CITY OF GEORGETOWN ORDINANCE NO. 2002-

AN ORDINANCE RELATED TO THE AMENDMENT OF THE GEORGETOWN/SCOTT COUNTY SUBDIVISION & DEVELOPMENT REGULATIONS REGARDING ARTICLE XI – STORM WATER MANAGEMENT

WHEREAS: The existing Subdivision & Development Regulations requirements are not satisfying the community's needs. The regulation requirements must be updated to reflect the current professional thinking, engineering principles and best management practices to address storm water management. Scott County boasts some of the most prestigious streams in Kentucky. North Elkhorn, South Elkhorn and Eagle Creeks are used extensively for fishing and recreation. In addition to these streams, Georgetown and Scott County obtains the majority of its water from the Royal Spring Aquifer, a natural resource unique in Kentucky, which is fed by groundwater recharge. It is important to safeguard these waterways from pollutants and changes in their ecology.

The Storm Water Manual is only one part of the overall storm water plan. The manual, once adopted, will become an integral part of the City of Georgetown's Phase II permit. The City has contracted with an outside firm for mapping and location of all drainage features within the urbanized area. This work and the required permit must be filed with the Kentucky Division of Water by March 2003.

All new developments, including those that require substantial renovations or expansions, within the urbanized area will be required to adhere to the new manual. Every time that a piece of land is developed, certain and expected changes occur. Changes potentially in the amount of groundwater recharge and even surface run-off can be impacted. The new regulations hope to reduce and offset those issues. Anytime silt and construction debris are allowed to leave a construction site, the effectiveness of constructed drainage systems, including catch basins, drain pipes, swales and easements, is reduced.

The intent of this proposed ordinance is to provide an appropriate means to maintain the integrity and durability of existing and proposed storm water systems within our neighborhoods and the City of Georgetown;

WHEREAS: This proposed amendment to the Georgetown-Scott County Subdivision & Development Regulations has been submitted to the citizens through a properly advertised public hearing before the Georgetown-Scott County Planning and Zoning Commission conducted at their August 8, 2002, and September 12, 2002, public meeting. The Commission voted unanimously to recommend the adoption of this amendment to the City Council of Georgetown;

NOW, THEREFORE, BE IT ORDAINED BY THE COUNCIL FOR THE CITY OF GEORGETOWN, KENTUCKY, as follows:

SECTION ONE: NEW PROVISIONS.

[New language is underlined. Language which is unchanged is not marked. Superseded language is shown as ~~stricken~~.]

1. A. -
    1. unchanged
    2. unchanged
    3. unchanged
    4. unchanged
    5. unchanged
    6. unchanged
    7. unchanged

    B. -
    1. unchanged
    2. unchanged
    3. unchanged
    4. unchanged
    5. unchanged
    6. unchanged
    7. for all ~~detention basins and inflow and outflow structures:~~ storm water facilities and inflow and outflow structures must be evaluated to include, if warranted, the following:
        a. unchanged
        ~~b. design hydrographs of inflow and outflow fo the 25-year, 24-hour or 10-year one hour events for the site under existing and developed conditions;~~
        ~~c. demonstration that the floor of the basin will be constructed and compacted to provide at least a 2% minimum slope to the outlet pipe to ensure that detained waters fully drain and do not create a~~

~~health and safety hazard or visual nuisance.~~
~~d. Demonstration that overflow for a storm in excess of the design capacity will be provided and designed to function without specific attention as part of the excess stormwater passage.~~
b. provide anti-seep collars details for storm water impoundment facilities that have dewatering times greater than 48 hours, or permanent pools.
c. dewatering features, such as valve structures and/or underlying drain systems, are to be included for facilities other than standard detention designs, for example, permanent pools, constructed wetlands, infiltration basins, bioretention areas, etc.
d. water budget analyses are to be done for all storm water facilities with permanent pools.
e. outlet pipes for all storm water impoundments are to be reinforced concrete pipes.
f. construction plans are to include all compaction requirements and tolerances for all proposed water impoundments, dams, and channel/stream crossings.
g. provide a means of access to all proposed storm water facilities.

8. storm water impoundment facilities are to serve as temporary sediment basins until the contributing drainage area exceeds 90 percent build out. At that time, they shall be converted over to the approved post developed storm water facility.

C. Storm water manual (note all of the following language is new and to be added)

1. ***Requirements:*** Developments that occur within Scott County are required to provide the Planning Commission a *Storm Water Management Plan* that addresses all the elements of the hydrologic cycle. These elements include, and are not limited to, the following:
    a. Groundwater recharge
    b. Water quality protection
    c. Channel protection
    d. Water quantity control

    The plan is to include construction drawings showing all

details on how to construct the proposed improvements and a drainage report providing all necessary calculations to comply with each element. All storm water management plans are to be reviewed and approved by the Planning Commission Engineer. The Georgetown City Engineer must also approve plans for developments that are within the Georgetown City Limits.

