volume of 100% upstream BMP Credit in cubic feet

   b. Calculating the volume generated by two inches of runoff over the tributary area to the proposed basin, and including three feet of freeboard over the calculated design high water elevation.

3. The permeability of the soils shall follow all requirements set forth for large BMPs with the exception of the following:

a. The Basin shall be able to dewater a 100-year storm (V_{100R}) within 72 hours based on the infiltration rates.
b. When calculating the volume of storage, no credit will be given for infiltration volume within the basin. However, infiltration volume from upstream BMPs may be credited towards the total retention volume required.

4. An infiltration trench is not considered an acceptable substitution for permeable soils.

5. The general requirements listed in section 3a (page 25) for detention basins shall be followed for retention basins. Furthermore, retention basins shall be designed with an infiltration gallery, which shall consist of a minimum of 2 standpipes connected by horizontal perforated plastic pipe (minimum 12" diameter) bedded in stone trenches at least two feet below the designed basin bottom elevation. The proposed gallery should cover at least 50% of the basin floor area.

6. An overflow route from the retention basin must be provided. Elevations of surrounding buildings, development or other features that would be impacted by a basin overflow must be indicated. The overflow route may not endanger any existing structures or features. Downstream drainage easement s may be required for the overflow route.

7. The proprietor must submit infiltration test pit results or infiltration results from a soil boring taken within the basin bottom area to a depth of 25 feet below existing ground or 20 feet below proposed basin bottom elevation. Note that infiltration test results from a soil boring will be reduced by a factor of two, in order to reflect reduced accuracy of estimated infiltration rates associated with soil borings in comparison to test pits.

8. The Drain Commissioner reserves the right to require additional storage up to that required by two consecutive 100 year storm events based on the results of soils data or the overflow assessment.

2.3. Stormwater Conveyance

The general stormwater conveyance design criteria is outlined in Appendix G. All structures will be constructed in accordance with governing specifications (Michigan Department of Transportation, EGLE, Livingston County Road Commission, or Livingston County Drain Commissioner). In the event of no other governing specifications, the latest edition of the Michigan Department of Transportation standards will be observed. Where possible natural streams should be preserved. Unless otherwise noted, most of these streams are under EGLE's jurisdiction.

1. Vegetated Swales/Open Ditches

a. Open ditch flow velocities will be neither siltative nor erosive. In general, the minimum acceptable velocity for the 10-year storm will be 1.5 ft./sec., and the maximum acceptable velocity will be 4.0 ft./sec. Where the above velocity is exceeded, the channel shall be protected by cobble paving or other means to prevent scour.

b. Side slopes of ditches should be no steeper than 3:1. Soil conditions, vegetative cover, and maintenance ability will be the governing factors for determining slope requirements.

c. In general, a four-foot clearance will be provided between open swale/ditch inverts and underground utilities unless special provisions are employed. Special provisions, for example, could be the encasement of utility lines in concrete when crossing under the channel. In no case will less than two (2) feet of clearance be allowed.

d. Bridge footings will be at least two (2) feet below the established drain bottom elevation. The elevation to be provided by the Livingston County Drain Commissioner.

2. Enclosed Drainage Structures

a. Enclosed storm drain systems will be sized to accommodate the 10-year storm, with the hydraulic gradient generally kept below the top of the pipe. In no case shall the elevation of the hydraulic gradient exceed a point lying one (1) foot below the rim elevation of a manhole, catch basin, or inlet. Velocities are to be a minimum of 2.5 feet per second and a maximum of 10 feet per second.

b. Pipes shall be free flowing and self-draining. Therefore, no portion of a storm drainage system shall be permanently submerged.

c. Drainage structures will be located as follows:

1) To assure positive drainage of all areas of the subdivision not designated as stormwater retention or detention areas. Natural, small, undrained areas, or "potholes," are desirable and can be maintained as natural retention areas if the following apply:

a) An easement is designated for the entire "pothole" area up to and including the spillway elevation.

b) No portion of the easement shall be located within the building envelope.

c) Side slopes of the "pothole" are no greater than 3:1.

d) For drains proposed to be under the jurisdiction of the Drain Commissioner, restrictions relating to use of the low area are cited in the master deed/bylaws and seller's disclosure for the affected lots.

2) At all low points of streets and rear yards unless easements and overflow spillways protect rear yard swales. Drainage structure locations should be

clearly defined using road stationing with offsets, dimensions from property lines or a project coordinate system. If coordinates are used for this purpose, they should also be provided for the parcel's property corners.

3) Such that there is no flow across a street intersection.

4) For smaller enclosed pipes (12-24 inches), manholes will not be spaced more than 400 feet apart. Longer runs up to 600 feet may be allowed for larger sized pipe, but in all cases the Drain Commissioner must deem maintenance access adequate.

d. The catch basin or inlet covers should be designed to accept the 10-year design storm. No ponding of water should occur during this storm event unless an easement is provided for the ponding area.

e. Discharge from enclosures shall be designed as follows:

1) All outlets will be designed so that velocities will be appropriate to, and will not damage, receiving waterways. Discharge points shall be no more than 2 feet above the ordinary highwater mark.

2) All outlets will be provided with flared end sections or headwalls.

3) Outlet protection shall employ engineered riprap design. Median riprap size, dimensions, and total quantity in square yards shall be determined based on the pipe size, design velocity, and discharge. All riprap shall be underlain with suitable geotextile fabric. A minimum of 10 square yards of 6" minimum size angular (round stone is not permitted) rip-rap shall be provided at all outlets (flared end sections). Other approved materials will be provided as necessary to prevent erosion.

4) The soils above and around the outlet will be compacted and stabilized to prevent piping around the structure. Riprap extending 2 feet above the ordinary high-water mark is recommended for all outlets.

f. In addition to criteria outlined in Appendix G, pipe will conform to the following:

1) Pipe joints will be such as to prevent excessive infiltration or exfiltration.

2) All materials will be of such quality of usable life expectancy of at least 50 years and shall conform to Michigan Department of Transportation, Livingston County Road Commission, and Livingston County Drain Commissioner Specifications. Materials shall also comply with all appropriate A.S.T.M. standards.

g. In areas where local ordinance requires sump pump leads to be connected into an enclosed system the stormwater conveyance system, shall be sized accordingly.

2.3.1. Channel and Pipe Sizing

1. The "Manning's" formula will be used to size the open channel or pipe.

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

Where: Q = flow, in cubic feet per second
A = cross sectional area, in square feet
n = Manning's coefficient of roughness (see Appendix G for reference)
R = hydraulic radius = A/P, in feet
P = wetted perimeter
S = slope of the bottom of the drain (see Appendix G for permissible slopes)

A minimum "n" of 0.035 will be used for the roughness coefficient of an open channel unless special treatment is given to the bottom and side slopes, such as sod installation, riprap, or paving.

If the Manning's formula is not used, the Drain Commissioner shall approve the alternative method used.

Under Michigan State Law (Act 451, P.A. Part 301 of 1994), crossroad pipes (e.g. culverts) draining 2 square miles or more must be reviewed and approved by the Michigan Department of Environment, Great Lakes, and Energy. This does not supersede review and approval by the Livingston County Drain Commissioner's office.

All storm sewer pipe, excluding crossroad pipes, shall have a minimum diameter of 12 inches. The minimum size of a crossroad pipe shall be 15 inches or equivalent pipe arch.

Crossroad pipes draining less than 2 square miles of upstream watershed will be sized by the Owner's Engineer and reviewed by the Livingston County Drain Commissioner's office.

Wing walls, headwalls, end sections and all other culvert extremities will be designed to assure the stability of the surrounding soil. Michigan Department of Transportation standard designs shall be observed unless special exemption is given. Animal guards shall be installed on all pipes larger than twelve (12) inches in diameter.

Sizing of culvert crossings will consider entrance and exit losses as well as tailwater conditions on the culvert. Once the design flow is determined, the required size of the culvert will be determined by 1 of the following methods:

- The "Manning's" formula
- The inlet headwater control/outlet tailwater control nomographs
- Other methods approved by the Drain Commissioner

2.4. Keeping a Site in Compliance (Long Term O&M)

Long-term Operations and Maintenance (O&M) requirements for County Stormwater Systems and Non-County Stormwater Systems are summarized below.

County Stormwater Systems

The following applicable MS4 Permit O&M requirements apply to all regulated County Stormwater Systems owned, operated and maintained by the Livingston County or the LCDC's office:

1. Prior to the start of any development or redevelopment activity meeting the criteria defined herein, the County shall obtain a Drain Permit from the LCDC's office. Coordination with the LCDC's Permitting Department is recommended at the conceptual stage of development projects to ensure that permit requirements are clearly identified early in the planning process.
2. To ensure consistent perpetual O&M of the site's stormwater system and to enhance water quality protection, prior to Drain Permit issuance, the LCDC's Permitting Department shall review and approve the County's site-specific Stormwater Management O&M Plan including the following requirements:
    a. Purpose of the plan.
    b. Drainage area description and details.
    c. Description of the stormwater system and its individual components.
    d. Specific short-term, intermediate and long-term maintenance tasks.
    e. Inspection and maintenance tasks, frequencies and responsibilities.
    f. Employee and contractor training requirements and responsibilities.
    g. Approved construction drawings including stormwater calculations, details, elevations and a location map, etc.
    h. The County shall submit an Annual Stormwater System O&M Summary, for their stormwater systems, to the LCDC's Permitting Department for County MS4 permit reporting. Individual County Departments are responsible for completing all O&M tasks and for maintaining detailed O&M tracking records (See Part I below) for their stormwater systems.

Non-County Stormwater Systems

The following applicable MS4 Permit O&M requirements apply to all regulated Non-County Stormwater Systems owned, operated and maintained by others, which directly connect to a County Stormwater System:

1. Prior to the start of any development activity meeting the site applicability criteria defined herein, a Drain Permit shall be obtained from the LCDC's Permitting Department. Coordination with the LCDC's Permitting Department is recommended at the conceptual stage of development projects to ensure that permit requirements are clearly identified early in the planning process.

2. To ensure consistent perpetual O&M of the site's stormwater system and to enhance water quality protection, prior to Drain Permit issuance, the LCDC's Permitting Department shall review and approve the site-specific Stormwater Management O&M Agreement between the community and property owner. A fully executed Stormwater Management O&M Agreement is required prior to issuance of the Drain Permit. This agreement shall consist of the following requirements:

   a. Legal Description: A legal description and reduced copy map to identify the land parcel(s) affected by this Agreement. This map shall be prepared for each site and must include a reference to a Subdivision Plat, parcel survey, or Condominium Master Deed, and a map to illustrate the affected parcel(s).

   b. Stormwater System Description and Map: A written description and location map of the entire stormwater system. This map must be prepared for each site and the scale of the map shall show necessary detail.

   c. Stormwater O&M Plan: The site-specific Stormwater O&M Plan shall include the following requirements:

      - Purpose of the plan.
      - Drainage area description and details.
      - Description of the stormwater system and its individual components.
      - Specific short-term, intermediate and long-term maintenance tasks.
      - Inspection and maintenance tasks, frequencies and responsibilities.
      - Employee and contractor O&M training requirements and responsibilities.
      - Approved construction drawings including stormwater calculations, details, elevations and a location map, etc.
      - Property owners are responsible for completing all O&M tasks and maintaining O&M records for their stormwater systems. Property Owners shall submit an Annual Stormwater System O&M Summary to their community for tracking and enforcement as required in the MS4 permit.
      - For properties with a direct stormwater connection to a regulated county stormwater system, the community shall submit the Annual Stormwater System O&M Summary to the LCDC's Permitting Department for LCDC's MS4 permit reporting requirement. **The community is responsible for maintaining detailed O&M records and for implementing local code enforcement requirements.**

   d. Memorandum of Stormwater Management Operations and Maintenance Agreement: This O&M Memorandum acknowledges a perpetual requirement of stormwater system operations and maintenance, which is recorded with the Register of Deeds to put any future property owners, or interest holders, on notice of the Stormwater System and the Stormwater O&M Plan. This O&M Memorandum references the required Stormwater Management O&M Agreement, which resides with the local community to ensure consistency and periodic updates as necessary. A copy of the recorded document shall be submitted to LCDC prior to closure of the Drain Permit.

Appendix K - Stormwater Management O&M Agreement is an approved **"**example" agreement, however, the LCDC office recognizes that community-specific O&M agreements, ordinances and programs may also be proposed and submitted to LCDC for approval. When developing alternative O&M programs for consideration, the community should reference EGLE's Post-Construction Stormwater Runoff Controls Program Compliance Assistance Document (available on EGLE's website)

SECTION 3 - DEFINITIONS

Acronyms

BMPs – Best Management Practices

C – The relative imperviousness factor

CPRC – Channel Protection Rate Control

CPVC – Channel Protection Volume Control

EGLE – Michigan Department of Environment, Great Lakes, and Energy

FEMA – Federal Emergency Management Agency

Ft. (‘)– Feet

GIS – Geographic Information Systems HEC14 – Hydrologic Engineering Center’s Hydraulic Design of Energy Dissipators for Culverts and Channels

HEC-RAS – Hydrologic Engineering Center’s River Analysis System

in. (“) Inches

LCDC – Livingston County Drain Commissioner

NAVD 88 – North American Vertical Datum (1988)

NOAA – National Oceanic and Atmospheric Administration

NPDES – National Pollutant Discharge Elimination System

MEP – Maximum Extent Practicable

O&M – Operations and Maintenance

Q_{cf} – Channel Forming Flow

Q_p – Peak Flow

t_c – Time of Concentration

TR-55 – Technical Release 55, *Urban Hydrology for small watersheds,* (USDA-SCS, 1986)

TSS – Total Suspended Solids

USDA – United States Department of Agriculture

USGS – United States Geological Survey

WQ – Water Quality

Definitions

The definitions for certain terms as enumerated in the Land Division Act, 1967 PA 288, and Sections 9101 and 9102 of the Soil Erosion and Sedimentation Control Act, Part 91 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, are herein incorporated by reference.

100-Year Flood: a rainfall depth that has a 1% chance of being exceeded in a given year. Using NOAA Atlas 14, this rainfall depth is 5.4 inches.

Applicant: the person or group applying for the permit. Typically, this is either the Owner or a designated representative.

Basins: a recessed area being used for stormwater retention or detention.

Best Management Practices (BMP): structural, vegetative, or managerial measures or activities which help to achieve soil erosion and sedimentation control objectives.

County Drain: Drains established pursuant to the Michigan Drain Code of 1956, MCL 280.1 et seq., as amended, that are under the jurisdiction of LCDC.

Contractor: any person(s) under written contract with the landowner to perform the described work.

Developer: a person, partnership, or corporation building one building, or building one building for occupancy by other than owner or creating or developing any parcel of land for any use other than agriculture or form thereof.

Drainage Area: the entire upstream land area from which stormwater runoff drains to a particular location, including any off-site drainage area. (i.e. small watershed)

Easements: a legal right, granted by a property owner to another entity, allowing that entity to make limited use of the property involved for a specific purpose. Easements should be recorded with the Livingston County Register of Deeds to allow for full disclosure and transfer with the sale of land.

Engineer: a professional engineer registered in the State of Michigan.

Erosion: the process by which the land surface is worn away by the action of wind or water.

