Part A: Procedures and Design Criteria for Stormwater Management Systems

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.

I. Site Drainage - General Requirements

A. **Stormwater Discharge**

In no event shall the maximum design rate of discharge exceed that stated in Part A, Section 1.11.13, page 19.

It is the proprietor's obligation to meet this standard. Should a stormwater system, as built, fail to comply with the rules herein, it is the proprietor's responsibility to 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.

B. **Determination of Surface Runoff**

The "rational method" of calculating stormwater runoff is generally acceptable for sites less than 640 acres in size. For sites over 100 acres, due caution should be exercised. Other methodologies for predicting runoff, such as runoff hydrographs, may be required by the Drain Commissioner for sizing the drainage systems on sites that are deemed potentially problematic. Acceptable alternative methods include:

- Corps of Engineers HEC-1
- Soil Conservation Service UD-21, TR-20 and TR-55

1. All design rainfall events will be based on the SCS Type II distribution.

2. Computations of runoff hydrographs that do not rely on a continuous accounting of antecedent moisture conditions will assume a conservative wet antecedent moisture condition.

3. For watersheds equal to or greater than two square miles, where approval of the Michigan Department of Environmental Quality is required, the MDEQ will compute the runoff rates at no cost. MDEQ requires applicants to use the UD-21 method by SCS in lieu of the rational method. This method was developed for small watersheds by SCS and can be used for watersheds up to 10 square

miles. The current version of UD-21 contains updated rainfall curves. Computer programs such as HEC-1 and HEC-RAS, MDEQ permit applications, etc., can be downloaded from the MDEQ's web site located at http://www.deq.state.mi.us/lwm.

4. A summary of Livingston County soils and corresponding hydrologic groups is provided in Appendix G.

II. Design Standards for Constructed Stormwater Management Facilities

A. Retention and Detention Systems

NOTE:

- Extensive literature is available on specific design concepts and alternatives, and references are available within this document's bibliography (see Part C, References).
- Diagrams for this section are contained within Appendix H. Several other structural BMPs not referenced within the following text are also illustrated.

1. General Requirements

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.

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

b. Public safety will be a paramount consideration in stormwater system and pond design. Providing safe retention/detention is the proprietor's responsibility. Pond designs will incorporate gradual side slopes, topsoiling, seeding and mulching, plantings per landscape plan if one is required, and safety shelves. Where further safety measures are required, the proprietor is expected to include them within the proposed development plans.

c. Stormwater management systems incorporating pumps shall not be permitted in developments with multiple owners, such as subdivisions and site condominiums. 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. Special requirements, such as the establishment of an operations/maintenance/replacement escrow account by the Developer, may be imposed to help defray special assessments

that would be levied upon future property owners for maintenance of the system.

d. 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 ponds may be located.

e. 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) Regional retention/detention is not available.

   3) The provision of above-ground retention/detention on a existing commercial parcel less than two acres in size would preclude development of the property under its current zoning. Parcels split after January 2002 will not be permitted to utilize underground retention/detention under this exception.

f. 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.

   2) The capacity of the forebay will be equivalent to 5% of the 100-year storm volume based on the area tributary to the inlet.

   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.

g. For safety purposes and to minimize erosion, basin side slopes will generally not be flatter than one-foot-vertical to 20-feet-horizontal (20:1), nor steeper than one-foot-vertical to three-feet-horizontal (3:1). For drains 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.

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

i. All basins will have provisions for a defined emergency spillway, routed so that it can be picked up by the main outflow channel while not discharging directly over the outlet pipe. The emergency spillway will be set at an elevation six inches above the design high water elevation.

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

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

2. **Detention Requirements**

On-site management of storm drainage will be designed for control of flooding, downstream erosion, and water quality. Submission of flow calculations, cross-sections, and other pertinent data will be required.

a. A minimum of one foot of freeboard will be required for all detention basins.

b. At a minimum, the volume of storage provided for flood control will be equal to or in excess of that required by the Livingston County Drain Commissioner's "A Simple Method of Detention Basin Design" for a 100-year frequency storm (see Appendix I). If the methodology in Appendix I results in the maximum design rate discharge exceeding that stated in Part A, Section 1.II.B, page 19, additional storage will be required.

c. The volume and storage provided for controlling the “bankfull” flood will be equal to or in excess of the total rain from a 1.5-year, 24-hour storm. This storage volume is slightly increased from Cp_v, the channel protection storage volume, as used in Appendix H. This can be determined by:

8160 x acreage x the relative imperviousness factor C = cubic feet

The release rate from the “bankfull” storage volume will be such that this volume will be stored not less than 24 or more than 40 hours.

d. The "first flush" of runoff is defined as the first 0.5 inch of runoff over the entire site. The majority of this volume will be captured in the sediment forebay, with the residual volume detained for a minimum of 24 hours. The volume of the first flush can be determined by:

1815 x acreage x the relative imperviousness factor C = cubic feet

e. Basin Inlet/Outlet Design

1) 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.