Construction Plans: All *Storm Water Management Plans* shall provide details related to all aspects of the construction. Developments are to be designed to ensure that controls are in place that would prevent or minimize water quality impacts. Designers are to develop and implement strategies, which include a combination of structural and/or non-structural Best Management Practices (BMPs) appropriate for the community. The plans must also ensure adequate long-term operation and maintenance of BMPs through notes or labels on construction drawings, Final Subdivision Plats, and Final Development Plans.
Drainage Reports: Studies are required to provide calculations supporting the use of the BMPs specified in the plans. These studies are to be submitted in conjunction with the Construction Plans for proposed developments. The following is a list of minimum criteria to be included in all drainage reports:

1. Summary tables outlining all hydrologic quantities needed to support the storm water management plans.
2. Soil survey maps showing the existing soil conditions for a proposed development.
3. Ponding elevations for each of the proposed storm water structures, storm water facilities, and closed contour areas.
4. Flow depths for all open channel conditions that are a part of the proposed plans.
5. Identification of all the swales, diversion ditches, roadway ditches, 100 year drainage ways, and floodplains.
6. Evaluation of storm water systems that receive

runoff from proposed developments; systems being defined as any type of structure or open channel that conveys runoff.

7. Pre and postdeveloped watershed maps showing all parameters used by designers to produce their storm water plans.
8. Maps that show all subcatchments draining to each proposed structure.
9. Label the analysis points where the study terminates. All points of analysis are to be set to evaluate the potential of compounding peak flow conditions downstream of developments. Analysis points are to be approved by the Planning Commission Engineer.

Additional Requirements: ***All developments must also incorporate the following criteria into their designs:***

a. Finish floor elevations for proposed single family and multifamily residential units are to be at least two feet above the 100-year water surface elevations of all waterways, overflow conditions, overland flow areas, and ponding areas.
b. Commercial facilities are to be evaluated for protection from 100 year flooding conditions.
c. Designs are not to include any fill to be placed in 100 year drainage ways and floodplains, unless proposed construction complies with Article XII, Section 1200 of the *Subdivision and Development Regulations*, and any and all permits from the Federal, State, and Local agencies are obtained prior to construction.
d. Other than what is described in item #3, any and all permits required by Federal, State, and Local agencies for developments must be obtained prior to the commencement of that process regulated by the permits.

2. ***Groundwater Recharge:*** Base flows of local streams and waterways are fed by groundwater sources. Developments can cause changes in the amount of water that would be used to support base flows. As the

impervious area of a site increases, so does the volume of runoff. To maintain adequate base flows and stream ecosystems, developments must incorporate practices in their storm water management plan to provide for treated groundwater recharge. The amount of recharge that a site is capable of providing depends on topographic factors such as slope, types of vegetation, hydrological soil groups, and locations of rock layers. The average annual recharge volume for a site can be estimated by taking the average annual recharge rate of the hydrological soil group(s), dividing that by the average annual rainfall (44.05 inches), and then multiplying that result by 90 percent. The following table provides a summary of the recharge requirements:

Hydrologic Soil Group (HSG)	**Average Annual Recharge Volume (in/yr)**	**Soil Specific Recharge (S_{in}) (in)**
A	18	0.37
B	12	0.25
C	6	0.12
D	3	0.06

Scott County Soils

Soil Series	**NRCS HSG**	**Depth to Bedrock (ft)**	**Seasonal High Water Table (ft)**	**Permeability (in/hr)**	**Suitability as Road Fill**
Ashton	B	>4	>5	0.6-2.0	Fair
Cynthiana	D	1-1.5	>5	0.6-2.0, 0.2-0.6	Poor
Dunning [1]	D	>3.5	0-0.5	0.6-2.0, <0.2	Poor
Eden	C	1.5-3.5	>5	0.6-2.0, <0.2	Poor
Faywood	C	1.5-3.5	>3.5	0.6-2.0, 0.2-0.6	Poor
Huntington					

[1]	B	>4	>3	0.6-2.0	Fair
Lowell	C	>3.5	>5	0.2-0.6, 0.6-2.0	Poor
Maury	B	>5	>5	0.6-2.0, 0.6-6.0	Fair, Poor
McAfee	C	1.5-3.5	>3.5	0.2-0.6, 0.6-6.0	Poor
Newark [1]	C,D	>4	0.5-1.5	0.6-2.0	Fair, Poor
Nicholson	C	>5	1.5-2.5	<0.2, 0.6-2.0	Poor
Nolin [1]	C	4	3	0.6-2.0	Fair
Disturbed Soil	D	-	-	-	-

Note: S(in) = (S)(P).

(1): Subject to common flooding.