Existing Grade: the vertical location of the existing ground surface prior to excavating or filling.

Finished Grade: the final grade or elevation of the ground surface conforming to the proposed design.

Floodplain: for a given flood event, that area of land adjoining a continuous watercourse that has been covered temporarily by water. This design standard, the term floodplain includes all physical floodplains whether or not they have been officially mapped by FEMA.

Grading: any stripping, excavating, filling including hydraulic fill, stockpiling, or any combination thereof and shall include the land in its excavated or filled condition.

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

Infiltration: the absorption of water into the ground.

Lake: the Great Lakes and all natural and artificial inland lakes and/or impoundments that have definite banks, a bed, and visible evidence of continued occurrence of water and a surface area of water that is equal to or greater than 1 acre. This does not include sediment basins and lakes constructed for the sole purpose of cooling water or for treating polluted water.

Landowner (Owner): the person who owns or holds a recorded easement on the property or who is engaged in construction in a public right-of-way. It includes a designated agent who has written authorization from the landowner to sign the application and secure a permit in the landowner's name.

Maximum Extent Practicable (MEP): Based on the constraints of the proposed development site, including analysis of the soils, the groundwater table elevation, and the applicability of infiltration as a mitigation tool to reduce post-construction discharge rates, as proposed by the developer's engineer and reviewed by LCDC.

Permittee: any person to whom a permit is issued pursuant to these rules.

Rip Rap: large and small stone or aggregate used to reduce water velocity at the outlet of a pipe. The correct installation requires the use of angular (or crushed) stone, and a geotextile fabric be laid on suitably prepared ground surface prior to the stone placement to best secure soil.

Runoff: water that is not absorbed by plants or infiltrated into the soil but runs off the surface of the ground to the lowest point.

Sanitary Sewer: underground pipes that collect wastewater.

Single Family Dwelling: a building construction for the sole purpose of housing the members of one immediate family.

Site: any lot or parcel of land, or combination of contiguous lots or parcels of land, where grading is performed or permitted.

Site Grading: the final elevation and slope of the ground at a site.

Soil: all earth material of whatever origin that overlies bedrock, and including, but not limited to, the decomposed zone of bedrock which can be readily excavated by mechanical equipment.

Steep Slope: a slope which is characterized by increased runoff, erosion, and sediment hazards.

Storm Drain: a conduit, pipe, natural channel, or human-made structure which serves to transport storm water runoff.

Stormwater Management System: Any structure, feature, or appurtenance subject to the Ordinance, or a rule promulgated pursuant to the Ordinance, that is designed to collect, detain, retain, treat, or convey stormwater runoff, including without limitation buffer strips, swales, gutters, catch basins, closed conduits, detention systems, pretreatment systems, wetlands, pavement, unpaved surfaces, structures, watercourses, or surface waters.

Stream: a river, creek, storm drain, or other watercourse which may or may not be serving as a drain as defined in Act No. 40, of the Public Acts of 1956, as amended, which has definite banks, a bed, and visible evidence of continued flow or continued occurrence of water, including the connecting waters of the Great Lakes.

Surveyor: a professional surveyor registered in the State of Michigan.

Swale: a natural or human made depression shaped as a channel to route runoff water.

Time of Concentration (T_C): The time duration (typically in minutes) that is required for stormwater runoff from the most remote area of the watershed to reach a given location in a stormwater management system.

Vegetative Cover: grasses, shrubs, trees, and other vegetation which holds and stabilizes soils.

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

Water Main: a pressurized water supply pipe.

Waters of the State: the Great Lakes and their connecting waters, inland lakes and streams, and wetlands as regulated by Michigan law.

Watershed: The complete area or region of land draining into a single outlet, watercourse, surface water, or closed conduit that is separate from other watersheds by a divide.

Wetted Perimeter: the cumulative contact area between water and the surface beneath it over a cross sectional area.

Appendix A:
Section 433 Agreement Package

AGREEMENT FOR THE ESTABLISHMENT OF A COUNTY DRAIN AND COUNTY DRAINAGE DISTRICT FOR THE (*INSERT DEVELOPMENT NAME AND TYPE*) PURSUANT TO SECTION 433 OF ACT NO. 40 OF THE PUBLIC ACTS OF 1956, AS AMENDED

THIS AGREEMENT, made and entered into this_____ day of _____, 20_, by and between BRIAN JONCKHEERE, LIVINGSTON COUNTY DRAIN COMMISSIONER, 2300 East Grand River, Suite 105, Howell, Michigan, hereinafter referred to as "Drain Commissioner" on behalf of the proposed **(insert drain name, use development name)** Drain Drainage District; and **(insert corporation name)** _____, a Michigan **(insert corporation type)**, **(insert address)** as owner(s) of land described in Exhibit A attached hereto, hereinafter referred to as "Landowner".

WITNESSETH:

WHEREAS, Section 433 of Act No. 40 of the Public Acts of 1956, as amended, authorizes the Drain Commissioner to enter into an Agreement with the Landowner and developer, if any, to establish a drain which was constructed by the Landowner or developer to service an area of its own land as a County Drain; and,

WHEREAS, Landowner, pursuant to Section 433 of Act No. 40 of 1956, as amended, wishes to provide drainage service to its own lands and has requested same to be established and dedicated as a County Drain under the jurisdiction of the Livingston County Drain Commissioner; and,

WHEREAS, Landowner has been advised and understands and agrees to assume the total cost of the construction of the drain to include engineering, inspection, easement acquisition, legal and administrative expenses and costs attendant to this Agreement; and,

WHEREAS, Landowner further understands that the Drain constructed, or to be constructed, pursuant to this Agreement, when finally accepted by the Drain Commissioner, will be known as the (insert drain name), Drain and that the land to be drained will be known and constituted as the (insert drain name) Drain Drainage District and will be subject to assessments, for costs of future operation, inspection, maintenance and improvement; and,

WHEREAS, Landowner has agreed to assume and pay all costs as set forth herein, and,

WHEREAS, Landowner has obtained, at its own expense, a certificate from a registered professional engineer satisfactory to the Drain Commissioner to the effect that the Drain has sufficient capacity to provide adequate drainage service without detriment to or diminution of the drainage service which the outlet currently provides. A copy of said certificate being attached hereto as Exhibit B.

NOW, THEREFORE, in consideration of the premises and covenants of each, the parties hereto agree as follows:

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

2. The Landowner agrees to pay the costs of construction of said Drain and drainage facilities, including the acquisition of the necessary rights of way or easements, engineering, surveying, inspection, legal and administration costs. In addition, the Landowner has deposited with the Drain Commissioner an amount of money equivalent to five (5%) percent of the costs of construction of the Drain, not to exceed Two Thousand Five Hundred and No/l00 ($2,500.00) Dollars, which monies are to be deposited in a special drain fund to be used for future maintenance of the Drain, hereinafter referred to as "**(insert drain name)** Drain Maintenance Fund."

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

4. Landowner shall secure all necessary permits or authorizations as may be required by local, state or federal law and provide copies to the Drain Commissioner. The Drain Commissioner shall be provided copies of all correspondence and reports involving any governmental agency with respect to the Drain.

5. The **(insert drain name)** Drain Maintenance Fund is agreed and understood as being for the sole benefit of the **(insert drain name)** Drain and use thereof may be made by the **(insert drain name)** Drain Drainage District at large, or part thereof, and that such payment shall not relieve the subject property from any future assessments levied pursuant to the Drain Code of 1956, as amended.

6. Landowner agrees to indemnify and hold harmless the Drain Commissioner and the **(insert drain name)** Drain Drainage District for any and all claims, damages, lawsuits, costs and expenses, arising out of or incurred as a result of the Drain Commissioner assuming responsibility for the drain under federal, state and/or local environmental laws and regulations, including all future amendments to such laws or regulations and the administrative and judicial interpretation thereof, except for liability arising out of the gross negligence or intentional wrongful conduct of the Drain Commissioner or its agents.

7. Modification, amendments or waivers of any provisions of the Agreement may be made only by the written mutual consent of the parties.

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This Agreement shall become effective upon its execution by the Landowner and the Drain Commissioner and shall be binding upon the successors and assigns of each party.

IN WITNESS WHEREOF, the parties hereto have caused this Agreement to be executed by the duly authorized officers as of the day and year first above written.

(INSERT DRAIN NAME) DRAIN DRAINAGE DISTRICT

_____
By: Brian Jonckheere
Livingston County Drain Commissioner

(INSERT COMPANY NAME)

_____
By:_____
Its:_____

[IF A CONDOMINIUM ASSOCIATION HAS BEEN FORMED, PROVIDE THIRD SIGNATORY & ADDITIONAL NOTARY LOCATION FOR AN AUTHORIZED REPRESENTATIVE OF A CONDOMINIUM ASSOCIATION TO SIGN]

STATE OF MICHIGAN)
) ss.
COUNTY OF LIVINGSTON)

On this_____day of_____, 200_, before me, a Notary Public in and for said County, personally appeared BRIAN JONCKHEERE, LIVINGSTON COUNTY DRAIN COMMISSIONER, to me known to be the person described in and who executed the foregoing instrument and acknowledged the same to be her free act and deed.

_____
Notary Public
Livingston County, Michigan
My Commission Expires: _____

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STATE OF MICHIGAN)
) ss.
COUNTY OF LIVINGSTON)

On this_____day of_____, 200_, before me, a Notary Public in and for said County, personally appeared **(INSERT SIGNATORY NAME)**, to me known to be the person described in and who executed the foregoing instrument and acknowledged the same to be his/her free act and deed.

_____
Notary Public
Livingston County, Michigan
My Commission Expires: _____

Instrument Drafted By:
(INSERT DRAFTEE NAME)

When Recorded Return To:
Brian Jonckheere
Livingston County Drain Commissioner
2300 East Grand River, Suite 105
Howell, MI 48843

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433 STORM WATER DRAINAGE DISTRICT CHECK LIST

SUBDIVISION OR CONDOMINIUM (circle one)
DEVELOPMENT NAME:
TOWNSHIP: SECTION:
ENGINEER: PHONE: FAX:
CONSULTING ENGINEER DRAINAGE REVIEW APPROVAL BY:_____, DATE:
DRAIN COMMISSIONER DRAINAGE REVIEW APPROVAL DATE: _____

CHECK LIST FOR ITEMS SUBMITTED				
ITEM REQUIRED	(footnote, see pg. 2)	DATE REC'D	REVIEWED BY:	DATE
A. STORM DRAIN CONSTRUCTION ESTIMATE	(1)			
B. $2,500.00 APP FEE AND ADMINISTRATIVE FEE	(2)			
C. TENTATIVE 433 AGREEMENT TO ESTABLISH DISTRICT				
D. RECORDED 433 AGREEMENT TO ESTABLISH DISTRICT LIBER:_____PAGE(S):_____	(3)			
E. TENTATIVE RELEASE OF RIGHT OF WAY (ROW) FORM(S)				
F. RECORDED RELEASE OF ROW: LIBER:_____PAGE(S):_____	(4)			
G. DRAIN COMMISSIONER SIGNS FINAL PLAT	(5)			
H. EROSION CONTROL PERMIT IN GOOD STANDING	(6)			
I. PROPRIETOR'S ENGINEER DAILY INSPECTION RPTS.	(7)			
J. PROPRIETOR'S ENGINEERS ACCEPTANCE REPORT				
K. FINAL INSPECTION (Jointly with Road Commission)				
L. AS BUILT AND FINAL PLAT MYLARS				
M. APPROVAL OF PROPLED DEED RESTRICTIONS	(8)			

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N. PREPARATION & APPROVAL OF ASSESSMENT ROLL (9)			
O. ACCEPTANCE OF ROADS BY LCRC			
P. COMPLETION OF MAINTENANCE BOND (10)			
R. DETERMINATION OF PRACTICABILITY & FINAL ACCEPTANCE BY LCDC (11)			
SITE CONDOMINIUM SPECIFIC REQUIREMENTS:	DATE REC'D	REVIEWED BY:	DATE
TENTATIVE MASTER DEED (9)			
MASTER DEED ACCEPTANCE (9)			
COPY OF RECORDED MASTER DEED			

FOOTNOTES:

(1) Prior to issuance of a grading permit Developer's Professional Engineer shall submit for LCDC approval a cost estimate for construction of all drainage structures located outside proposed public road right of ways.

(2) $2,500.00 Fee is intended as the drain account balance reserved for future maintenance at final acceptance. Additional fees shall be submitted for administrative expenses of establishing a district according to the Drain Commissioners fee schedule, including legal review of documents, any recording fees incurred by the district, final inspection costs, and publication of the drainage district. The $2,500.00 fee is based on a stormwater system consisting solely of gravity components. Systems with non-gravity components are subject to fees above and beyond $2,500.00. pursuant to Section 196 of the Michigan Drain Code, Act 40 of the Public Acts of 1956, as amended.

(3) 433 Agreement to Establish District shall be signed by an authorized representative of the Owner and Drain Commissioner and be submitted for recording at the Livingston County Register of Deeds prior to approval of construction plans, and the sale of any lots in a plat, or units in a site condominium. If property is sold on a land contract, both land contract vendor and vendee must sign the agreement. If more than one individual, corporation, partnership, or limited liability company has interest in the property, duly authorized representatives of each shall sign the 433 Agreement. Developer shall obtain on the 433 Agreement the signatures of all Landowners or Unit Owners to whom lots are sold, if any.

(4) Where the preliminary plat, the construction plans, or the Exhibit B documents approved by the LCDC show drainage easements, a legal description of all easements shall be included on a Release of Right-of-Way Form, which shall be in a LCDC-approved format, signed by an authorized representative of the landowner/developer, and recorded prior to the sale of any lots which are to be encumbered by easements. If lots are sold prior to the Developer releasing an easement to the District, the Developer shall obtain all necessary easements on said lots for completion of the project. Any lots sold on land contract must have the signature of both land contract vendor and vendee on the easement.

(5) The Drain Commissioner shall be in receipt of a signed 433 Agreement, all necessary cash deposits, and approved deed restrictions prior to construction plan approval and/or signing of the final plat.

(6) Landowner/Developer shall not be in violation of permit conditions and all fees to date shall be fully paid.

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(7) The proprietor shall retain a qualified inspector, supervised by a registered professional engineer, to perform infrastructure construction inspection & assure construction according to LCDC approved plans. Inspection activities shall be documented by written daily reports acceptable to the LCDC. Daily inspection reports shall be bound & submitted to the LCDC for review prior to final acceptance.

(8) Deed Restrictions & Master Deeds shall be submitted and approved by the LCDC prior to construction plan approval. The Landowner shall include standard language provided by the LCDC for Deed Restrictions & Master Deeds, & remove or modify any language objectionable to the LCDC prior to recording.

(9) Effective March 1, 1999, Developer's Engineer shall develop & submit a proposed assessment roll, on paper and in electronic format, for future drain maintenance in the development. The roll shall include benefit factors for each lot in the development that is not common-owned property (e.g. parks or open space). Benefit factors shall be based on use of roads, lot size, topography, etc. The sum of the benefit factors for each parcel shall equal 1.0, and benefit factors for each parcel shall be carried to five decimal places.

(10) Prior to Final Acceptance of the Drainage Infrastructure the Developer shall complete a 2-year maintenance bond for the development, which shall guarantee the performance of the developer in the event that defective work is found after final acceptance of the drain.