2) 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:

a. increasing the length-to-width ratio of the entire design.

b. 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

3) The outlet will be well protected from clogging.

4) Riser Design

a. The use of a perforated standpipe-type riser structure to assure an appropriate detention time for all storm events is required.

b. Orifices used to maintain a permanent pool level should withdraw water at least one foot below the surface of the water.

c. Hoods or trash racks shall be installed on the riser to prevent clogging. Grate openings shall be a maximum of three inches.

d. Orifice plates are discouraged. Where an orifice plate is to be used in the standpipe to control discharge, it will have a minimum diameter of four inches

c. The riser shall be placed near the pond embankment to provide for ready maintenance access.

d. Barrels and risers will be constructed of materials that will reduce future maintenance requirements. The riser pipe shall be a minimum of 36 inches in diameter for riser pipes up to four feet in height. Riser pipes greater than four feet in height shall be 48 inches in diameter. Riser pipes will be constructed with concrete bottoms.

e. Where feasible, a drain for completely de-watering the pond should be installed for maintenance purposes.

5) Outlet Design

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

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

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

3. **Permanent Retention Ponds**

a. Freeboard: Retention Basins shall provide three feet of freeboard.

b. Storage Volume

Retention basins will be capable of storing two inches of runoff from the entire tributary area, contingent upon the following:

1) An overflow assessment will be required. The assessment should include descriptions of the surrounding areas, including nearby homes, which would be impacted in the event of an overflow.

2) The proprietor must submit a soil boring log taken within the basin bottom area to a depth of 25 feet below existing ground or 20 feet below proposed basin bottom elevation.

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. If such additional storage is required, freeboard requirements may be reduced at the discretion of the Drain Commissioner.

4. **Wet Detention Basins**

a. Storage Volume and Freeboard Requirements

Storage volume and freeboard requirements shall be identical to that for a dry basin (see Appendix I). For a gravity outflow wet basin, storage volume is defined as "the volume of detention provided above the invert of the outflow device." Any volume provided below the invert of the outflow device will not be considered as detention.

At a minimum, the volume of the permanent pool should be at least:

2.5 x 0.5 inch* x runoff coefficient x site drainage area in cubic feet.

* 0.5 inch represents the mean storm event. This was determined by adding the total precipitation rainfall recorded at Detroit Metro Airport from 1977 to 1987 and dividing by the total number of storm events. Storms below 0.2" of precipitation, snowfall, and snowmelt were omitted.

b. Wet detention pond configuration will be as follows:

1) Surface area to volume ratio should be maximized to the extent feasible.

2) In general, depths of the permanent pool should be varied and average between three and six feet.

3) A minimum length-to-width ratio of 3:1 should be used unless structural measures are used to extend the flow path.

4) Ponds should be wedge-shaped, narrower at the inlet and wider at the outlet.

5) Irregular shorelines are preferred.

c. A marsh fringe should be established near the inlet or forebay and around at least 50% of the pond's perimeter.

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

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

5. **Extended Detention Basins**

Extending the detention time to at least 24 hours of dry or wet ponds is an effective, low-cost means of removing particulate pollutants and controlling increases in downstream bank erosion. Positive impacts of ED ponds include creation of local wetland and wildlife habitat, limited protection of downstream aquatic habitat, and recreational use in the infrequently inundated portion of the pond.

A two-stage design is required, with separate outlet controls to detain both the 1.5-year and larger rain events.

a. *Lower Stage (wet pond area)*
The lower stage should contain a shallow, permanent pool designed to store and treat the "first flush," or 0.5 inch, of runoff over the entire site. This pool should be managed as a shallow marsh or wetland and average 6-12 inches in depth.

At a minimum, the volume of runoff detained in the entire lower stage should be equivalent to the runoff volume produced by a 1.5-year storm.

b. *Upper Stage*
The upper stage should be sized for the 100-year, 24-hour storm and should be graded to remain dry except during large storms.