References:

2000 Maryland Stormwater Design Manual Volumes I & II.
Soil Survey of Scott County, Kentucky.
Urban Hydrology for Small Watersheds, TR-55.
LFUCG Stormwater Manual, 1999

The soil specific recharge is determined by calculating a volume to be treated and infiltrated by a structural practice or by a percent area method involving a non-structural practice. The following formula is to be used for a structural practice:

$$GR_V = \frac{1}{12}(S_{in})(0.05 + 0.009 \cdot I)(A)$$

GR_V = Groundwater recharge volume, acre-ft.
S_{in} = Soil specific recharge, in.
I = Percent impervious, %.
A = Total area of site, acre.

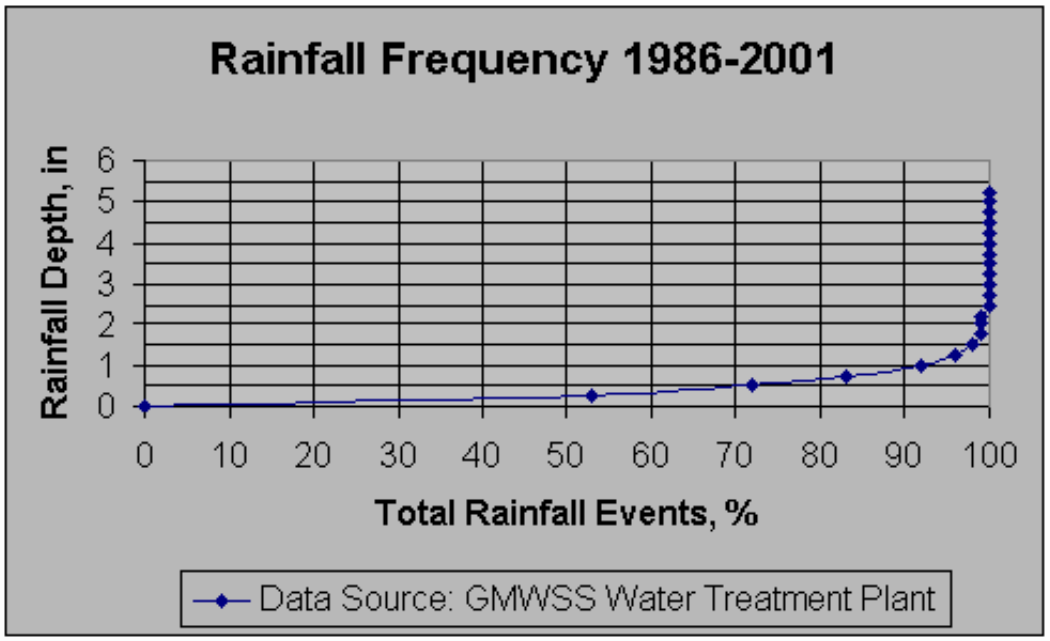
Examples of structural practices that can be used for groundwater recharge are bioretention areas, infiltration facilities, terraformed berms, and infiltration swales.

Since Scott County is in a karst region, designers that

intend to use structural practices for groundwater recharge must evaluate potential areas to ensure that these proposed facilities would be adequate and not have an adverse impact on surrounding areas, such as increasing the water table. Designers are to ensure that the groundwater recharge volume is to exit proposed facilities through natural infiltration or a designed outlet, and that the volume is treated by BMPs prior to infiltration. Dewatering times for structural practices should not exceed 48 hours. Groundwater recharge requirements may be waived for redevelopments only if approved by the Planning Commission Engineer.

3. ***Water Quality Protection:*** The water chemistry of runoff is extremely important to the health of creeks and streams. When enough rainfall occurs, runoff from land areas is transported from these sites to drainage ways. These drainage ways eventually reach the creek systems of Scott County. Depending on the types of sites, pollutants are transported by the force of the runoff or by its physical factors such as temperature and pH level. Water quality BMPs are to be used to the maximum extent practical to minimize these impacts and to treat runoff from all proposed impervious surfaces.

   For adequate treatment, 90 percent of the average annual rainfall must be treated by stormwater BMPs. Rainfall records from GMWSS water treatment plant shows that approximately 90 percent of total storm events occurred with 1 inch of rainfall or less.



The following equation is used to determine the water quality volume needed to be treated for a development:

$$WQ_v = \frac{1}{12}(P)(0.05 + 0.009 \cdot I)(A)$$

WQ_V = Water quality volume, acre-ft.

P = 90 percent of total storm events, 1 inch.

I = Percent impervious, %.

A = Total area of site, acre.