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

This document is subject to future revision by the LCDC and in no way limits the authority of the LCDC to impose requirements beyond those listed above.

OTHER NOTES:_____

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EXHIBIT B

I, **[INSERT ENGINEER NAME]**, a Registered Professional Engineer in the State of Michigan, do hereby certify to the following for the **[INSERT DRAIN NAME, USE DEVELOPMENT NAME]**, Drain Drainage District in Section [**INSERT SECTION NUMBER] of [INSERT TOWNSHIP NAME]**:

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

2. To my knowledge, there is

   a. Existing capacity in the existing drains to serve the lands to be developed without detriment to or diminution of the sanitary sewer or storm drainage service provided or to be provided in the foreseeable future in the existing district.

   b. No foreseeable adverse impact on downstream proprietors created by the storm water flow from the ***[INSERT DRAIN NAME, USE DEVELOPMENT NAME]*** Drain Drainage District.

_____

[TYPE ENGINEER NAME & NUMBER]

Date:_____

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DRAINAGE EASEMENT

For and in consideration of prospective benefits to be derived by reason of the construction, operating and maintaining of a certain Drain under the supervision of the Livingston County Drain Commissioner, 2300 East Grand River Avenue, Howell, Michigan, as hereinafter described,

[insert tax I.D.# of land, if applicable]

[insert name(s) and address of owner(s)]

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

[enter legal description of land here or refer to attached exhibit]

The Right of Way or Easement conveyed is described as:

[enter easement description here or refer to attached exhibit]

The route and course of said Drain is described as follows, to-wit:

[enter the route and course of drain here or refer to attached exhibit]

This conveyance is based upon the above described line of route and shall be deemed to include the extreme width of said Drain as shown in the survey thereof, to which survey reference is hereby made for a more particular description, and includes a release of all claims to damages in any way arising from or incident to the opening and maintaining of said Drain across said premises; and also the feet of ground on either side of the center line of said Drain, for the construction thereof; and shall be deemed a sufficient conveyance to vest in the Drainage District an easement in said lands for the uses and purposes of drainage together with such rights of entry upon, passage over, deposit of excavated earth and storage of material and equipment on such lands, as may be necessary or useful for the construction, maintenance, cleaning out and repair of such drain.

Witness, (my, our) hand and seal, dated_____, 20__.

[INSERT CORPORATION NAME IF ON BEHALF OF A CORPORATION]

_____

Printed Name:_____

[PRINT JOB TITLE IF ON BEHALF OF A CORPORATION]

DRAFT

[PROVIDE SECOND SIGNATURE IF HUSBAND AND WIFE OR OTHER SECOND OWNER]

DRAFT

STATE OF MICHIGAN)
) SS
COUNTY OF LIVINGSTON)

On_____, 20___, before me, a Notary Public in and for said County, personally appeared____to me known to be the person described in and who executed the foregoing instrument, and does acknowledge that they executed same as their free act and deed.

_____
Notary Public
Livingston County, Michigan
My Commission Expires:_____

[PROVIDE SECOND NOTARY WITNESS IF MORE THAN ONE SIGNATURE]

Instrument Prepared by:
[INSERT DRAFTEE NAME & ADDRESS]

When Recorded Return to:
Brian Jonckheere
Livingston County Drain Commissioner
2300 East Grand River, Suite 105
Howell, Michigan 48843

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Appendix B:
Preliminary Plat or Plan Checklist

PRELIMINARY PLAT OR PLAN CHECK LIST

SUBDIVISION NAME:_____ DATE:_____
LOCATION:_____ REVIEWED BY:_____

The following information shall be included on all Plans submitted for approval by the Livingston County Drain Commissioner.

	Item	Included Yes or No	Approved Yes or No
1.	The location of the proposed development by means of a small location map.		
2.	The township, city, or village in which the parcel is situated, including the section and fractional portion thereof, Town and Range Designation		
3.	Name, email, address & telephone no. of Owner		
4.	Name, email, address & telephone no., signature and seal of engineer		
5.	North arrow and scale		
6.	Benchmark description (2 minimum)		
7.	Legend		
8.	Typical road cross-section (Label road as “Public Road” or “Private Road”)		
9.	Lot Information: Unit numbers, dimensions (scaled or computed), setback lines, and square footage (minimum)		
10.	Minimum house grade and basement opening elevation for each lot		
11.	Typical lot grading plan detail or statement		
12.	Development boundary with metes & bounds property description, tied to nearest government corner		
13.	Identification of all adjoining parcels (for subdivision show lot number, subdivision name, Liber and page number, for acreage parcels, show tax roll number and owners name)		
14.	Existing buildings (label those under construction with address)		
15.	Existing and proposed roads with name and R.O.W. width		

	Item	Included Yes or No	Approved Yes or No
16.	Soil boring logs and locations (to include ground elevation at each boring log and water table information). Logs from site report prepared for Environmental Health Division are acceptable.		
17.	Existing contours at 1 ft. intervals or less, with NAVD 88 datum.		
18.	Existing and proposed easements (w/dimensions, both utility and drainage easements)		
19.	All existing drainage courses and structures (w/proper labeling as to type, size and invert elevations)		
20.	Flood plain contour (existing and proposed)		
21.	Identification of agency to assume maintenance responsibility for the drainage system		
22.	A map, showing the drainage boundary of the proposed development and its relationship with existing drainage patterns.		
23.	Any water course passing through the development, including the area of upstream watershed, current zoning, and preliminary calculations of runoff from the upstream area for both the Flood Control Volume and the Channel Protection Rate Control Volume, for fully-developed conditions according to the current land use plan for the area.		
24.	Proposed drainage system identifying all open and enclosed portions. Approximate boundaries and acreages of tributary areas of proposed and existing inlets, catch basins and culverts shown.		
25.	Proposed detention or retention basins (w/volume and dimension; show computations). If retention basin, provide overflow failure analysis, if detention provide evidence of adequacy of outlet.		
26.	The location and description of any other on-site and adjacent off-site features that may be relevant in determining the overall requirements for the development. For example: High tension power lines or underground transmission lines, cemeteries, parks, sewers, water mains, septic fields, wells and any proposed environmental mitigation features.		

Appendix C:
Construction Plan Checklist

CONSTRUCTION PLAN CHECK LIST

	Item	Included Y/N	Approved Y/N
1.	The property description including total acreage as well as the location of the proposed project by means of a small location map. If the project is to be completed in phases, the boundary and the number of acres in each phase shall also be included.		
2.	The proposed project layout with all dimensions, including the proposed drainage system for the project.		
3.	A map, showing the drainage boundary of the proposed project and its relationship with existing drainage patterns.		
4.	The location and description of all on-site and adjacent off-site features including but not limited to: adjoining roads and subdivisions; railroads; high tension power lines and/or underground transmission lines; cemeteries; parks; natural and artificial watercourses, wetlands and wetland boundaries, floodplains, lakes, bays, and lagoons; designated natural areas and significant natural features, any proposed environmental mitigation features; drains, sewers, water mains, septic fields, and wells; existing and proposed easements.		
5.	Plans, profiles and details of all roads and storm sewers. The storm sewer details will include type and class of pipe, length of run, percent of slope, invert elevations, rim elevations, depth of burial, backfill type, depth and compaction, and profile of the hydraulic gradient.		
6.	Storm sewer calculations indicating the number of acres, calculated to the nearest tenth of an acre, contributing to each specific inlet/outlet, the calculated hydraulic gradient elevation, maximum flow in cfs and the flow velocities for enclosed systems.		
7.	Plans, profiles, & details of all open ditch drains, drainage swales, and drainage structures.		
8.	Plans and details of the proposed soil erosion and sedimentation control measures, both temporary (during construction) and permanent.		
9.	Plans and details of proposed retention/detention facilities. Test pit or Soil borings are required at the sites of these facilities.		
10.	A drainage area map, overlaid onto a copy of the site grading plan, which clearly shows the areas tributary to each inlet and/or storage basin.		
11.	Topographic maps, at one-foot contour intervals or less on NAVD 88, showing existing and proposed grades, as well as off-site topography over at least 200 feet of the adjoining property. Maps will also show all existing water courses, lakes and wetlands, and the extent of all off-site drainage areas contributing flow to the development.		
12.	All drain field locations as approved by the Livingston County Environmental Health Department & of all expansion areas. Drain fields shall not be located within drainage easements and shall comply with isolation distance requirements stated in the Livingston County sanitary code.		

Appendix D:
Livingston County Soil Types

HYDROLOGIC SOIL GROUPS FOR LIVINGSTON COUNTY

Soil properties influence the process of generation of runoff from rainfall and must be considered in methods of runoff estimation. When runoff from individual storms is the major concern, the properties can be represented by a hydrologic parameter which reflects the minimum rate of infiltration obtained for a bare soil after prolonged wetting. The influences of both the surface and the horizons of a soil are therefore included.

Four hydrologic groups are used. The soils are classified on the basis of water intake at the end of the long-duration storms occurring after prior wetting and after an opportunity for swelling, and without the protective effects of vegetation. In the definitions to follow, the infiltration rate is the rate at which water enters the soil at the surface and which is controlled by surface conditions, and the transmission rate is the rate at which the water moves in the soil and which is controlled by the horizons. The hydrologic soil groups, as defined by the SCS soil scientists, are:

A. (Low runoff potential) Soils having high infiltration rates even when thoroughly wetted and consisting chiefly of deep, well to excessively drained sands or gravels. These soils have a high rate of water transmission.

B. Soils having moderate infiltration rates when thoroughly wetted and consisting chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures. These soils have a moderate rate of water transmission.

C. Soils having slow infiltration rates when thoroughly wetted and consisting chiefly of soils with a layer that impedes downward movement of water, or soils with moderately fine to fine texture. These soils have a slow rate of water transmission.

D. (High runoff potential) Soils having very slow infiltration rates when thoroughly wetted and consisting chiefly of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a clay-pan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission.

The following table gives the hydrologic soil group for each soil series and, in some instances, gives several possible hydrologic soil group classifications for a series. In using this table, the first group shown (capital letter) is the native or natural group that the soil series is usually classified under when its water intake characteristics have not been significantly changed by artificial drainage, land use, or other factors. The second group shown is the probable maximum improvement that can be made through artificial drainage and the maintenance or improvement of soil structure. Generally speaking, those series having several possible classifications are soils with relatively high-water tables so that artificial drainage measurably improves their ability to absorb rainfall and thus reduce runoff.

HYDROLOGIC SOIL GROUPS FOR LIVINGSTON COUNTY

Soil Series	Hydrologic Group
Arkpoa	B
Barry	B/D*
Berville	B/D
Boger	B
Breckenridge	B/D
Bronson	B
Brookston	B/D
Carlisle	B
Colwood	B/D
Conover	C
Edwards	B/D
Fox	B
Gilford	B/D
Hillsdale	B
Houghton	A/D
Lamson	B/D
Linwood	A/D
Soil Series	Hydrologic Group
Locke	B
Metamora	B
Metea	B
Miami	B
Minoa	C
Oakville	A
Oshtemo	B
Ottokee	A
Owosso	B
Pewamo	C/D
Rifle	A/D
Sebewa	B/D
Spinks	A
Tawas	A/D
Thettard	A
Warners	C
Wasepi	B
Washtenaw	C

* Two soil groups, such as B/D, indicates the undrained/drained situation.
Source: USDA Soil Conservation Service, March 1990.

Appendix E:
Infiltration Testing Measurement

INFILTRATION TESTING

The infiltration testing must provide information related to the conditions at the bottom of the infiltration BMP. General infiltration test guidelines are as follows:

1. Any test used to determine infiltration rates for BMPs, shall be performed at the location and extend to the bottom elevation of the proposed infiltration BMP.
2. Infiltration tests must not be conducted in the rain, within 24 hours of significant rainfall events {>0.5 inches), when the ground is frozen, or when the temperature is below freezing.
3. Infiltration tests should be conducted in the field.
4. All infiltration rates used for the design of BMPs must be certified by a Professional Engineer licensed in the State of Michigan and submitted to the WRC's office.
5. Following all testing, the surface must be restored.
6. Additional infiltration tests may be necessary due to subsurface variability, water table depth or topography. The Livingston County Drain Commissioner's Office will determine if more tests will be required.

Infiltration tests may include, but not limited to, the following methods:

1. Test Pits used in conjunction with any of the infiltration tests listed below
    a. Double-ring Infiltrometer test – estimate for vertical movement of water through the bottom of the test area
        i. ASTM 2003 Volume 4.08, Soil and Rock (I): Designation D 3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using a Double-Ring Infiltrometer
        ii. ASTM 2002 Volume 4.09, Soil and Rock (II): Designation D 5093-90, Standard Method of Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring
    b. Percolation test – Estimate for vertical movement of water through the bottom and sides of the test area
    c. Encased falling head permeability test – estimate for vertical movement of water through the bottom of the test area
    d. Guelph permeameter
    e. Constant head permeameter (Amoozemeter)
2. When using test pits, a minimum of 2 infiltration tests are required per test pit.
3. Soil Borings
    a. The use of soil borings to determine infiltration rates is discouraged. If soil borings are used in lieu of test pits, a safety factor of 2 is applied to the final Ksat Value. This is due to the limited sample and the inability to test in-situ soil characteristics when preforming a soil boring.

Note: Other tests selected by the design engineer that can accurately represent the in-situ infiltration rate may be used at the discretion of the Livingston County Drain Commissioner's Office.

The following infiltration (Ksat) values shall be used to determine the appropriate design methods for infiltration BMPs:

Ksat Values	
Ksat ≥ 0.50 in/hr	No supplemental measures are required for Infiltration BMPs to provide the infiltration volume
0.50 in/hr ≥ Ksat ≥ 0.24 in/hr	Install supplemental measures, which may include subsoil amendment, or an underdrain placed at the top of the storage bed layer to ensure dewatering in the event underlying soils fail to provide adequate drawdown or dewatering time. If underdrains are selected, design shall allow stormwater to percolate through the soils first, with the underdrain serving as a secondary outlet, by placing the underdrain in the upper level of the BMP, with pipe perforations located along the underdrain invert.
Ksat ≤ 0.24 in/hr	***Soil are not suitable for infiltration Alternative volume reducing LID practices must be used to the MEP to reduce stormwater volume.***

Appendix F:
Sample Calculations

EXAMPLE STORMWATER MANAGEMENT DESIGN CALCULATIONS

A = 20.10 acre site, Weighted "C" = 0.50, Q_{all} = 0.15 cfs/acre

Required Water Quality Volume

= V_{wq} = 1"/12"(43,560)(C)(A)

V_{wq} = 3,630(0.50)(20.10) = 36,482 C.F.

Required Channel Protection Volume

= V_{cp} = 1.3"/12"(43,560)(C)(A)

V_{cp} = 4,719(0.50)(20.10) = 47,426 C.F.

To be stored and infiltrated below outlet elevation.

Required Forebay Volume

= V_{wq} When Detention Basin Infiltration is Proposed (or 15% of V_{wq} With Upstream Infiltration or if Infiltration is not feasible)

= 36,482 C.F. Forebay Volume to be discharged to detention basin at same rate as the Extended Detention Volume is discharged from the basin

Required Extended Detention Volume (For Channel Protection Rate Control)

= V_{ed} = 1.9"/12(43,560)(C)(A)

V_{ed} = 6,897(0.50)((20.10) = 69,315 C.F.