A low flow channel, stabilized against erosion, will be provided through the dry portion of the basin. This channel should have a minimum grade of 0.5%, and the remainder of the basin should drain toward this channel at a grade of at least 1%. The low flow channel should end at the lip of the lower stage, where riprap or gabion baffles will be placed to prevent scour and re-suspension.

6. **Stormwater Wetland Systems**

Background
Stormwater wetlands are defined as constructed systems explicitly designed to mitigate the stormwater quality and quantity impacts associated with development. They do so by temporarily storing stormwater runoff in shallow pools that creates growing conditions suitable for emergent and riparian wetland plants. The runoff storage, complex micro-topography, and emergent plants in the stormwater wetland together form an ideal system for the removal of urban pollutants. Because of their water quality benefits, the use of stormwater wetlands is encouraged.

As a general rule, stormwater wetlands should not be located within delineated natural wetland areas.

The design of an effective and diverse stormwater wetland requires a sophisticated understanding of hydrology and wetland plant ecology. Therefore, a qualified professional with specific wetland expertise must oversee wetland construction, re-construction, or modification. Example schematics of a stormwater wetland system are provided in Appendix H. A reference for the design of stormwater wetlands is by Thomas R. Scheuler, "Design of Stormwater Wetland Systems" (published by the Metropolitan Washington Council of Governments).

a. Stormwater wetland systems must be designed to perform in conformance with all standards for storage volume and discharge rate established in these rules.

b. For developments with stormwater wetlands systems proposed to be maintained by the Drain Commissioner, the developer will provide for the

monitoring of wetland plantings and replacement as needed for a two-year period after construction.

7. **Stormwater Conveyance**

All structures will be constructed in accordance with governing specifications (Michigan Department of Transportation, 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.

1. Natural Streams and Channels

   a. Natural streams are to be preserved. Natural swales and channels should be preserved whenever possible.

   b. If channel modification must occur, the physical characteristics of the modified channel will meet the existing channel in length, cross-section, slope, sinuosity, and carrying capacity.

2. Vegetated Swales/Open Ditches

   a. Swales should:

      - Follow natural, pre-development drainage paths insofar as possible.
      - Be well vegetated, wide, and shallow (see Appendix H).

   b. 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.

   c. 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.

   d. 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 three feet of clearance be allowed.

   e. All bridges will be designed to provide a two-foot minimum flood stage freeboard to the underside of the bridge. Footings will be at least one foot below the invert grade of the channel. Depending on soils, additional footing depth may be required.

3. 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 foot below the rim elevation of a manhole, catch basin, or inlet.

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:

- An easement is designated for the entire "pothole" area up to and including the spillway elevation.
- No portion of the easement shall be located within the building envelope.
- Sideslopes of the "pothole" are no greater than 3:1.
- 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 sellers disclosure for the affected lots.

2) At all low points of streets and rear yards unless easements and overflow spillways protect rear yard swales.

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.

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

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 approved geotextile fabric. 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 three feet above the ordinary high water mark is recommended for all outlets.

f. In addition to criteria outlined in Appendix J, 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 as to guarantee a maintenance-free 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.

8. Channel and Pipe Sizing

1. The "Mannings" formula will be used to size the open channel or pipe.

$$Q = (1.49/n)AR^{2/3}S^{1/2}$$

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

2. 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.

3. If the Mannings formula is not used, the Drain Commissioner shall approve the alternative method used.

4. Under Michigan State Law (Act 451, P.A. Part 301 of 1994), cross-road pipes (e.g. culverts) draining two square miles or more must be reviewed

and approved by the Michigan Department of Environmental Quality. This does not supersede review and approval by the Livingston County Drain Commissioner's office.

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

6. Cross-road pipes draining less than two square miles of upstream watershed will be sized by the proprietor's engineer and reviewed by the Livingston County Drain Commissioner's office.

7. Wing walls, headwalls, 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.

8. 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 one of the following methods:

    a. The "Mannings" formula
    b. The inlet headwater control/outlet tailwater control nomographs
    c. Other methods approved by the Drain Commissioner

III. Natural Wetlands

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

A. Wetlands will be protected from damaging modification and adverse changes in runoff quality and quantity associated with land developments. Before approval of the final plat or construction plans, all necessary wetland permits from the Michigan Department of Environmental Quality (MDEQ) will be in place.