The following table [1] lists the amounts of impervious areas that can expected from different types of development, and the water quality depth in inches per given area:

Land Use/Cover Type	**Average Impervious Cover (%)**	**Water Quality Depth (in)**
Paved parking lots [2]	100	0.95
Roofs	100	0.95
Driveways	100	0.95
Streets and roads [2]	100	0.95
Commercial and business districts	85	0.82

Industrial	72	0.70
Town houses	65	0.64
Residential 1/8 acre lots or less	65	0.64
Residential 1/4 acre lots	38	0.39
Residential 1/2 acre lots	30	0.32
Residential 1/2 acre lots	25	0.28
Residential 1 acre lots	20	0.23
Residential 2 acre lots	12	0.23

[1]: Based on NRCS TR-55 modeling criteria.

[2]: Excluding right-of-way.

Note: Water quality volume must be accounted for by storm water credits and/or BMPs.

Targeted Pollutants: Designers are to use structural and non-structural BMPs to the maximum extent practical to treat the water quality volume. Individual treatments, or a combination of BMPs, can be used to achieve this goal.

Different land uses can generate different types of runoff pollutants. For instance, a proposed refueling station would produce a higher concentration of hydrocarbons per acre than a proposed residential subdivision. Selection of BMPs should be based on the anticipated pollutants for a site. Some examples of typical pollutants for different applications are:

1. Residential
    i. Setteable solids
    ii. Total suspended solids
    iii. Nitrogen
    iv. Phosphorous
    v. Metals
2. Commercial and industrial
    i. Hydrocarbons

ii. Trash
iii. Setteable solids
iv. Total suspended solids
v. Nitrogen
vi. Phosphorous
vii. Metals

Additional Storm Water Controls for Specific Commercial Areas: Specific design criteria for the following types of development are to be used:

1. Restaurants/grocery stores
    i. Dumpster pad areas are to drain into the proposed storm sewer system.
    ii. A pretreatment device is to be used at dumpster locations that drain into the storm sewer system.
    iii. Pretreatment device is only to receive surface water from dumpster pad.
    iv. Configuration and pretreatment to be approved by Scott County Health Department.
    v. Operation and maintenance criteria to be included in the Construction Plans and Final Development Plans.
2. Refueling stations
    i. Canopy refueling areas are to drain to the sanitary sewer.
    ii. Grade elevations are set to ensure that the only surface area draining into the sanitary system is from the pad itself.
    iii. No external rainwater can drain into the sanitary lines.
    iv. A pretreatment device is to be used for discharges draining into the sanitary system.
    v. Configuration and pretreatment to be approved by GMWSS.
    vi. Operation and maintenance criteria to be included in the Construction Plans and Final Development Plans.
3. Repair shops/oil change facilities/car lots
    i. Interior vehicle areas are to drain into the

sanitary system.

ii. A pretreatment device is to be used for discharges draining into the sanitary system.

iii. Configuration and pretreatment to be approved by GMWSS.

iv. Operation and maintenance criteria to be included in the construction drawings and Final Development Plans.

4. Automotive and truck wash facilities

i. Covered wash bays are to drain into the sanitary sewer system.

ii. Grade elevations set to ensure that the only surface areas draining into the sanitary system is from the bays themselves.

iii. No external rainwater can drain into the sanitary lines.

iv. A pretreatment device is to be used for discharges draining into the sanitary system.

v. Configuration and pretreatment to be approved by GMWSS.

vi. Operation and maintenance criteria to be included in the construction drawings and Final Development Plans.

Treated groundwater recharge volumes can count towards the required water quality volumes; however, neither the groundwater recharge or water quality volumes are to be included in the channel protection and the water quantity control portion of the regulations.

4. ***Channel Protection:*** Developments that require impervious areas and compacted fills reduce the amount of rainfall that previously infiltrated into the underlying soils. The rainfall is then converted into runoff, which eventually drains into the Scott County creek systems. Frequent rainfall events help to shape stream geometries. Uncontrolled events after development can cause degradation to channel areas. To protect channels from

this degradation, developments are to provide extended detention for the 1 year/ 24 hour event, and allow the runoff produced to dewater over a 12 hour period. Storm water facilities designed for this condition will release flow at a rate not to exceed erosive flow rates in downstream channels. Channel protection may be waived but not limited to proposed sites that have less than 2 cfs for the post developed state.

Designers are encouraged to protect channel and stream areas by not designing developments that require fill in headwater stream channels, to within 50 feet of the bankfull conditions (1.5 to 2 year return periods) of minor waterways, and floodplains. Developments that utilize this option may qualify for density credits or other considerations similar to a Planned Urban Development (PUD).

Channel and stream areas that are disturbed due to grading and/or other construction activities must be stabilized and comply with Article XII, Section 1200 of the Subdivision and Development Regulations.