To be discharged over 48 hours

Extended Detention Volume Discharge Rate

= Q_{ed} = V_{ed} /(48 hr)(60 min)(60 sec)

69,315/172,800 = 0.40 cfs

To be used for both Forebay & Detention Basin Outlet Control Design

Required Water Quality Treatment Rate

= Q_{wq} = (C)(A)(97/Tc+30)

Q_{wq} = (0.50)(20.10)(97/21.0+30)

Q_{wq} = 19.11 cfs

Note: T_c = 21.0 min From Storm Sewer Design

1 Yr. Storm Treatment Rate Requirement if a mechanical treatment device is used instead of a forebay for water quality purposes.

100 Yr. Storm Inlet Rate

= $Q_{100in} = (C)(A)(83.30/ (T_c+9.17)^{0.81})$

$Q_{100in} = (0.50)(20.10)(83.30/(21.0+9.17)^{0.81})$

$Q_{100in} = 53.01$ cfs

Note: $T_c = 21.0$ min From Storm Sewer Design

100 Yr. Storm Allowable Outlet Rate

= Q_{100all} = Lesser of Restricted Rate for Drain or Variable Release Rate (Q_{vrr})

$Q_{100all} = 0.15$ cfs/acre x 20.10 acres = 3.02 cfs

Variable Release Rate (When Applicable)

= $Q_{vrr} = 1.1055 – 0.206$ LN (A)

$Q_{vrr} = 1.1055 – 0.206$ LN (20.10)

$Q_{vrr} = 0.487$ cfs/acre

Required 100 Yr. Storm Detention Volume

Storage Curve Factor

= $R = 0.206 – (0.15)(LN(Q_{all}/Q_{100in}))$

$R = 0.206 – (0.15)(LN(3.02/53.01))$

$R = 0.636$

100 Yr. Storm Volume In

= $V_{100in} = 18{,}985(C)(A)$

$V_{100in} = 190{,}799$ C.F.

Required 100 Yr. Storm Storage Volume Above Outlet

= $V_{100det} = (V_{100in})(R) – V_{cp}$ Credit

= 190,799(0.636) – 47,426

= 121,348 – 47,426 = 73,922 C.F.

Since 73,922 c.f. Is More Than the Required Extended Detention Volume of 69,315 C.F., the Minimum Required 100 Yr. Storm Storage Volume Is the 100 Year Storm Storage Volume of 73,922 C.F.

Design Calculations For Infiltration of Channel Protection Volume

For Sandy Loam (Type B) Soils with a 1”/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 1.0”/hr x 72 hr = 72” or 6 ft.
Max. Surface Water Storage Depth = 1.0”/hr x 24 hr = 24” or 2 ft.
Infiltration Depth During Storm = 1.0”/hr x 6 hr = 6” or 0.5 ft.
Potential Soil Storage Depth = 1.0”/hr x 48 hr = 48” or 4 ft.
Potential Soil Storage Depth EQV = 48”x0.25 porosity = 12” or 1 ft.

- Since the potential soil storage is relatively expensive & the soils are reasonably permeable, the most economical storage to meet the infiltration requirement will still be surface water storage located in the bottom of the detention basin.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (2 ft. Surface + 0.5 ft. Infiltration) Depth
= 18,970 S.F. Required

For Loamy (Type C) Soils with a 0.50”/hr In-Situ Infiltration Rate:

Max. Total Water Storage Depth = 0.50”/hr x 72 hr = 36” or 3.0 ft.
Max. Surface Water Storage Depth = 0.5”/hr x 24 hr = 12” or 1.0 ft.
Infiltration Depth During Storm = 0.5”/hr x 6 hr = 3” or 0.25 ft.
Potential Soil Storage Depth = 0.5”/hr x 48 hr = 24” or 2.0 ft.
Potential Soil Storage Depth EQV = 24”x0.25 porosity = 6” or 0.5 ft.

- Since the soil permeability is relatively low, a combination of surface water storage & soil storage will be utilized in the bottom of the detention basin to meet the infiltration requirement.

The Detention Basin Bottom Infiltration Area Required
(Below the basin outlet elevation)
= 47,426 C.F./ (1 ft. Surface + 0.25 ft. Infiltration + 0.5 ft. Soil) Depth
= 27,101 S.F. Required

Design Calculations for Required Storage & Outlet Orifice With 1"/hr Infiltration Rate

Storage Volumes Required For Infiltration Within Basin Bottom Area

- In Forebay Above Outlet Elevation = 100% V_{wq} = 36,482 C.F.
- In Detention Basin Below Outlet Elevation 2.0/2.5xV_{cp} = 37,941 C.F.
  With 2 Foot Maximum Depth & 18,970 S.F. Avg. Bottom Area
- In Combined Detention Basin & Forebay (Above Outlet)
  = V_{ed} of 69,315 C.F. & V_{100det} of 73,922 C.F.

Storage Volume Provided In Forebay

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)
850.0 (L.W.)	12,100	0	0	0	0
851.0	14,400	13,250	1.0	13,250	13,250
852.0	16,900	15,650	1.0	15,650	28,900
852.5 (H.W.)	18,225	17,563	0.5	8,782	37,682

Storage Volume Provided In Detention Basin

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)	Cumulative Volume Incl. Forebay (C.F.)
848.0 (Bot.)	16,500	0	0	0	0	0
849.0	19,250	17,875	1.0	17,875	17,875	0
850.0 (L.W.)	22,200	17,725	1.0	20,725	38,600	0
851.0	25,350	23,775	1.0	23,775	23,775	61,457
852.0 (H.W.)	28,700	27,025	1.0	27,025	50,800	88,482
853.0 (F.B.)	54,750	41,725	1.0	41,725	92,525	130,207

Required Forebay 100% V_{wq} Storage Elevation (Above Outlet)
= (0.5(36,482-28,900)/8,782) + 852.0 = 852.43
Required Detention Basin Sump 80% V_{cp} Storage Elevation
= (1.0(37,941-17,875)/20,725) + 849.0 = 849.97
Required Detention Basin Storage Elevations (Above Outlet)
For V_{ed} = (1.0(69,315-61,457)/27,025) + 851.0 = 851.29
For V_{100det} = (1.0(73,922-61,457)/27,025) + 851.0 = 851.46

Extended Detention Orifice Design

Orifice Area = $Q_{ed}/0.62\sqrt{2(g)(h)}$
Orifice Area = $0.40/0.62\sqrt{2(32.2)(0.65)}$
Orifice Area = 0.09972 S.F.

Number of 1" Dia. Holes Required
= 0.09972/0.00545 = 18.30 Holes

Where: Q_{ed} = Discharge Rate
Q_{ed} = 0.40 CFS
g = 32.2 Ft/Sec^2
h = Avg. Hyd. Head
h = 0.5 (851.29-850.00)
h = 0.65 Ft.

Use 18 – 1" Dia. Orifice Holes At El. 850.00
On Both Forebay & Detention Basin Outlet Control Structures
(Forebay OCS Rim El. 852.50 & Detention Basin OCS Rim El. 852.00)

100 Year Storm Orifice Design

Flow Through Extended Detention Orifices With Full Hydraulic Head:
Q_{ED} = $18(0.00545)0.62\sqrt{2(g)(h)}$
Q_{ED} = $18(0.00545)0.62\sqrt{2(32.2)(1.46)}$
Q_{ED} = 0.59 CFS

Where: h = Full Hyd. Head
h = 851.46-850.00
h = 1.46 Ft.

Flow Through 100 Year Storm Orifices:
$Q_{100YR} = Q_{100all} - Q_{ed}$
Q_{100YR} = 3.02-0.59 = 2.43 CFS

Orifice Area = $Q_{100YR}/0.62\sqrt{2(g)(h)}$
Orifice Area = $2.43/0.62\sqrt{2(32.2)(0.17)}$
Orifice Area = 1.18453 S.F.

Where: h = Full Hyd. Head
h = 851.46-851.29
h = 0.17 Ft.

Number of 3" Dia. Holes Required
= 1.18453/0.04909 = 24.13 Holes

Use 24 – 3" Dia. Orifice Holes At El. 851.29
On The Detention Basin Outlet Control Structure
(Detention Basin OCS Rim El. 852.00)

Design Calculations For Required Storage & Outlet Design With 0.5”/hr Infiltration Rate

Storage Volumes Required For Infiltration Within Basin Bottom Area

- In Forebay Above Outlet Elevation = 100% V_{wq} = 36,482 C.F.
- In Detention Basin Below Outlet Elevation 1.0/1.75xV_{cp} = 27,101 C.F.
  With 1 Foot Maximum Depth & 27,101 S.F. Avg. Bottom Area
- In Combined Detention Basin & Forebay (Above Outlet)
  = V_{ed} of 69,315 C.F. & V_{100det} of 73,992 C.F.

Storage Volume Provided In Forebay

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)
850.0 (L.W.)	12,100	0	0	0	0
851.0	14,400	13,250	1.0	13,250	13,250
852.0	16,900	15,650	1.0	15,650	28,900
852.5 (H.W.)	18,225	17,563	0.5	8,782	37,682

Storage Volume Provided In Detention Basin

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)	Cumulative Volume Incl. Forebay (C.F.)
849.0 (Bot.)	25,850	0	0	0	0	0
850.0 (L.W.)	29,400	27,625	1.0	27,625	27,625	0
851.0	33,150	31,275	1.0	31,275	31,275	68,957
852.0 (H.W.)	37,100	35,125	1.0	35,125	66,400	104,082
853.0 (F.B.)	63,750	50,425	1.0	50,425	116,825	154,507

Required Forebay 100% V_{wq} Storage Elevation (Above Outlet)
= (0.5(36,482-28,900)/8,782) + 852.0 = 852.43
Required Detention Basin Sump 57.14% V_{cp} Storage Elevation
= (1.0(27,101/27,625) + 849.0 = 849.98
Required Detention Basin Storage Elevations (Above Outlet)
For V_{ed} = (1.0(69,315-68,957)/35,125) + 851.0 = 851.01
For V_{100det} = (1.0(73,922-68,957)/35,125) + 851.0 = 851.14

Extended Detention Orifice Design

Orifice Area = $Q_{ed}/0.62\sqrt{2(g)(h)}$
Orifice Area = $0.40/0.62\sqrt{2(32.2)(0.51)}$
Orifice Area = 0.11257 S.F.

Number of 1" Dia. Holes Required
= 0.11257/0.00545 = 20.65 Holes

Where: Q_{ed} = Discharge Rate
Q_{ed} = 0.40 CFS
g = 32.2 Ft/Sec^2
h = Avg. Hyd. Head
h = 0.5 (851.01-850.00)
h = 0.51 Ft.

Use 20 – 1" Dia. Orifice Holes At El. 850.00
On Both Forebay & Detention Basin Outlet Control Structures
(Forebay OCS Rim El. 852.50 & Detention Basin OCS Rim El. 852.00)

100 Year Storm Orifice Design

Flow Through Extended Detention Orifices With Full Hydraulic Head:
Q_{ED} = $20(0.00545)0.62\sqrt{2(g)(h)}$
Q_{ED} = $20(0.00545)0.62\sqrt{2(32.2)(1.14)}$
Q_{ED} = 0.58 CFS

Where: h = Full Hyd. Head
h = 851.14-850.00
h = 1.14 Ft.

Flow Through 100 Year Storm Orifices:
$Q_{100YR} = Q_{100all} - Q_{ed}$
Q_{100YR} = 3.02-0.58 = 2.44 CFS

Orifice Area = $Q_{100YR}/0.62\sqrt{2(32.2)(h)}$
Orifice Area = $2.44/0.62\sqrt{2(32.2)(0.13)}$
Orifice Area = 1.36014 S.F.

Where: h = Full Hyd. Head
h = 851.14-851.01
h = 0.13 Ft.

Number of 3" Dia. Holes Required
= 1.36014/0.04909 = 27.71 Holes

Use 27 – 3" Dia. Orifice Holes At El. 851.01
On The Detention Basin Outlet Control Structure
(Detention Basin OCS Rim El. 852.00)

Design Calculations For Required Storage & Outlet When Infiltration Is Not Feasible

Storage Volumes Required

- In Forebay Above Outlet Elevation = 15% V_{wq} = 5,472 C.F.
- In Combined Detention Basin & Forebay (Above Outlet)
  = V_{ed} of 69,315 C.F. & V_{100det} of 121,348 C.F.

Storage Volume Provided In Forebay

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)
850.0 (L.W.)	1,600	0	0	0	0
851.0	2,500	2,050	1.0	2,050	2,050
852.0	3,600	3,050	1.0	3,050	5,100
852.5 (H.W.)	4,225	3,913	0.5	1,957	7,057
853.0	4,900	4,563	0.5	2,119	9,176

Storage Volume Provided In Detention Basin

Contour	Area (Sq. Ft.)	Avg. Area (Sq. Ft.)	Incr. Depth (Ft.)	Incremental Volume (C.F.)	Cumulative Volume (C.F.)	Cumulative Volume Incl. Forebay (C.F.)
850.0 (L.W.)	17,200	0	0	0	0	0
851.0	22,000	19,600	1.0	19,600	19,600	28,776
852.0	27,000	24,500	1.0	24,500	44,100	53,276
853.0	32,200	29,600	1.0	29,600	73,700	82,876
853.0	37,100	34,650	0	0	73,700	82,876
854.0 (H.W.)	44,000	40,550	1.0	40,550	114,250	123,426
855.0 (F.B.)	50,400	47,200	1.0	47,200	161,450	170,626

Required Forebay 15% V_{wq} Storage Elevation (Above Outlet)
= (0.5(5,472-5,100)/1,957) + 852.0 = 852.10
Required Detention Basin Storage Elevations (Above Outlet)
For V_{ed} = (1.0(69,315-53,276)/29,600) + 852.0 = 852.54
For V_{100det} = (1.0(121,348-82,876)/40,550) + 853.0 = 853.95

Extended Detention Orifice Design

Orifice Area = $Q_{ed}/0.62\sqrt{2(g)(h)}$
Orifice Area = $0.40/0.62\sqrt{2(32.2)(1.27)}$
Orifice Area = 0.07134 S.F.

Number of 1" Dia. Holes Required
= 0.07134/0.00545 = 13.09 Holes

Where: Q_{ed} = Discharge Rate
Q_{ed} = 0.40 CFS
g = 32.2 Ft/Sec^2
h = Avg. Hyd. Head
h = 0.5 (852.54-850.00)
h = 1.27 Ft.

Use 13 – 1" Dia. Orifice Holes At El. 850.00
On Both Forebay & Detention Basin Outlet Control Structures
(Forebay OCS Rim El. 852.50 & Detention Basin OCS Rim El. 854.00)

100 Year Storm Orifice Design

Flow Through Extended Detention Orifices With Full Hydraulic Head:
Q_{ED} = $13(0.00545)0.62\sqrt{2(g)(h)}$
Q_{ED} = $13(0.00545)0.62\sqrt{2(32.2)(3.95)}$
Q_{ED} = 0.70 CFS

Where: h = Full Hyd. Head
h = 853.95-850.00
h = 3.95 Ft.