B. Per MDEQ regulations, direct discharge of untreated stormwater to a natural wetland is prohibited. All runoff from the development will be pre-treated to remove sediment and other pollutants prior to discharge to a wetland. Such treatment facilities will be constructed and vegetation established before property grading begins.

C. Whenever possible, a permanent buffer strip, preferably vegetated with native plant species, will be maintained or restored around the periphery of wetlands.

D. Wetlands will be protected during construction by appropriate soil erosion and sediment control measures (See Part B of these rules).

IV. Lot Grading

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. The Drain Commissioner has no regulatory authority over landscaping activities under the Soil Erosion Control Act. It is the Drain Commissioner's responsibility to review the development plan and ascertain if it is consistent with sound stormwater management and drainage practices. The development grading plan will provide for the following:

A. The initial grading of the development 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 subdivision.

B. Where finished grades indicate a substantial amount of drainage across adjoining lots, inlet structures and piped outlets shall be provided in side yards along lot lines. A drainage swale of sufficient width, depth, and slope will be provided on the lot line to intercept local drainage for adjoining rear yards. To ensure that property owners do not alter or fill drainage swales, easements will be required over areas deemed necessary by the Drain Commissioner.

V. Soil Erosion, Sedimentation, and Pollution Control

Discharge of sediment or other polluting materials to a waterway that is under the jurisdiction of the Drain Commissioner, either within or outside of the subdivision, will be considered pollution to a County drain, and hence a violation of section 280.423 of the Michigan Drain Code. Under the Michigan Drain Code, pollution of a county drain is a criminal misdemeanor, punishable by fine or imprisonment.

A. Soil Erosion/Sedimentation Control

1. All erosion control measures will be regularly inspected and maintained. See the Administrative Policy for the Livingston County Soil Erosion Control Program in Part B of this Manual, the Livingston County Soil Erosion Control Ordinance in Part C of this manual, and the Soil Erosion and Sedimentation Control Act, Part 91 of the Natural Resouces and Environmental Protection Act, for specific requirements.

2. Before entering any natural water course, protected wetland, County drain, or other body of water, best management practices will be utilized to remove pollutants, including sediment, from stormwater runoff. Pollutant removal methods will include capture and treatment of the "first flush" and "bankfull" (1.5-year) storm events.

3. Headwalls, grouted riprap, or other stabilization measures will be provided where necessary to prevent erosion. Permanent erosion protection will be placed at bends, drain inlets and outlets, and other locations as needed in all

open ditches. Outlets to ditches will be placed within two feet of the average low water elevation of the water course.

4. Ditches with steep grades or unstable soils will be protected by sod, vegetative erosion control, geotextile fabric, riprap, or other means to prevent scour. Every effort should be made to reduce the velocity of flow as much as possible at all storm drain outlets. Outlet velocities will be non-erosive.

5. All detention/retention basins will be permanently stabilized to prevent erosion.

B. Pollution Control

1. In commercial and industrial developments, appropriate methods for separating pollutants shall be required. When used, oil and grit separator shall be installed off-line or in locations where flow velocities have been determined to be lower than scouring velocity in a 10-year storm. Where off-line facilities are proposed, a maintenance program, including an identified method and site for waste disposal, is required. All stormwater pollution prevention plans (SWPPP) shall be submitted to the Drain Commissioner and be approved by the appropriate local or State agency. If evidence of approval cannot be provided, the lot owner shall submit the SWPPP for approval by the Drain Commissioner's office at owner's expense.

2. Structures designed to remove trash and other debris from stormwater will be installed as required on stormwater management facilities prior to their outlet into the county drain.

3. Additional water quality protection measures may be required depending on the nature and location of the development and the receiving waters.

VI. 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.

VII. Easements

A. Wording relative to easement information shown on the plat or site plan will be as 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.

B. 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.

C. 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:

1. 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.

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

3. 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

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

VIII. Safety Considerations

A. Drainage system components, especially all ponds, will be designed to protect the safety of all persons coming in contact with the system. The following criteria will apply:

1. All wet detention basins will have a level safety ledge at least four feet in width and one foot below the invert of the outlet pipe water depth, and other design and landscaping features as may be needed to provide for protection of the public.

2. Animal guards shall be placed on all outlet pipes with a diameter greater than 15 inches.

3. Signs may be required to alert residents to use limitations (i.e. warning against swimming, ice skating, etc.) of any stormwater basin if the Drain Commissioner will have permanent maintenance jurisdiction. Warnings may also be required in the master deed.