References:

2000 Maryland Stormwater Design Manual Volumes I & II. Center for Watershed Protection.

5. ***Water Quantity Control:*** Typically with development, the volume of runoff increases due to the addition of impervious areas, the compaction of soil materials, and removal of vegetative cover. Some rainfall that once percolated into the ground would now travel over the surface. Developments must provide stormwater features that reduce the peak flow rates after development to what the runoff rates were prior to construction. In addition to the 1 year channel protection requirement, storm events that need to be adhered to are the 10, 25, and 100 year/ 24 hour events. Rainfall intensities for those events are to be taken from Division of Water Engineering Memorandum No. 2, current edition or most recent version. In the past, there have been storms that exceeded these design storm events. Designers are encouraged to analyze proposed developments with such

rainfall intensities, if they feel that it is necessary for safe guarding any proposed infrastructure.

Storm Sewer Design: Proposed storm sewers systems that have the potential of being maintained by any municipality or government utility in Scott County must adhere to the following guidelines:

1. All proposed storm lines are to be reinforced concrete pipe (RCP), ADS-N12 or high density polyethylene equivalent, A-2000, or aluminized type II corrugated metal pipe (CMP) with bituminous coating. Please note that CMP can only be used when a designer calls for a 48 inch line or greater in an urbanized area with the approval of the Planning Commission Engineer and City Engineer. CMP is not permitted in rural areas.
2. Minimum pipe diameter for proposed lines is 12 inches.
3. The maximum length between any storm sewer structures, serving less than a 48 inch line, is 300 feet.
4. Bedding details and joint specifications are to be provided with all construction drawings and shall comply with manufacturing recommendations.
5. A storm sewer structure must be used if a proposed storm line extends beyond the maximum length, is altered in horizontal or vertical alignment, or changes in pipe material. Structures are also to be used at the beginning and ending points for proposed storm lines.
6. Proposed systems are to be designed to handle the 10 year/ 24 hour event capacity with no flow above crown of pipe. Flow interception for structures must be based on bypass conditions. No proposed system is to surcharge in the 100 year/ 24 hour event.
7. Designers are to design storm sewers that prevent the 100 year/ 24 hour runoff from crossing roadway crowns for local and continuous streets. For collectors and arterials,

runoff spread and ponding are restricted to 6 feet from the face of curb in the 10 year/ 24 hour event.

8. 100 year/ 24 hour water surface elevations are to be determined for all proposed storm sewer structures, such as headwalls and surface inlets.
9. In residential subdivisions that include curb and gutter as part of their roadway design, proposed storm lines are to be daylighted at the rear of proposed lots.
10. Overflow swales are to be provided at sag locations in commercial and residential subdivisions.
11. The Planning Commission Engineer and Public Works Department or equivalent must approve the types of structures proposed for storm water systems that could be maintained by a municipality of Scott County.

Culverts and Bridges: Proposed channel and stream crossings are to include a means to convey the 100-year flow. Culverts are typically used in situations where drainage ways do not have any base flows associated with them. Head conditions occur on the upstream side to force the peak flow through the structure(s). Proposed culverts are to be designed so that the 100-year water surface elevation is one foot below the overtopping elevation of the embankment. Bridge structures are to be used at creek and stream crossings where base flow conditions do exist (base flow being defined as water being present in channel and stream areas during dry weather conditions). These structures are to be designed to convey the 100-year flow rate unimpeded, and allow the 100-year water surface elevation to be one foot below the bottom of the slab. All proposed bridges are to be certified by the designer after construction. Prior to construction all permits are to be obtained from Corps of Engineers and/or Division of Water, if applicable.

Other design considerations that apply to culverts and bridges are listed in the following:

1. Live load considerations for anticipated construction traffic, fire service vehicles, refuse trucks, commercial vehicles, etc.
2. Public protection for pedestrian and bicycle traffic, if applicable.
3. Headwalls for the upstream and downstream sides of proposed culverts. Fences or railing are to be provided for headwall that are for 30 inch lines or greater.
4. Railing design for bridges.
5. End treatments for culverts to minimize erosion and sediment transport.
6. Scouring protection for bridge piers and abutments.
7. Fish passage.
8. Streambank stabilization designs for backwater areas and accelerated flows downstream.

There are areas within Scott County, particularly in the north, where existing roadways are already in place and lying in the floodplain. In situations where roads must be improved due to development, any portion of the roadway that is flooded by the 100 year event or less must be reconstructed to provide a concrete cap with a footer design on the upstream side, to reduce the potential of a roadway being washed out.

Open Channel Design: Developments that use open channels to convey runoff must adhere to the following guidelines:

1. Convey the 100 year event.
2. Designs not to exceed the channel lining's critical shear force and permissible velocity in the 10 year event.
3. Select the appropriate roughness values for proposed channels.
4. Provide any armoring needed for hydraulic jump and bend conditions.

6. ***Storm Water Credits:*** Storm water credits are water quality reductions permitted through specific site design criteria. These credits are established to help reduce the impacts on Scott County's stream systems. The credits are calculated based on the procedures outlined and subtracted from the water quality requirements for a development.