Flow Through 100 Year Storm Orifices:
$Q_{100YR} = Q_{100all} - Q_{ed}$
Q_{100YR} = 3.02-0.70 = 2.32 CFS

Orifice Area = $Q_{100YR}/0.62\sqrt{2(g)(h)}$
Orifice Area = $2.32/0.62\sqrt{2(32.2)(1.41)}$
Orifice Area = 0.39268 S.F.

Where: h = Full Hyd. Head
h = 853.95-852.54
h = 1.41 Ft.

Number of 3" Dia. Holes Required
= 0.39268/0.04909 = 8.00 Holes

Use 8 – 3" Dia. Orifice Holes At El. 852.54
On The Detention Basin Outlet Control Structure
(Detention Basin OCS Rim El. 854.00)

Appendix G:
Storm Conveyance Design Parameters

STORM DRAINAGE DESIGN CRITERIA

A. STORM SEWERS

1. The required discharge capacity shall be determined by the Rational Method:

$$Q = ACI$$

a. The 10 year design storm of I=175/(t + 25) shall be used. The minimum value of time of concentration (t) shall be 15 minutes.

b. The run-off coefficient C shall be as recommended on Pg. 51 of ASCE Manual 37 Design and Construction of Sanitary and Storm Sewers, 1969. (See Annex 1.) Where a weighted coefficient is employed, the computations shall be attached to project plans.

2. Sewer design, velocities, capacity, and friction losses shall be based on Manning's formula, generally with n = 0.013 for concrete pipe and 0.021 for corrugated metal pipe.

$$Q = \left(\frac{1.486}{n}\right) r^{2/3} s^{1/2}$$

3. The following are permissible slopes for each pipe size (n = 0.013). Maximum velocities for outlet pipes shall be non-erosive.

Pipe Size	**Minimum % of Grade** 2.5ft/sec	**Desirable Range % of Grade** 4 ft/sec	8 ft/sec	**Maximum% of Grade** 10 ft/sec
10"	0.4	1	3.98	6.22
12"	0.32	0.78	3.12	4.88
15"	0.24	0.58	2.32	3.62
18"	0.2	0.46	1.82	2.84
21"	0.16	0.38	1.48	2.3
24"	0.14	0.3	1.24	1.94
27"	0.12	0.26	1.06	1.66
30"	0.1	0.22	0.92	1.44
36"	0.08	0.18	0.72	1.12
42"	0.06	0.14	0.58	0.92
48"	0.06	0.12	0.5	0.76
54"	0.04	0.1	0.38	0.6
60"	0.04	0.1	0.34	0.54
66"	0.04	0.08	0.32	0.48

4. A complete set of storm sewer design computations shall accompany every set of final plans submitted for review.

5. Hydraulic gradients shall be shown as a part of all storm sewer profiles. In no case shall the elevation of hydraulic gradient exceed the elevation of a point lying one (1) foot below the rim elevation of a manhole, catch basin, or inlet. For storm sewers, the future extension of which is anticipated surcharging out of the pipe will not be permitted.

6. The storm sewer pipe shall have a minimum diameter of 12 inches when constructed in a public right-of-way or easement.

7. The storm sewer plan and profile drawing shall show the following data:

a.	Identification and numbering of manholes, catch basins, and inlets.
b.	Invert and casting elevations for all structures.
c.	Pipe length (c - c of structures).
d.	Pipe diameter.
e.	Pipe slope.
f.	Pipe class.
g.	Pipe joints (modified rubber groove joint).
h.	Porous backfill and special bedding where required.

8. Generally, manholes shall be placed not more than 400 feet apart for sewers less than 30 inches diameter, and 600 feet apart for larger sewers.

9. The minimum inside diameter of all manholes, catch basins, and inlet structures shall be 48 inches, with the following exception:

   Inlet structures from which water will be discharged directly into a catch basin may be 24 inches inside diameter. The depth of such inlets shall be no greater than 5.0 and no less than 3.5 feet from top of frame and cover to invert.

10. Manholes and inlet structures may be constructed of brick, manhole block, pre-cast concrete (ASTM C478), or cast-in-place concrete.

11. All manhole block or brick structures shall be plastered on the outside with 1 to 2.5 mix of Portland cement mortar, 1/2 inch thick. No lime shall be added.

12. Inlet structures in the public street right-of-way shall be spaced a maximum of 400 feet apart of a maximum of 400 feet each way from high points. The spacing and/or number of inlet structures required to accommodate the design flows in streets and in private drives and parking areas shall be based on a maximum of 1 cfs per 90 square inches of opening in an inlet or catch basin cover.

13. Inlet Capacity

Designation*	Curb	Capacity (cfs) Ditch	Sump Condition
C	1.2		
D-4	0.9		
E		1.0	3.4
G		0.5	2.1
K	2.0		
H	2.5		
* MDOT			

MDOT cover K is the accepted standard in public streets. Other covers, having equivalent cross-sectional area of opening, are acceptable at other locations.

14. Generally, drops of over 2.0 feet at manholes, from invert of higher pipes to lower pipe, shall be avoided.

15. Unless otherwise permitted by the Livingston County Road Commission, all storm sewer pipe within the public road right-of-way shall be of reinforced concrete and conform to the specifications for reinforced concrete sewer pipe ASTM C-76. All piped components of drainage systems in new developments proposed to be public shall be of reinforced concrete conforming to ASTM C-76.

16. Concrete pipe joints shall have rubber gaskets conforming with ASTM 443. Joints in concrete pipe having a diameter of 30 inches and larger shall be pointed up on inside with mortar after backfilling has been completed.

17. Where drainage is outletted to County drains or natural water courses, such outlets shall be so designed as to enter the drain or water course at an angle of 90 degrees or less, as determined by the upstream centerline. Headwall, pre-formed end sections, grouted rip-rap, or specially designed outlet structures will be required.

18. All catch basins and inlets shall be as specified by the Michigan Department of Transportation Detail I-5C.

    All manholes for pipes 42 inches in diameter and under shall be specified by the Michigan Department of Transportation Detail I-1C.

    Special details will be required for manholes placed on pipe 48 inches in diameter and larger.

    Outlet velocities and elevation: Outlets located such that they are in a non-erosive position, generally with an elevation no more than two feet above the toe of slope.

B. OPEN CHANNELS

1. The required discharge capacity shall be determined by Rational Method (see STORM SEWERS).

C. CULVERTS

1. The required discharge capacity of all culverts except drive culverts shall be determined by Rational Formula (see STORM SEWERS).
2. All culverts other than driveway culverts shall be designed in accordance with procedures specified in the Hydraulic Engineering Circular No. 5 (Hydraulic Charts for the Section of Highway Culverts) U.S. Department of Commerce, Bureau of Public Roads. Computations for all culverts thus designed shall accompany the final plans and shall include both designs for inlet and outlet-controlled flows.
3. All culverts other than drive culverts shall be equipped with headwalls and/or preformed end sections.
4. The following is data which shall be provided in the final plans for all culverts other than driveway culverts:

a.	Length
b.	Diameter
c.	Invert Elevations
d.	Type
e.	Protection

5. Minimum size of a drive culvert shall be 12 inches.
6. Minimum size of a cross road culvert shall be 15 inches or equivalent pipe arch.
7. The pipe used in culverts may be reinforced concrete culvert pipe or corrugated metal pipe and pipe arch. The pipe furnished shall conform to the Current Specifications for Reinforced Concrete, Storm Drain and Sewer Pipe, ASTM Designation: C-76 or to the Current Specifications for Corrugated Metal Culvert Pipe AASHTO Designation: M-36.

AVERAGE VALUES OF THE MANNING ROUGHNESS FACTOR FOR VARIOUS BOUNDARY MATERIALS

Boundary Material	Manning n
HDPE pipe	0.011
Finished concrete	0.012
Planed wood	0.012
Concrete pipe	0.013
Unplaned wood	0.013
Unfinished concrete	0.014
Cast Iron	0.015
Brick	0.016
Riveted steel	0.018
Corrugated metal	0.022
Rubble	0.025
Earth	0.025
Gravel	0.029
Earth, with stones and weeds	0.035

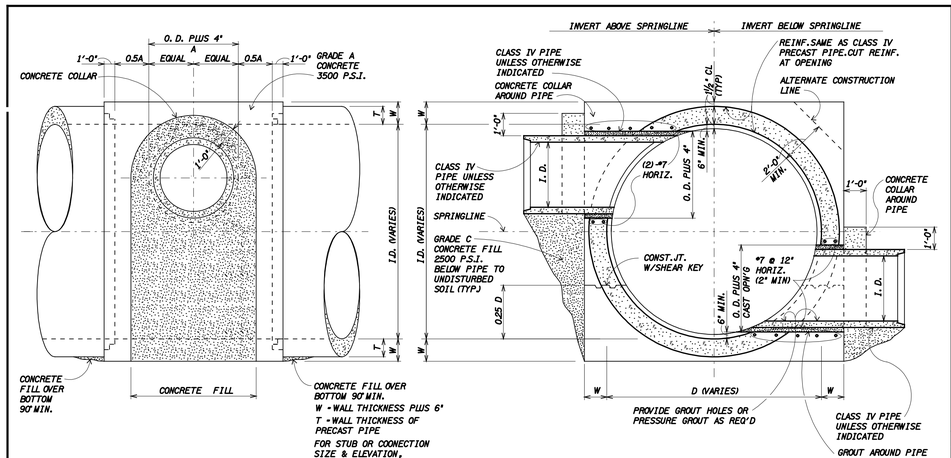
Reference: Fluids Mechanics, 5th Edition, by V. L. Streeter, McGraw Hill 1971, N.Y., N.Y., page 279

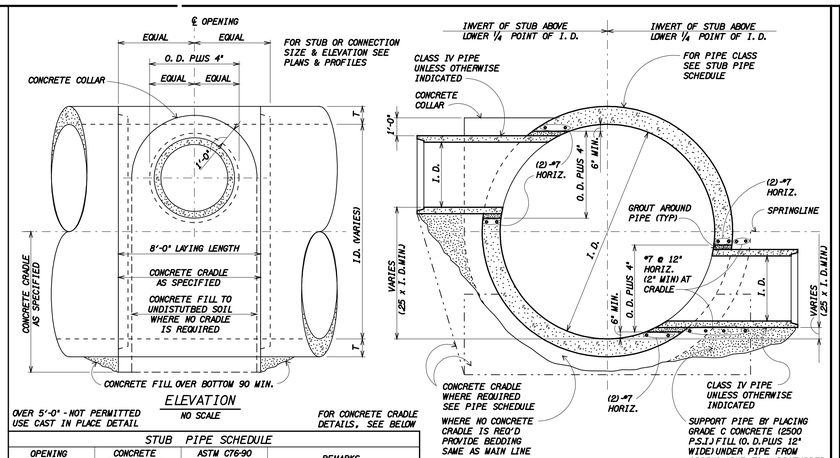
VALUES OF RELATIVE IMPERVIOUSNESS

Type of Surface	C Factor
Water Surfaces	1.00
Roofs	.90 to 1.00
Asphalt or concrete pavements	.90 to 1.00
Gravel, brick, or macadam surfaces	.60 to .80
Impervious soils	.60 to .80
Impervious soils with turf	.40 to .60
Slightly pervious soils	.30 to .50
Slightly pervious soils with turf	.20 to .40
Moderately pervious soils	.20 to .30
Moderately pervious soils with turf	.15 to .25
Completely undeveloped pervious soils	.10 to .20
Playgrounds	.20 to .35
Unimproved	

These values are for slopes from 1 % to 4 %; steeper slopes will be higher.

Appendix H:
Storm Drain Backfill Detail

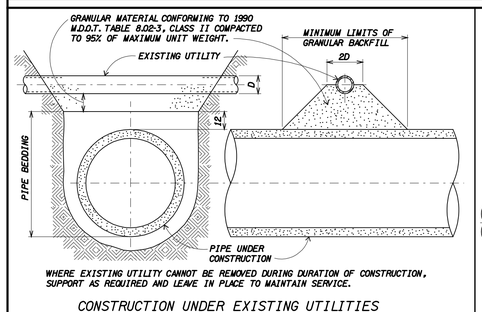




STUB PIPE SCHEDULE

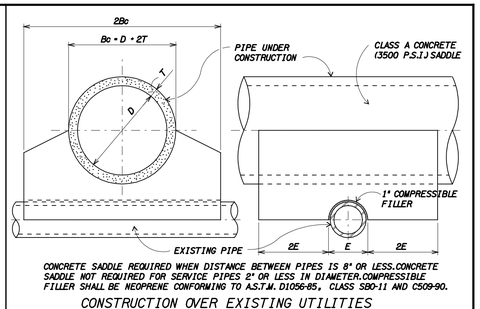
OPENING SIZE	CONCRETE CRADLE TYPE	ASTM C76-90 CLASS	REMARKS
2'-0" & SMALLER	NONE	ONE CLASS OVER MAIN LINE	#7 BARS ABOVE & BELOW OPN'G IN PIPE NOT REQUIRED
2'-1" THRU 4'-0"	NONE	IV	
	B	SAME AS MAIN LINE	USE CLASS V & CLASS IV MAIN LINE
4'-1" THRU 5'-0"	B	IV	USE CLASS V & CLASS IV MAIN LINE

STANDARD STUBS & CONECTIONS TO SEWERS



WHERE EXISTING UTILITY CANNOT BE REMOVED DURING DURATION OF CONSTRUCTION, SUPPORT AS REQUIRED AND LEAVE IN PLACE TO MAINTAIN SERVICE.

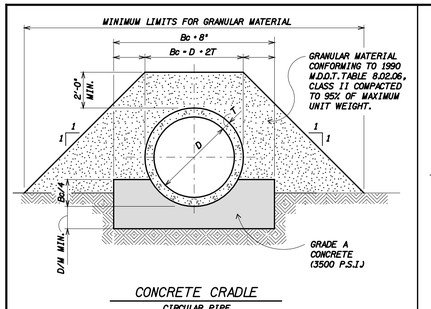
CONSTRUCTION UNDER EXISTING UTILITIES



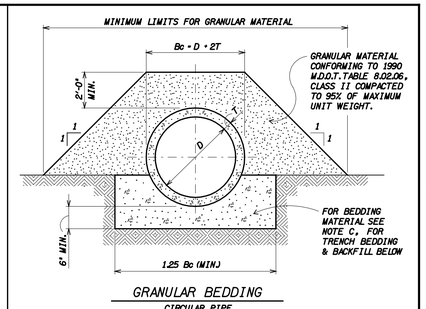
CONCRETE SADDLE REQUIRED WHEN DISTANCE BETWEEN PIPES IS 8" OR LESS. CONCRETE SADDLE NOT REQUIRED FOR SERVICE PIPES 2" OR LESS IN DIAMETER. COMPRESSIBLE FILLER SHALL BE NEOPRENE CONFORMING TO A.S.T.M. D1056-85, CLASS SB0-11 AND C509-90.

CONSTRUCTION OVER EXISTING UTILITIES

METHOD OF CROSSING EXISTING UTILITIES WITH NEW CONSTRUCTION

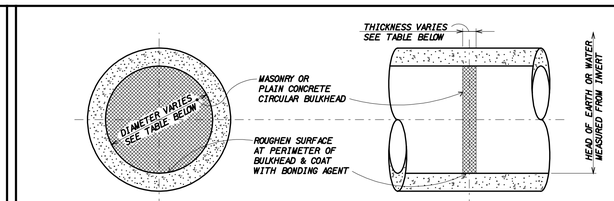


CONCRETE CRADLE
CIRCULAR PIPE



GRANULAR BEDDING
CIRCULAR PIPE

EMBANKMENT BEDDING & FILL



MASONRY BULKHEAD SHALL BE BRICK OR SOLID CONCRETE BLOCK WITH MORTAR CONSISTING OF ONE PART PORTLAND CEMENT, ¼ PART LIME & 3½ PARTS SAND.

PLAIN CONCRETE BULKHEAD SHALL BE CLASS A (3500 P.S.I.) CONCRETE.

BONDING AGENT SHALL BE GRACE PRODUCTS "DARAWELD", LARSON PRODUCTS "WELDCRETE", OR EQUAL.

CIRCULAR SECTION DIAMETER (INCHES)	ALLOWABLE HEAD OF WATER ABOVE INVERT * (FEET)													
	MASONRY BULKHEAD THICKNESS (INCHES)					PLAIN CONCRETE BULKHEAD THICKNESS (INCHES)								
	8"	12"	16"	20"	24"	4"	6"	8"	10"	12"	14"	16"	18"	20"	22"	24"
36" & SMALLER	16	35	61	95		10	22	38	58	83	113	—	—	—	—	—
42"	12	26	45	70	100	8	16	28	43	61	83	108	—	—	—	—
48"	10	20	35	54	77	7	13	22	33	48	64	83	105	—	—	—
54"	8	16	28	43	62	6	11	18	27	38	51	66	83	103	—	—
60"	7	14	23	36	50	—	9	15	22	31	42	54	68	84	101	—
66"	—	12	20	30	42	—	8	13	19	26	35	45	57	70	84	100
72"	—	11	17	26	36	—	—	11	16	23	30	39	48	59	71	84
78"	—	10	15	22	31	—	—	9	14	20	26	33	42	51	61	72
84"	—	9	14	20	27	—	—	—	13	18	23	29	36	44	53	63
90"	—	—	12	18	24	—	—	—	12	16	21	26	32	39	47	55
96"	—	—	11	16	22	—	—	—	11	14	19	23	29	35	42	49
102"	—	—	10	15	20	—	—	—	10	13	17	21	26	31	37	44
108"	—	—	—	14	18	—	—	—	—	12	16	20	24	29	34	40
114"	—	—	—	13	17	—	—	—	—	11	15	18	22	26	31	36
120"	—	—	—	12	16	—	—	—	—	—	14	17	20	24	29	33
126"	—	—	—	—	15	—	—	—	—	—	13	16	19	23	26	31
132"	—	—	—	—	14	—	—	—	—	—	—	15	18	21	25	29
144"	—	—	—	—	—	—	—	—	—	—	—	—	14	16	22	25

* CONDITIONS BEYOND TABLE VALUES REQUIRE SPECIAL BULKHEADS AS SHOWN ON PLANS

STANDARD MASONRY & PLAIN CONCRETE BULKHEADS

GENERAL CONCRETE NOTES

1. THE CONTRACTOR SHALL VERIFY ALL CONDITIONS & MEASUREMENTS AT THE SITE & SHALL REPORT ANY DISCREPANCIES TO THE ENGINEER PROCEEDING WITH THE WORK.
2. CONCRETE SHALL BE GRADE A WITH A MINIMUM COMPRESSION STRENGTH OF 3500 P.S.I. AT 28 DAYS UNLESS OTHERWISE NOTED.
3. REINFORCEMENT STEEL SHALL BE NEW BILLET STEEL CONFORMING TO ASTM A615-90, GRADE 60, INCLUDING SUPPLEMENTARY REQM'TS S1, REINF. FOR TIES & STIRRUPS MAY BE NEW BILLET STEEL CONFORMING TO ASTM A615-90, GRADE 40.
4. REINFORCEMENT BAR DETAILING & PLACING SHALL CONFORM TO ACI 318-89 "BUILDING CODE", & TO DETAILS & DETAILING OF CONCRETE REINFORCEMENT ACI 315-80, & MANUAL OF ENGINEERING & PLACING DRAWINGS FOR REINFORCED CONC. STRUCT. ACI 315R-SP-66 (88) PLACE (2) #5 BARS, 4'-0" LONGER THAN OPENING, EACH FACE AROUND ALL OPENINGS IN WALLS & SLABS.
5. PROVIDE (1) #5 DIAGONAL x 3'-0" LONG, TOP & BOTTOM, EACH CORNER OF OPENING.
6. WALLS SHALL BE ADEQUATELY BRACED UNTIL SUPPORTING SLABS HAVE REACHED THEIR DESIGN STRENGTH.
7. PROVIDE CORNER BARS SAME SIZE & SPACING AS HORIZONTAL REINFORCEMENT ON OUTSIDE FACE OF ALL CORNERS.
8. MINIMUM COVER TO REINFORCEMENT SHALL BE AS FOLLOWS: A) 3" FOR CONCRETE POURED AGAINTS GROUND; B) WHERE FORMS ARE USED, MINIMUM COVER SHALL BE 2" FOR BARS LARGER THAN #5 & 1½" FOR BARS #5 & SMALLER.
9. MINIMUM LAP OF REINFORCEMENT SHALL BE CLASS C, AS CALLED FOR IN TABLE 20.2 OF SP-17A (78).
10. KEYWAYS SHALL BE 2"x4", UNLESS OTHERWISE NOTED.
11. PROVIDE ¾"x 45° CHAMFER AT EXPOSED EDGES UNLESS OTHERWISE NOTED.

TYPES OF PIPES & JOINTS

PIPE					JOINT	
MATERIAL	SIZE (ROUND)	SPEC.	CLASS	REMARKS	DESCRIPTION	SPEC.
PLAIN CONCRETE	4" - 26"	A.S.T.M. C14 - 90	1, 2 & 3			
REINFORCED CONCRETE	12" - 144"	A.S.T.M. C76 - 90	I -V		MODIFIED GROOVE TONGUE WITH RUBBER GASKET.	A.S.T.M C443 - 85A *
	12" - 144"	1990 M.D.O.T. 8.08.03	I -V	SPECIAL DESIGNS SUPPLEMENT A.S.T.M. C-76	INSIDE CEMENT POINTING FOR 42" & LARGER PIPE.	
	156" - 204"	A.S.T.M. C76 - 90	I -V	SPECIAL DESIGN		
	EQUIVALENT ROUND 18" - 144"	A.S.T.M. C507 - 90	HE - I THRU HE - IV	ELLIPTICAL PIPE	TONGUE & GROOVE BITUMINOUS JOINT WITH INSIDE CEMENT POINTING.	
	18" - 144"	A.W.W.A. C305 - 74	C76 - 83 EQUIVALENT I -V	PRESSURE PIPE, NON-CYLINDER TYPE	STEEL RINGS & RUBBER JOINTS	A.W.W.A. C302 - 74
VITRIFIED CLAY	4" - 26"	N.C.P.I. ER4 - 67	EXTRA STRENGTH		*AWIT* *O-RING* *AWIT-A-RING* *STRE-TITE* *DEFLEC/TITE* *TYLOX* *LDIXON* *UNILOC* *NOBEL* *WEDGELOCK*	A.S.T.M. C - 425 - 90a *

* EXCEPT AS SUCH SPECIFICATIONS RELATE TO INFILTRATION LIMITATION.

STANDARD SEWER DETAILS

BRIAN JONCKHEERE

LIVINGSTON COUNTY DRAIN COMMISSIONER

LIVINGSTON COUNTY — MICHIGAN

DATE	ADDITIONS AND/OR REVISIONS			
2-24-97	ISSUED FOR BIDS			

DRAWER	SCALE	DR.	CK.	APP.
		K.G.B.	E.P.D.	W.H.A.

JOB NO. 970785 — DATE

HUBBELL, ROTH & CLARK, INC.
CONSULTING ENGINEERS
555 HULET DRIVE, BLOOMFIELD HILLS, MICH. — P.O. BOX 824, 48303-0824

SHEET NO. SD-2 OF

TRENCH BACKFILL NOTES:

SPECIAL BACKFILL FOR TRENCHES (TRENCH "A") SHALL BE USED AT ALL LOCATIONS CALLED FOR ON THE PLANS & REQUIRED IN THE SPECIFICATIONS

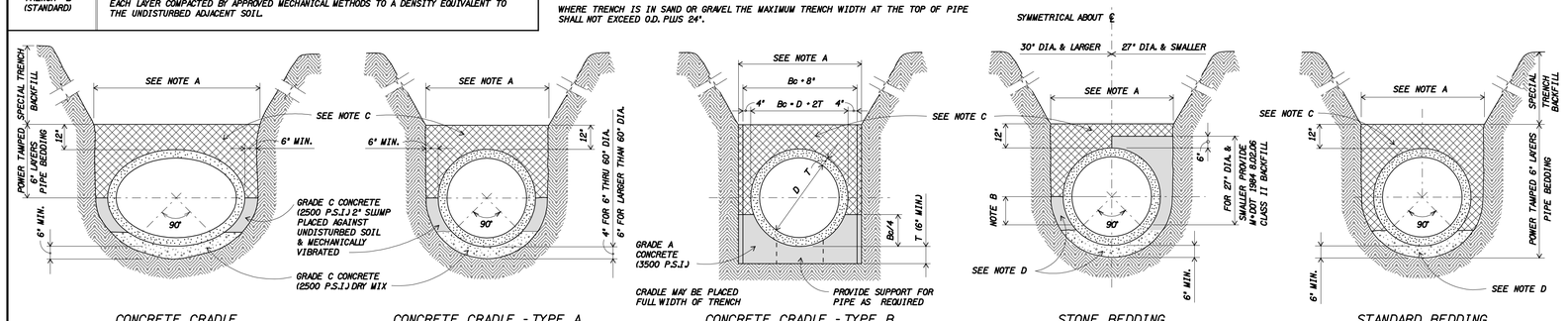
WHERE NOTED ON THE PLANS OR PROFILES THUS : |—TRENCH "A"—| TRENCH "A" SHALL BE USED AT LOCATIONS REQUIRED BY THE SPECIFICATIONS. TRENCH "B" SHALL BE USED FOR THE BALANCE OF THE WORK.

WHERE TRENCH IS IN SAND OR GRAVEL THE MAXIMUM TRENCH WIDTH AT THE TOP OF PIPE SHALL NOT EXCEED O.D. PLUS 24".

TRENCH	TRENCH BACKFILL
TRENCH "A" (SPECIAL)	BANK RUN SAND MEETING THE REQUIREMENTS OF 1990 M.D.O.T. 8.02.06 "GRANULAR MATERIALS FOR FILL & SUBBASE", CLASS II MATERIALS SHALL BE PLACED IN ACCORDANCE WITH 1990 M.D.O.T. 2.08.10-d-1 "CONTROLLED DENSITY METHOD" WITH EACH LAYER COMPACTED TO 95 PERCENT OF MAXIMUM UNIT WEIGHT.
TRENCH "B" (STANDARD)	SUITABLE EXCAVATED MATERIAL (EXCLUDING BLUE CLAY) PLACED IN ONE FOOT LAYERS WITH EACH LAYER COMPACTED BY APPROVED MECHANICAL METHODS TO A DENSITY EQUIVALENT TO THE UNDISTURBED ADJACENT SOIL.

TYPES OF BEDDING

STANDARD PIPE BEDDING SHALL BE USED EXCEPT WHERE THE OTHER TYPES OF PIPE BEDDING ARE CALLED FOR ON THE PLANS & PROFILES



NOTE A: BELOW A POINT 12" ABOVE THE TOP OF THE PIPE, THE TRENCH WIDTH SHALL PROVIDE A CLEARANCE OF NOT LESS THAN 6" BETWEEN PIPE & TRENCH. TRENCH WIDTH SHALL NOT EXCEED THAT SHOWN IN THE MAXIMUM TRENCH WIDTH TABLE.

NOTE B: FOR 30" DIA. AND LARGER PIPE, MATERIAL SHOWN THUS [▭] SHALL BE PEASTONE.

NOTE C: PIPE BEDDING MATERIALS SHOWN THUS [▭] SHALL BE SELECTED EXCAVATED MATERIAL (EXCEPT BLUE CLAY). WHERE TRENCH "A" IS SPECIFIED, SPECIAL TRENCH "A" BACKFILL MATERIAL SHALL BE USED FOR PIPE BEDDING BACKFILL.

NOTE D: PIPE BEDDING CUSHION MATERIALS SHOWN THUS [▭] SHALL CONSIST OF MEETING THE GRADING REQUIREMENTS OF 1990 M DOT, TABLE 8.02-1, COARSE AGGREGATE 6A, BLAST FURNACE SLAG OR CRUSHED STONE CONTAINING SUFFICIENT SMALLER SIZED AGGREGATE TO PREVENT MIGRATION OF EARTH OR BACKFILL MATERIAL INTO BEDDING MATERIAL & CAREFULLY PREPARED SO THAT THE ENTIRE BOTTOM ¼ OF THE PIPE WILL BEAR AGAINST THE CUSHION. THE TYPE & THICKNESS OF THE BEDDING SHALL BE AS REQUIRED TO MAINTAIN CORRECT ALIGNMENT & GRADE & SHALL NOT BE LESS THAN 6". (THIS BEDDING CUSHION SUPERCEDES CUSHION REQUIRED BY THE SPECIFICATIONS)

MAXIMUM TRENCH WIDTH TABLE (IN)

PIPE I.D.	TRENCH WIDTH
4 -12	32
15	36
18	39
21	43
24	46
27	50
30	53
36	68
42	75
48	82
54	89
60	96
66	103
72	110
78	117
84	124
90	136
96	143
102	149
108	156
114	163
120	170
132	184
144	198
156	212
168 & LARGER	O.D. PLUS 30

TRENCH BEDDING & BACKFILL

DESIGN FILE = F:\1997\1997DT\1997DT085\cadd\civil\sd2.dgn
STROKE TIME = 25-MAY-2005 13:00
PLOT NAME = N/A
USER NAME = rose

Appendix I:
Lot Grading

LOT GRADING

The Livingston County Drain Commissioner will review the grading plan for sites that will be platted under Act 288 and a subdivision or site condominium included in the Chapter 18 Drain program. Positive drainage is required. Final lot grading inspection and any applicable elevation certification is under the jurisdiction of the local municipality. The minimum requirements are as follows:

1. The grading of the lot shall be such that surface runoff is directed away from homes and towards swales, ditches or drainage structures. Provision for drainage either by filling and grading or by providing some type of outlet shall be made for all areas within the proposed subdivision.