   The following is a list of the stormwater credits that are permitted for this community:

   1. Filter strips
   2. Vegetated channels
   3. Riparian buffers
   4. Terraformed Areas
   5. Rooftop disconnections
   6. Modular/porous pavements

   Note: Storm water credits are set to encourage "greener" site designs; however, they are not intended to be a substitution for the water quality protection of the regulations. All drainage from proposed impervious areas must be treated by a storm water BMP.

   1. *Filter Strips:* Filter strips are undisturbed grass areas that receive runoff from a development in the form of sheet flow. It is important to note that the filter area must remain undisturbed during construction to allow natural percolation to occur.

      Credit definition:

      1. Impervious areas draining to the filter strip are deducted from the total impervious area used to determine the water quality volume.
      2. An additional 0.075 acre-ft per acre of filter strip is also deducted from the remainder of the water quality volume.

      Credit criteria:

      1. Minimum filter strip widths are 50 feet.
      2. Runoff draining across filter strips shall be in the form of sheet flow only.
      3. The maximum contributing length draining to filter strips shall be 150 feet for residential development and 75 feet for commercial development. Designers are permitted to design filter strips to

treat larger areas as long as they follow the design procedure outlined for Riparian Buffers.

4. Slopes greater than 5 percent are to incorporate a means by which runoff is dispersed into sheet flow, for example, a level spreader or 30 feet grass buffer.
5. Filter strips near channels or drainage ways are to be set outside bankfull conditions.
6. The infiltration rate for the underlying soil must not be less than 0.25 in/hr.
7. Areas draining to filter strips that include rooftops of homes and buildings must have notes on Final Subdivision Plats and/or Final Development Plans stating that the roof drains are to be directed towards the filter strip areas.
8. Filter strips shall be set in easements, or in some other means for protection, on Final Subdivision Plats and/or Final Development Plans.

2. *Vegetated Channels:* Vegetated channels can be used for water quality treatment. These types of channels apply to roadway ditches, drainage ways in the rear of lots, conveyance systems for parking lot drainage, etc.

    Credit definition:

    1. Impervious areas draining through vegetated channels are deducted from the total impervious area used to determine the water quality volume.
    2. An additional 0.25 acre-ft per acre of channel area needed to convey the one inch storm event is also deducted from the remainder of the water quality volume.

    Credit criteria:

    1. The geometry of the channels must be either parabolic or trapezoidal.
    2. Channel side slopes are not to exceed 3:1.

3. The velocity of flow in the channel must be 1.0 feet per second or less for the runoff produced by the one inch storm event.
4. The 10 year/ 24 hr event is not to exceed the tractive force or permissible velocity of the vegetative cover or the underlying soil, whichever is greater.
5. No headwalls are to be in the direct path of the water quality discharge areas.
6. The infiltration rate for the underlying soil must not be less than 0.25 in/hr.
7. Areas draining to vegetated channels that include rooftops of homes and buildings must have notes on Final Subdivision Plats and/or Final Development Plans stating that the roof drains are to be directed towards the open channel areas.
8. Channels shall be set in drainage easements on Final Subdivision Plats and/or Final Development Plans, stating that there will be no obstructions or structures permitted in the easements including fences.

Sizing calculations: In order to satisfy Credit criteria #3, the curve number representing an area that is intended to be treated by a vegetated channel must be modified in order to get an accurate peak flow rate for the 1 inch storm.

WQ_{in} = Water quality depth, in.

P = 90 percent of total storm events, 1 inch.

I = Percent impervious, %.

$$WQ_{in} = (P)(0.05 + 0.009 \cdot I)$$

$$CN = \frac{1000}{10 + 5 \cdot P + 10 \cdot WQ_{in} - 10\left(WQ_{in}^{2} + 1.25 \cdot WQ_{in} \cdot P\right)^{1/2}}$$

CN = Curve number for water quality storm event.

References:

- Design of Stormwater Filtering Systems 1996. Center for Watershed Protection.

3. *Riparian Buffers:* This credit applies to developments that incorporate riparian buffer practices as a part of its design. The criteria are similar to filter strips except that it is a higher credit for water quality quantity.

    Credit definition:

    1. Impervious areas draining to the filter strip are deducted from the total impervious area used to determine the water quality volume.
    2. An additional 0.25 acre-ft per acre of buffer is also deducted from the remainder of the water quality volume.

    Credit criteria:

    1. Runoff draining across riparian buffers shall be in the form of sheet flow only.
    2. The velocity of flow in the in the buffers must be 1.0 feet per second or less for the runoff produced by the one inch storm event.
    3. Slopes greater than 5 percent are to incorporate a means by which runoff is dispersed into sheet flow, for example, a level spreader or 30 feet grass buffer.
    4. Riparian widths are to be based on a residence time of 9 minutes.
    5. Vines and shrubs are to be planted with a minimum density of 1700 stems per acre (one planting per 25 square feet at 5 feet on center), and trees planted at 450 stems per acre (one planting every 100 square feet at 10 feet on center).
    6. For diversity, six or more species from the planting list on pages 13 to 15 must be used for each riparian design.
    7. Riparian buffers near channels or drainage ways are to be set outside bankfull conditions.
    8. The infiltration rate for the underlying soil

must not be less than 0.25 in/hr.

9. Areas draining to riparian buffers that include rooftops of homes and buildings must have notes on Final Subdivision Plats and/or Final Development Plans stating that the roof drains are to be directed towards the riparian buffer areas.
10. Riparian buffers shall be set in easements, or in some other means for protection, on Final Subdivision Plats and/or Final Development Plans.

Sizing calculations:

$$Q = \frac{1.486}{n} A R^{2/3} S^{1/2}$$

Q = Flow rate, cfs.

n = Manning's roughness (0.24 for grass buffers, 0.35 for forested buffers).

A = Cross sectional area, sf.

R = Hydraulic radius, ft.

S = Channel slope, ft/ft.

T = Parallel length of buffer to bank.

$$A = \frac{1}{12}(T \cdot y)$$

y = Depth of flow (0.5 to 1.0), in.

$$R = \frac{T \cdot y}{2(6T + y)} \quad V = \frac{Q}{A}$$

V = Flow velocity, fps.

$$W = 60(V \cdot t)$$

W = Riparian buffer width, ft.

t = Resident time (9), min.

Planting list:

Herbaceous Ground Cover

Common Name	Scientific Name	Shade/Sun
River Oats	Chasmanthium latifolia	Shade
Indian Grass	Sorgastum nutans	Sun
Switch Grass	Panicum virgatum	Sun
Redtop	Agrostis alba	Sun
Deertongue	Panicum clandestinum	Shade
Broomsedge	Andropogon virginicus	Sun
Big Blue Stem	Andropogon gerardii	Sun
Frank's Sedge	Carex	Sun
Gray's Sedge	Carex grayii	Shade
Soft Rush	Juncus effusus	Sun
Flat Sedge	Cyperus strigosus	Sun
Lady Fern	Athyrium felix-femina	Shade
Sensitive Fern	Onoclea sensibilis	Shade
Cinnamon Fern	Osmunda cinnamomea	Shade
Common Boneset	Eupatorium perfoliatum	Sun
Golden Ragwort	Senecio aureus	Shade
Wrinkled Goldenrod	Solidago rugosa	Sun
Tall Goldenrod	Solidago gigantea	Sun
Beard Tongue	Penstemon hirsutus	Shade
Monkey Flower	Mimulus ringens	Shade
Cardinal Flower	Lobelia cardinalis	Shade

Great Blue Lobelia	Lobelia silphilitica	Shade

Vines and Shrubs

Common Name	**Scientific Name**	**Shade/Sun**
Cross Vine	Bigononia carpreolata	Shade
Trumpet Creeper	Campsis radicans	Sun
Climbing Hydrangea	Decumaria barbara	Shade
Giant Cane	Arundinaria gigantea	Sun
Buttonbush	Cephalanthus occidentalis	Sun
Meadowsweet	Spirea alba	Sun
Sweetspire	Itea virginica	Shade
Spicebush	Lindera benzoin	Shade
Paw-paw	Asimina triloba	Shade
Arrowwood	Viburnum dentatum	Shade
Nannyberry	Viburnum lentago	Sun
Swamp Haw	Viburnum nudum	Shade
Ninebark	Physocarpus opolifolius	Sun
Hazelnut	Corylus americana	Sun
Possum Haw	Ilex decidua	Sun
Winterberry	Ilex verticillata	Shade
Chokeberry	Aronia arbutifolia	Sun
Elderberry	Sambucus candensis	Sun
Juneberry	Amelanchier arborea	Shade
Mountain Camelia	Stewartia ovata	Shade
Sweetbells	Leucothe racemosa	Shade
Smooth Azalea	Rhododendron	Shade

	arborescens	
Silky Dogwood	Cornus amomum	Sun
Redosier Dogwood	Cornus stolonifera	Shade
Rough-leaf Dogwood	Cornus drummondii	Shade
Pagoda Dogwood	Cornus alternifolia	Shade
Smooth Alder	Alnus serrulata	Sun
Sandbar Willow	Salix interior	Sun
Silky Willow	Salix sericea	Sun
Dwarf Willow	Salix humilis var. macrophylla	Sun
Pussy Willow	Salix discolor	Sun
Streamco Willow	Salix purpurea	Sun
Bankers Willow	Salix x cotteti	Sun
Heart-leaf Willow	Salix rigida	Sun

Trees

Common Name	**Scientific Name**	**Height (ft)**	**Spread (ft)**
Black Willow	Salix nigra	60-100	50-85
Boxelder	Acer negundo	30-60	25-50
Red Maple	Acer rubrum	50-100	20-40
Silver Maple	Acer saccharinum	50-80	35-50
Green Ash	Fraxinus pennsylvanica	50-60	30-40
White Ash	Fraxinus americana	80	65
Red Elm	Ulmus rubra	70	55
Silverbell	Halesia carolina	30-40	20-35
	Diospryros		

Persimmon	virginiana	20-70	10-40
River Birch	Betula nigra	40-70	30-60
Black Gum	Nyssa sylvatica	30-90	20-30
Hackberry	Celtis occidentalis	40-70	40-50
Cottonwood	Populus deltoides	75-100	50-75
Sweet Gum	Liquidambar styraciflua	50-75	40-50
Tulip Poplar	Liriodendron tulipifera	60-90	30-50
Sycamore	Plantanus occidentalis	75-100	50-75
American Beech	Fagus grandiflora	50-90	40-75
Ironwood	Carpinus caroliniana	30	30
Yellow Buckeye	Aesculus octandra	70-90	40-55
Shellbark Hickory	Carya lacinosa	70-100	50-75
Shagbark Hickory	Carya ovata	70-100	45-65
Pecan	Carya illinoensis	100	70
Black Walnut	Juglans nigra	70-90	45-60
Bur Oak	Quercus macrocarpa	70-100	75-90
Pin Oak	Quercus palustris	50-90	25-45
Swamp Oak	Quercus bicolor	60-70	30-35
Swamp Chestnut Oak	Quercus michauxii	60-80	40-55

References:

Riparian Buffers Strategies for Urban

Watersheds, 1995.
LFUCG Stormwater Manual, 1999.

4. *Terraformed Areas:* Terraformed areas are places within a development that have been graded to promote stormwater infiltration, such as terracing and berming. Runoff is retained within a bermed area and allowed to percolate into the soil. Bermed swales, storage areas, and side-saddle impoundment areas are examples of this stormwater practice.

    Credit definition:

    1. The runoff volume, impounded by terraformed areas, is deducted from the groundwater recharge and water quality volumes.
    2. An additional 0.25 acre-ft per acre of terraformed area is also deducted from the remainder of the water quality volume

    Credit criteria:

    1. Slopes greater than 5 percent are to incorporate a means by which runoff is dispersed into sheet flow, for example, a level spreader or 30 feet grass buffer.
    2. Terraformed areas near channels or drainage ways are to be set outside the 10 year water surface elevation areas.
    3. The infiltration rate for the underlying soil must not be less than 0.25 in/hr.
    4. Areas draining to terraformed areas that include rooftops of homes and buildings must have notes on Final Subdivision Plats and/or Final Development Plans stating that the roof drains are to be directed towards the terraformed areas.
    5. Terraformed areas must drain within 48 hours.
    6. Terraformed areas shall be set in easements, or in some other means for protection, on Final Subdivision Plats and/or Final Development Plans.

5. *Rooftop Disconnections:* Downspouts from homes for single family detached developments including duplexes that do not tie into a storm sewer, or drain directly to impervious areas, will have a credit towards the water quality calculations.
    Credit definition:
        1. Rooftop areas draining directly across yard areas are deducted from the total impervious area used to determine the water quality volume.
        2. The maximum credit may not exceed roof areas of typical homes for proposed residential developments.
    Credit criteria:
        1. Yard areas receiving rooftop runoff are to be at least ⅓ of the roof areas.
        2. Discharges must at least travel across 30 feet of grass areas before reaching any impervious surfaces.
        3. This credit cannot be counted if the design for the proposed development already takes into account a BMP treatment for drainage areas that include proposed homes.
        4. Rooftops draining onto yard areas must have notes on Final Subdivision Plats and/or Final Development Plans stating that the roof drains are to be directed towards the yard areas.
6. *Modular/Porous Pavements:* Modular/porous pavement designs can be used for developments to promote infiltration of runoff. The performance of these pavements will depend on the application for which they are used, the construction parameters, and the manufacture's specifications. These designs are permitted in commercial and industrial areas, only upon the review and approval by the Planning Commission.
    Credit definition:
        1. Areas using modular/porous pavements will be treated as pervious areas for the

purposes of calculating groundwater recharge, water quality, and peak flow rates.

Credit criteria:

1. Installation is to be based on the manufacture's specifications.
2. Porosity of the fill material is based on what the designer specifies as material to be used.
3. Modular/porous pavements are limited to seasonal sale areas, overflow parking locations, and 25% of the total minimal required parking as part of the Development Plan process.
4. Proposed modular/porous pavement areas are to be installed after the contributing drainage area is fully constructed, to prevent clogging of the voids.
5. Subgrade compaction is to be evaluated and specifications provided to allow the modular/porous pavements to function as designed.