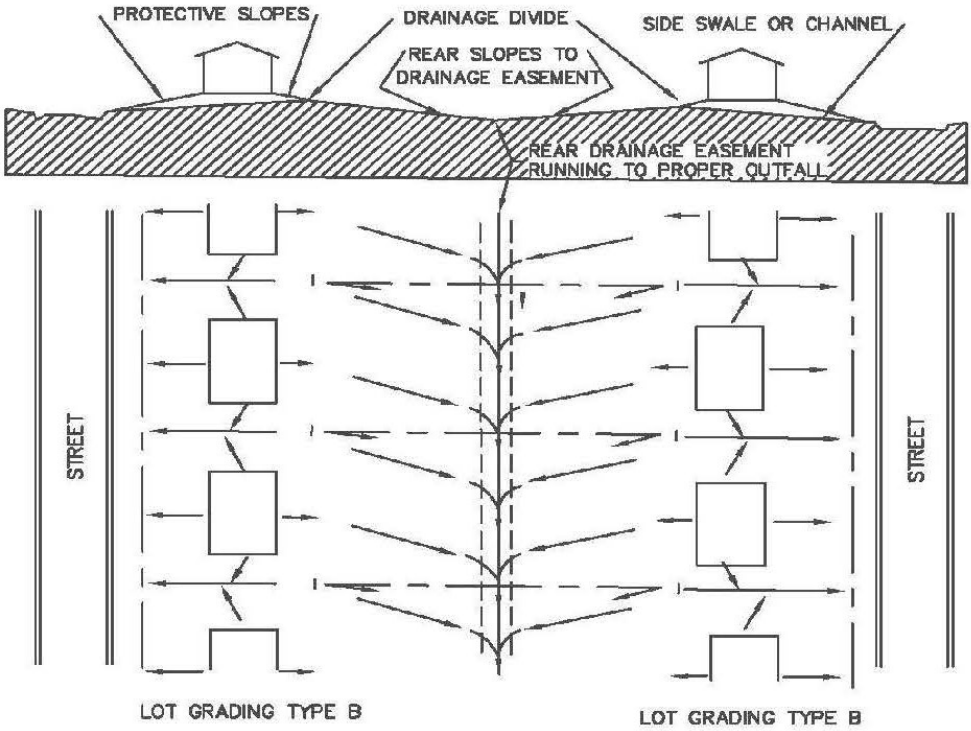
2. A minimum basement opening elevation, proposed finished floor grade, and proposed lot grading must be shown for each home or structure. A minimum of ½ foot of fall is required away from the home and between lots. Proposed grades may be indicated with spot grades or contours. A distinction between existing and proposed grades, as well as distinctions between daylight, walkout, or standard basements (eg. egress well) should be evident on the plans.

3. Where a walkout or daylight basement is proposed, sufficient grades should be shown at the location of the walkout to indicate positive drainage away from the walkout. Additional spot grades at the house corners and rear yard should be shown. Changes to recommended configurations of basement openings should not be made without consent of the local building official having authority.

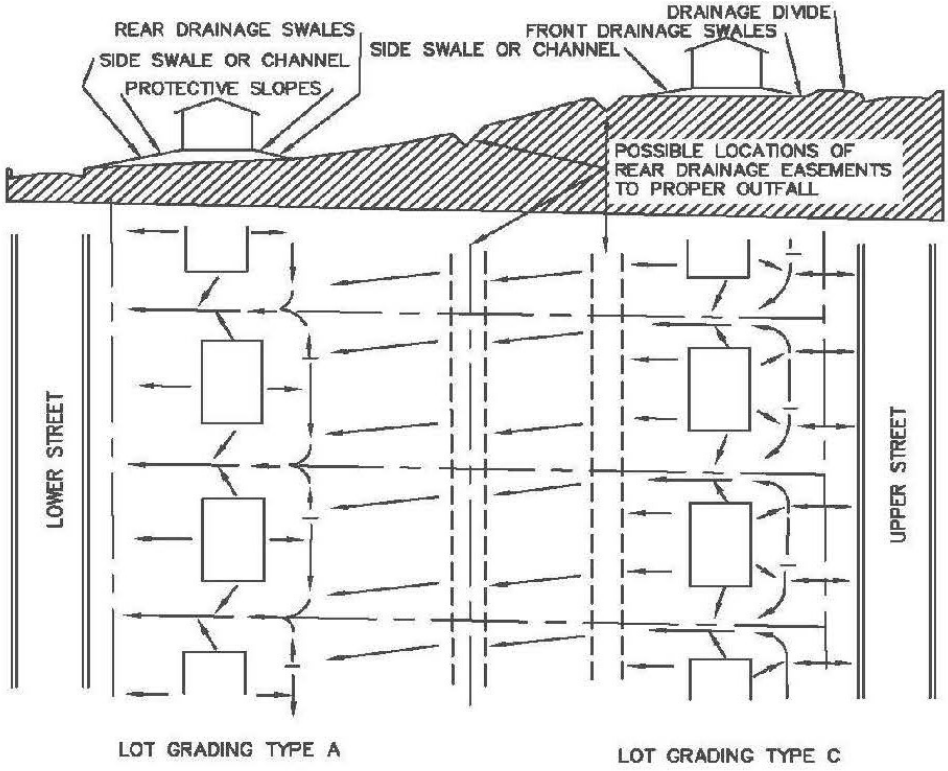
4. Where finished grades indicate a substantial amount of drainage across adjoining lots, a drainage swale of sufficient cross-section and slope shall be provided on the lot line to intercept this drainage.

5. Sufficient off-site topography must be shown to determine the extent of contributing runoff. Provisions must be made to accommodate the off-site contributing flow.

6. Lots that lie within a mapped flood plain shall satisfy the EGLE and FEMA requirements for subdivisions within a flood plain. In no case will the filling of a lot be permitted if the flood plain is so restricted as to cause possible flooding or back up of the stream.

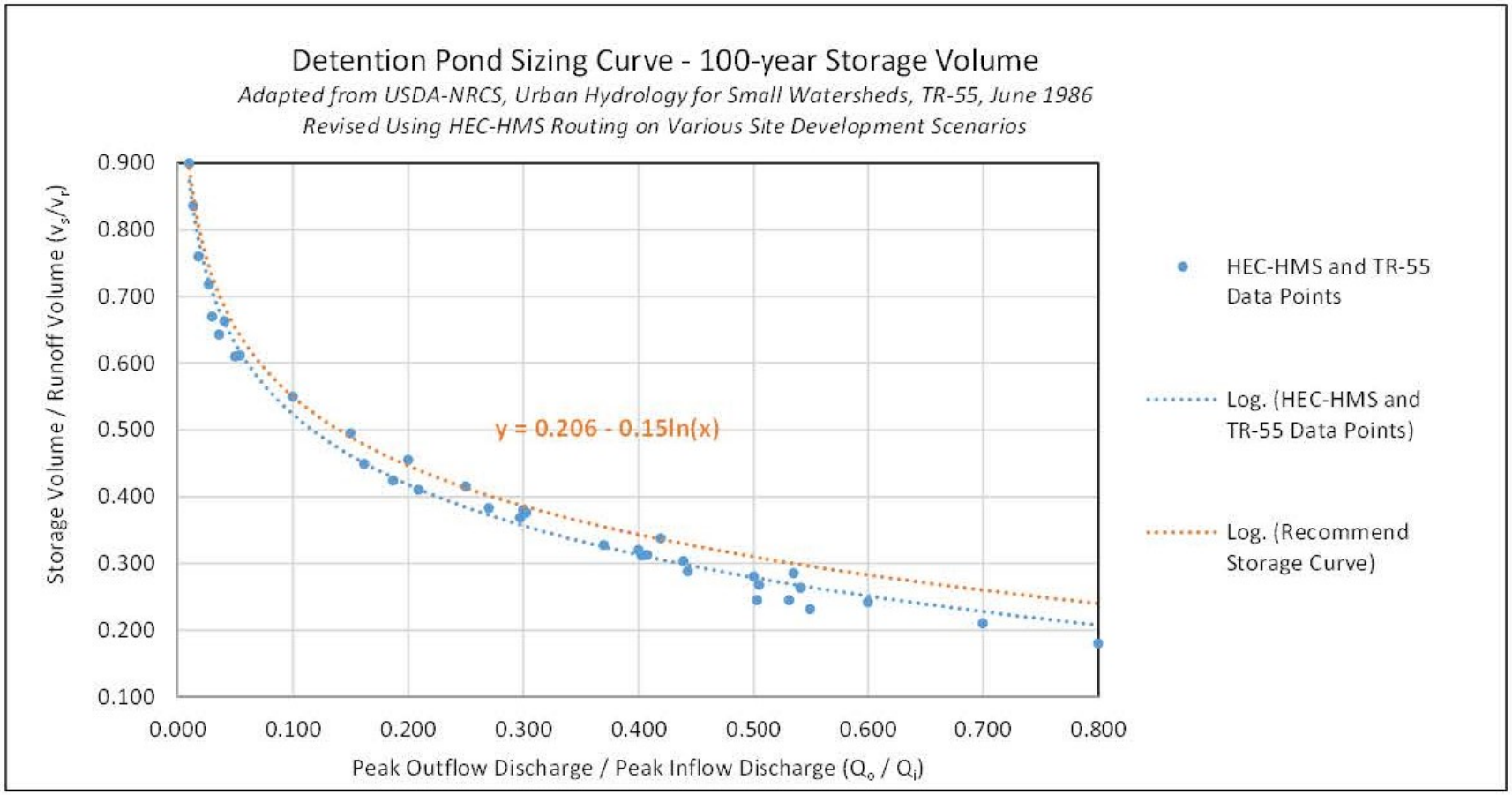


BLOCK GRADING TYPE 4: VALLEY ALONG REAR LOT LINES



BLOCK GRADING TYPE 3: STEEP CROSS SLOPE

Appendix J:
Design Reference



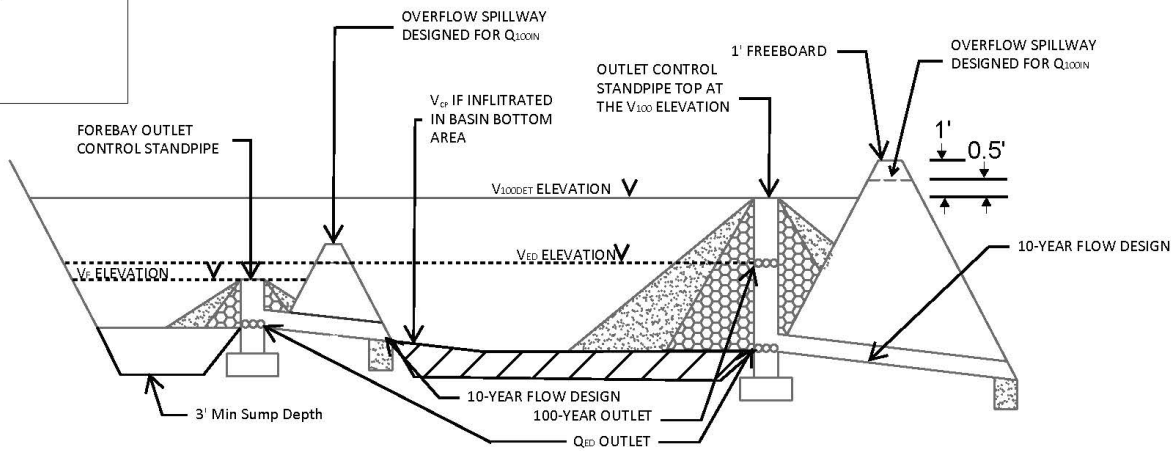
Original TR-55 Table included Qo/Qi values ranging from 0.10 to 0.80

Additional values added using HEC-HMS routing, including Qo/Qi values less than 0.10

TYPICAL DETENTION BASIN WITH FOREBAY

REQUIRED PROFESSIONAL ENGINEER CERTIFICATIONS

-CHANNEL PROTECTION VOLUME "CREDIT" ($V_{CP\text{-}C}$) ← 1.3"
-INFILTRATION RATES
-100-YEAR ALLOWABLE OUTLET RATE (Q_{100ALL})
-MEP FOR ACHIEVED INFILTRATION VOLUME
-STORMWATER SYSTEM O&M PLANS



WATER QUALITY VOLUME (V_{WQ})

V_{WQ}= (1"/12")(43,560)(C)(A)
V_{WQ}= (3,630)(C)(A)

CHANNEL PROTECTION VOLUME (V_{CP})

V_{CP}= (1.3"/12")(43,560)(C)(A)
V_{CP}= (4,719)(C)(A)

FOREBAY VOLUME (V_F)

A FOREBAY FOR ALL INLETS SHALL CAPTURE SILT, SAND, TRASH AND DEBRIS FOR REMOVAL. THEY ARE SIZED AT 15% OF THE WATER QUALITY VOLUME (V_{WQ})

V_F = (1"/12")(43,560)(C)(A)(P)
P_F =0.15

V_F IS A MINIMUM OF V_{WQ} WHEN DOWNSTREAM INFILTRATION IS PROPOSED

FOREBAY OUTLET SIZE

THE FOREBAY OUTLET SIZE IS THE SAME AS THE EXTENDED DETENTION OUTLET SIZE

NOTE: ALTERNATIVE FOREBAY OUTLETS REQUIRE PRE-APPROVAL FROM THE OCWRC

EXTENDED DETENTION VOLUME (V_{ED})

EXTENDED DETENTION CONTROLS THE 2-YEAR BANK FULL RELEASE RATE BY DEWATERING THE V_{ED} OVER 48-HOURS

V_{ED}= (1"/12")(43,560)(C)(A)(P)
P_{ED} =1.9

EXTENDED DETENTION OUTLET RATE

$Q_{ED}=(V_{ED})/((48)(60)(60))$

$H_{ED}=(V_{ED})/((4{,}800)(h)^{(1/2)})$

H_{ED}= NUMBER OF 1-INCH DEWATERING HOLES
h=TOTAL HEAD ON THE ORIFICES
NOTE: THIS EQUATION CONSIDERS THE AVERAGE HEAD TO BE 0.4 TIMES THE TOTAL HEAD

100-YEAR POST-CONSTRUCTION INLET RATE (Q_{100IN})

$$Q_{100IN} = (C)(A)\left(\frac{30.2033 * 100^{0.2203}}{(T_C + 9.1747)^{0.8069}}\right)$$

USE T_C FROM STORM SEWER DESIGN

100-YEAR ALLOWABLE OUTLET RATE (Q_{100ALL})

THE ALLOWABLE 100-YEAR OUTLET RATE, IN CFS, IS THE LESSER OF:

-OCWRC RESTRICTED RATE FOR THE DRAIN (Q_R)
-PRO-RATED SHARE OF THE DRAINS CAPACITY (Q_P)
OR
-THE VARIABLE RELEASE RATE (Q_{VRR})

Q_{VRR}=1.1055 - 0.206LN(A)

100-YEAR DETENTION VOLUME (V_{100DET})

R=0.206-(0.15)(LN(Q_{100ALL}/Q_{100IN}))

R=STORAGE CURVE FACTOR

V_{100IN}=(3,630)(C)(A)(p)
P_{100} = 5.23

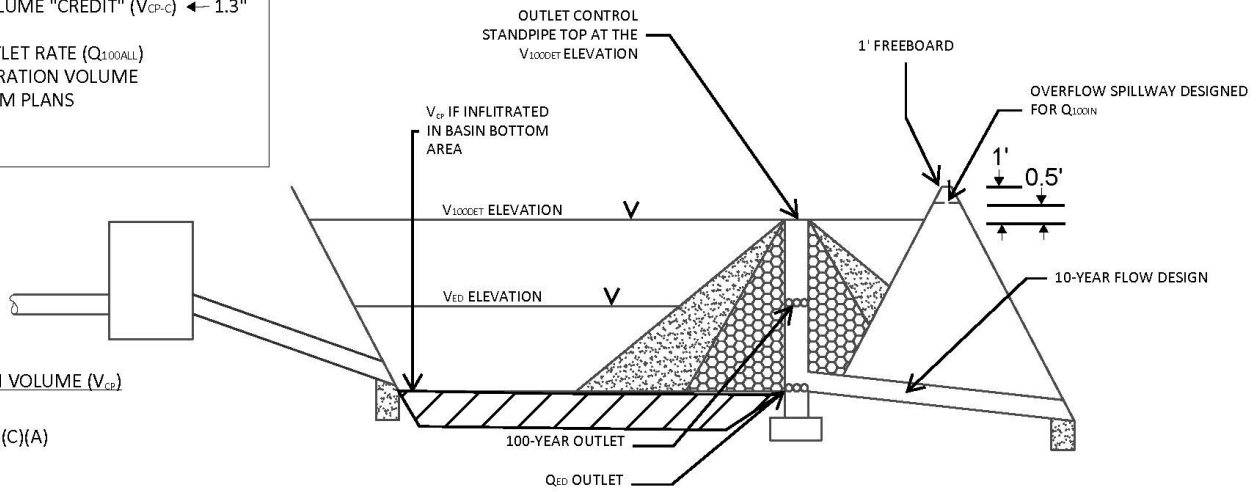
$V_{100DET}=(V_{100IN})(R)-V_{CP\text{-}C}$
(MINIMUM OF V_{ED})

REV-3/12/2021

TYPICAL DETENTION BASIN WITH MECHANICAL SEPARATOR

REQUIRED PROFESSIONAL ENGINEER CERTIFICATIONS

-CHANNEL PROTECTION VOLUME "CREDIT" (V_{CP-C}) ◄— 1.3"
-INFILTRATION RATES
-100-YEAR ALLOWABLE OUTLET RATE (Q_{100ALL})
-MEP FOR ACHIEVED INFILTRATION VOLUME
-STORMWATER SYSTEM O&M PLANS



CHANNEL PROTECTION VOLUME (V_{CP})

V_{CP}= (1.3"/12")(43,560)(C)(A)
V_{CP}= (4,719)(C)(A)

MECHANICAL SEPARATOR

REQUIRED WATER QUALITY TREATMENT IS 80 MG/L TSS, OR 80% TSS REMOVAL

SIZED BASED ON THE 1-YEAR WATER QUALITY PEAK FLOW RATE (Q_{WQ})

Q_{WQ}= (C)(A)(97/(Tc+30)

REPLACES FOREBAY REQUIREMENT

INSTALLED OFFLINE AND UPSTREAM OF ANY DETENTION OR RETENTION BASIN

NOTES:
-MUST BE NJDEP CERTIFIED
-EXCLUDES UPSTREAM CONTRIBUTING AREA'S WHERE 1-INCH WATER QUALITY CONTROL IS PROVIDED THROUGH OTHER BMP'S

EXTENDED DETENTION VOLUME (V_{ED})

EXTENDED DETENTION CONTROLS THE 2-YEAR BANK FULL RELEASE RATE BY DEWATERING THE V_{ED} OVER 48-HOURS

V_{ED}= (1"/12")(43,560)(C)(A)(P)
P_{ED}= 1.9

EXTENDED DETENTION OUTLET RATE

Q_{ED}=(V_{ED})/((48)(60)(60))

H_{ED}=(V_{ED})/((4,800)(h)$^{(1/2)}$)

H_{ED}= NUMBER OF 1-INCH DEWATERING HOLES
h=TOTAL HEAD ON THE ORIFICES
NOTE: THIS EQUATION CONSIDERS THE AVERAGE HEAD TO BE 0.4 TIMES THE TOTAL HEAD

100-YEAR POST-CONSTRUCTION INLET RATE (Q_{100IN})

$$Q_{100IN} = (C)(A)\left(\frac{30.2033 * 100^{0.2203}}{(T_c + 9.1747)^{0.8069}}\right)$$ USE T_c FROM STORM SEWER DESIGN

100-YEAR ALLOWABLE OUTLET RATE (Q_{100ALL})

THE ALLOWABLE 100-YEAR OUTLET RATE IS THE LESSER OF:

-OCWRC RESTRICTED RATE FOR THE DRAIN (Q_R)
-PRO-RATED SHARE OF THE DRAINS CAPACITY (Q_P)
OR
-THE VARIABLE RELEASE RATE (Q_{VRR})

Q_{VRR}=1.1055 - 0.206LN(A)

100-YEAR DETENTION VOLUME (V_{100DET})

R=0.206-(0.15)(LN(Q_{100ALL}/Q_{100IN}))

R=STORAGE CURVE FACTOR

V_{100IN}=(3,630)(C)(A)(P)
P_{100}=5.23

V_{100DET}=(V_{100IN})(R)-V_{CP-C}
(MINIMUM OF V_{ED})

REV-3/12/2021

Land Use Summary

must be included on the O&M Plan Sheet for all site plans

Land Use Data	**Characteristic**	**Existing Conditions**	**Proposed Condition**	
	Total Development Area (ac)			
	Impervious Area (ac)			
	Total Pervious Area (ac)			
Perviousness	**Change in Perviousness by Cover Type**			
	Meadow/fallow/natural areas (non-cultivated)	x.xx acres	x.xx acres	
	Improved areas (turf grass, landscape, row crops)	x.xx acres	x.xx acres	
	Wooded Areas	x.xx acres	x.xx acres	
Calculations	CPVC Volume ***Required*** (cubic feet)			
	CPVC Volume ***Provided*** (cubic feet)			
	CPRC Volume ***Required*** cubic feet)			
	CPRC Volume ***Provided*** (cubic feet)			
Soil Group	**Percent of site in each Hydrologic Soil Group**			
	A	B	C	D

The Professional Engineer who signs and seals this site plan certifies that the values in this table reflect the LCDC stormwater calculations required for this development and that geotechnical investigations were performed that provide conclusive documentation that demonstrates whether infiltration (i.e., CPVC) is practicable.

Notes:

- *The Professional Engineer Certification Statement (see above) must be included with the Land Use SummaryTable.*
- *Areas to be shown to the nearest 0.01 acre*
- *'Predominant' soil type shall the soil type with the largest percentage coverage over the designated land use(e.g., 70% Soil Type B and 30% Soil Type C shall be listed in the table as "Soil Type B")*
- *USDA soil types cannot be used to determine site suitability for infiltration and meeting the CPVC volume standard; direct infiltration testing will be required to determine site suitability for infiltration*

Appendix K:
Stormwater Management Operations and Maintenance Agreement

Stormwater Management Operations and Maintenance Agreement

This Agreement is made on [DATE], by and between [Community Name], (hereinafter "Community") whose address is [address] and [Owner Name], whose address is [address], (hereinafter "Owner"). Community and Owner agree as follows:

Article I. <u>The Subject Property</u>.

1.1 Owner owns the property located at and commonly known as [address or general description] (hereinafter the "Subject Property"). The legal description of the Subject Property is set forth at ***Exhibit A***.

Article II. <u>The Stormwater System</u>.

2.1 Owner, in accordance with Livingston County Stormwater Standards and State Municipal Separate Storm Sewer System permit requirements, agrees to install and maintain a Stormwater System on the Subject Property in accordance with approved plans and conditions. The Stormwater System is set forth at ***Exhibit B***.

2.2 After construction has been verified and accepted by the Community for the Stormwater System, the Owner shall file with the Community the "as-built" documents showing the design and construction details and shall reference this Agreement.

2.3 The Stormwater System will be governed by the terms and conditions in this Agreement.

Article III. <u>The Stormwater O&M Plan</u>.

3.1 The Owner shall be solely responsible for the installation, maintenance, and repair of the Stormwater System, drainage easements, and associated landscaping identified in Exhibit B in accordance with the Stormwater Management Operations and Maintenance Plan, hereinafter the "Stormwater O&M Plan" set forth at ***Exhibit C*** to this Agreement.

3.2 The Stormwater O&M plan is subject to approval by the Community.

3.3 The Owner agrees that the Stormwater O&M Plan is intended to and will serve the Subject Property in perpetuity.

3.4 The Owner, at its expense, shall secure from any affected owners of land all easements and releases of right-of-way necessary for implementation of the Stormwater O&M Plan and shall record them with the Livingston County Register of Deeds. These easements and releases of rights-of-way shall not be altered, amended, vacated, released, or abandoned without prior written approval of the Community.

3.5 No alterations or changes to the Stormwater O&M Plan shall be permitted unless they are deemed to comply with this Agreement and are approved in writing by the Community.

3.6 The Owner shall retain the services of a qualified inspector as described in Exhibit C – Maintenance Requirement 1) to operate and ensure the maintenance of the Stormwater O&M Plan.

3.7 The Owner shall annually, by December 30th, provide to the Community records (logs, invoices, reports, data, etc.) of inspections, maintenance, and repair of the Stormwater System in compliance with the Stormwater O&M Plan.

3.8 The Community agrees to enforce compliance with the annual inspection, maintenance and repair records as set forth in 3.7 above, such enforcement may require an ordinance.

Article IV. <u>Access and Enforcement</u>.

4.1 The Community or its designee is authorized to access the property as necessary to conduct inspections of the Stormwater System, implication of the Stormwater O&M Plan, or drainage easements to ascertain compliance with the intent of this Agreement.

Upon written notification by the Community or their designee of required maintenance or repairs, the Owner shall complete the specified maintenance or repairs within a reasonable time frame determined by the Community. The Owner shall be liable for the failure to undertake any maintenance or repairs so that the public health, safety and welfare shall not be endangered nor the road improvement damaged.

4.2 If the Owner does not keep the Stormwater System in reasonable order and condition, or complete maintenance activities in accordance with the Stormwater O&M Plan, or the reporting required in 3.7 above, the Community is authorized, but not required, to perform the specified inspections, maintenance or repairs in order to preserve the intended functions of the Stormwater System and prevent the Stormwater System from becoming a threat to public health, safety, general welfare or the environment.

4.3 In the case of an emergency, as determined by the Community, no notice shall be required prior to the Community performing emergency maintenance or repairs. The Community may levy the costs and expenses of such inspections, maintenance or repairs against the Owner.

The Community, at the time of entering upon said Stormwater System for the purpose of maintenance or repair, may file a notice of lien in the office of the Register of Deeds of Livingston County upon the property affected by the lien. If said costs and expenses are not paid by the Owner, the Community may pursue the collection of same through appropriate court actions and in such a case, the Owner shall pay in addition to said costs and expenses all costs of litigation, including attorney fees.

4.4 The Owner hereby conveys to the Community an easement over, on and in the property described in Exhibit A for the purpose of access to the Stormwater System for the inspection, maintenance and repair thereof, should the Owner fail to properly inspect, maintain and repair the Stormwater System.

Article V. Term and Covenants.

5.1 The Owner agrees that this Agreement shall bind all current and future owners of the property. The Owner agrees in the event that the Subject Property is sold, transferred, or leased to provide information to the new owner, operator, or lessee regarding proper inspection, maintenance and repair of the Stormwater System and Stormwater O&M Plan. The information shall accompany the first deed transfer and include Exhibits B and C and this Agreement. The transfer of this information shall also be required with any subsequent sale, transfer or lease of the Subject Property.

5.2 The Owner agrees that the rights, obligations and responsibilities hereunder shall commence upon execution of the Agreement.

Article VI. The Memorandum.

6.1 The Owner shall record with the Livingston County Register of Deeds a Memorandum of Stormwater Management Operations and Maintenance Agreement which serves as notice of this Agreement in a title search, the template for which is set forth at ***Exhibit D*** to this Agreement.

Article VII. Claims and Authority.

The Owner, its agents, representatives, successors and assigns shall defend, indemnify and hold Community harmless from and against any claims, demands, actions, damages, injuries, costs or expenses of any nature whatsoever, hereinafter "Claims", fixed or contingent, known or unknown, arising out of or in any way connected with the design, construction, use, maintenance, repair or operation (or omissions in such regard) of the Stormwater System, appurtenances, connections and attachments thereto which are the subject of this Agreement. This indemnity and hold harmless shall include any costs, expenses and attorney fees incurred by Community in connection with such Claims or the enforcement of this Agreement.

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

IN WITNESS WHEREOF, the Owner and Community have executed this agreement on the day and year first above written.

Owner

By:_____

Its: _____

STATE OF MICHIGAN)
)ss.
_____ COUNTY)

The foregoing instrument was acknowledged before me on this_____day of_____, 20____, by_____, the_____of _____.

_____
Notary Public

Community

By:_____

Its: _____

STATE OF MICHIGAN)
)ss.
_____ COUNTY)

The foregoing instrument was acknowledged before me on this_____day of_____, 20____, by_____, the_____of _____.

_____
Notary Public

Explanation of Exhibits

Exhibit A – Legal Description: Provide a legal description and reduced copy map to identify the land parcel(s) affected by this Agreement. This exhibit must be customized for each site. It must include a reference to a Subdivision Plat, Certified Survey number, or Condominium Plat, and a map to illustrate the affected parcel(s).

Exhibit B – Stormwater System Description and Map: Provide a written description and location map of the Stormwater System. This exhibit must be customized for each site. Map scale must be sufficiently large enough to show necessary detail.

Exhibit C – Stormwater O&M Plan: This exhibit explains the basic function of the stormwater management operation and maintenance plan, schedule, and budget providing the minimum specific maintenance activities and frequencies for each practice. The minimum elements of this exhibit include a description of the drainage area and the installed Stormwater System, a description of the specific maintenance activities which should include the following in addition to specific maintenance actions:

- Employee training and duties,
- Routine service requirements,
- Operating, inspection, and maintenance schedules, and
- Detailed construction drawings showing all critical components and their elevations.

The plan must include maintenance tasks and schedules. Refer to the Low Impact Development Manual for Michigan for maintenance task checklists for permanent BMPs and create a table of applicable maintenance tasks and schedules.

Exhibit D – Template for Memorandum of Stormwater Management Operations and Maintenance Agreement: This exhibit contains a template for said Memorandum to be recorded with the County Register of Deeds to put any future owners, or interest holders, on notice of the Stormwater System and the Stormwater System O&M Plan.

Memorandum of Stormwater Management Operations and Maintenance Agreement

The "Owner"_____and the "Community"_____have entered into a Stormwater Management Operations and Maintenance Agreement dated_____for real property located in the State of Michigan, County of Livingston, City of_____and further described as follows:

[real property description]

Commonly known as: _____

Parcel ID: _____

The Stormwater Management Operations and Maintenance Agreement provides for a stormwater management operation and maintenance plan for a stormwater system located on the real property. It authorizes easements for the local community to take enforcement action if the Agreement is breached. This Agreement runs with the land, binds all current and future owners of the real property and serves the real property in perpetuity.

Owner:

By:_____

Its: _____

STATE OF MICHIGAN)
)ss.
_____ COUNTY)

The foregoing instrument was acknowledged before me on this_____day of_____, 20__, by_____, the_____of _____.

_____
Notary Public

Recording Fee: $15.00

Drafted by and Return to: