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## **SECTION 115 - WATER QUALITY PROTECTION**

### **115.1 PURPOSE**

This section covers the design of Best Management Practices (BMPs) to minimize the adverse effects of urban stormwater runoff on the quality of receiving waters. This policy applies only to developments in the residential, commercial, office, and manufacturing (R, C, O, and M) zoning districts and Plot Assignment Districts (P.A.D.'s) or other special zoning districts meeting or exceeding the development densities allowed in the R, C, O, and M districts. It does not apply to A-R, Agriculture-Residential District or the A-1, Agriculture District.

The Greene County Northeast Development Plan identifies Fulbright Spring and Pierson Creek as valuable resource waters which are sources of the community's water supply. The Northeast Plan, as well as the Short Range Recommendations of the Watershed Task Force endorsed by the County Commission in September 1996, call for protection of these water resources by implementing the recommendations of the 1995 Fulbright Spring Protection Study (Reference 115.1). The requirements of this section will apply to all new developments in these watersheds.

As the role which urban runoff from the Springfield metropolitan area plays in the quality of the James River and Table Rock Lake becomes better understood, it is anticipated that water quality requirements will be extended to watersheds of the James River and its tributaries.

It is recognized that specific water quality standards, other than those contained in the Missouri Clean Water Laws, have not been developed or adopted for these receiving waters. The objective of this policy is not to meet specific reductions of targeted pollutants, but rather to provide a generally effective level of pollutant removal by using reasonable, cost effective measures. The goal is to minimize, to the maximum extent practical, adverse impacts on the quality of the receiving waters.

### **The Role of On-site Water Quality Management Practices**

It is important to recognize that the *structural Best Management Practices* (BMPs) for which design guidance is given in this section represent only one aspect of stormwater quality management. The most effective means of managing stormwater quality lie in overall watershed planning and zoning controls, and other *nonstructural* practices which are generally beyond the control of an individual development.

The Fulbright Spring study (Reference 115.1) made it clear that a strategy based upon full development in a watershed, with reliance solely upon structural BMP's to maintain water quality, will not be successful. A combination of non-structural and structural measures was recommended as the best means to manage the impacts of development on water quality.

Data from communities across the country has shown that, as the total impervious area in a watershed exceeds ten to fifteen percent (10-15%), water quality declines unless mitigative measures are taken. The most important management tool is to limit the impervious area in these watersheds to these values. While these limits may be attainable for the watershed as a whole, they may not be possible for individual development or sub-basins. Structural BMP's will be required for these developments.

## **115.2 GENERAL DESIGN GUIDELINES**

### **1. Minimize the amount of runoff.**

The total quantity of pollutants transported to receiving waters can be minimized most effectively by minimizing the amount of runoff. Both the quantity of runoff and the amount of pollutant wash-off can be minimized by reducing the amount of *directly connected impervious area (DCIA)*. Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Impervious areas are considered disconnected when runoff passes as sheet flow over grass areas, or through properly designed BMP's, prior to discharge from the site.

2. Maximize contact with grass and soil.

The opportunity for pollutants to settle out is maximized by providing maximum contact with grass and soil. Directing runoff over vegetative filter strips and grass swales enhances settling of pollutants as the velocity of flow is reduced. Infiltration of runoff into the soil is also increased.

3. Maximize holding and settling time.

According to ASCE (Reference 115.2), the most effective runoff quality controls reduce the runoff peak and volume. The next most effective controls reduce peak runoff rates only. For small storms the runoff rate should not exceed the pre-project peak flow rate from the fifty percent (50%) AEP (2-year) storm. Most obnoxious pollutants (exceptions include water soluble nutrients and metals) can be settled out.

By reducing the rate of outflow and increasing the time of detention storage, settling of pollutants and infiltration of runoff is maximized.

4. Design for small, frequent storms.

Drainage systems for *flood control* are designed for large, infrequent storm events. In contrast, stormwater quality controls must be designed for small, frequent storm events. In Greene County ninety percent (90%) of all twenty-four (24) hour rainfalls are one inch (1") or less (see Figure 104.3). Most pollutants are washed off in the "first flush", generally considered the first one-half inch ( $\frac{1}{2}$ ") of runoff.

5. Utilize BMP's in series where possible.

Performance monitoring of BMP's in Florida, Maryland, and Delaware has shown that the combined effect of providing several BMP's in a series can be much more effective in reducing the level of pollutants than providing a single BMP at the point of discharge. To the greatest extent practical, runoff should be directed first to vegetative filter strips, then to grass swales or channels, and then to extended detention basins, sand filters, etc.

6. Incorporate both flood control and water quality objectives in designs, where practical.

Incorporating both flood control and water quality criteria into a single stormwater management facility is not only possible, but is encouraged. Whenever practical, combining several objectives, such as water quality enhancement and flood control, maximizes the cost-effectiveness of stormwater management facilities.

### **115.3 REQUIREMENTS**

The following requirements will apply to any new development within the Fulbright Spring or Pierson Creek watersheds:

- 1) Stormwater runoff from any new development for which the total impervious area exceeds ten percent (10%) of the total land area of the development, must be directed through an extended wet or dry detention basin, or other properly designed BMP, prior to discharge from the site.
- 2) Runoff from fueling areas and other areas having a high concentration of pollutants will be required to be directed to a sand filter or other properly designed BMP which provides filtration as well as settling.
- 3) The required volume for capture and treatment shall be designed as the *water quality capture volume* (WQCV), and shall be determined as set forth in Section 115.4.1.
- 4) Detention storage must be provided to limit the peak flow rate from the fifty percent (50%) AEP (2-year) storm to pre-project values. Detention facilities for peak flow control shall be designed as set forth in Section 112.

### **115.4 DESIGN CRITERIA**

#### 115.4.1 Water Quality Capture Volume

Water quality BMPs shall be designed to capture the runoff from the 90<sup>th</sup> percentile rainfall for Greene County as well as to capture the first flush of pollutants from directly connected impervious areas within the proposed development.

The required water quality capture volume (WQCV) to be used in design of extended wet and dry detention basins and other BMPs whose design is based upon capture and treatment of storm water, shall be the greater of the following:

- 1) the first one-half inch (½") of runoff from the directly connected impervious area (DCIA) in the development, or
- 2) the *runoff* resulting from total rainfall depth of one inch (1") in twenty-four (24) hours over the entire development.

#### 115.4.2 Directly Connected Impervious Area (DCIA)

Impervious areas are considered connected when runoff travels directly from roofs, drives, pavement, and other impervious areas to street gutters, closed storm drains or concrete, or other impervious lined channels. Connected and disconnected impervious areas are illustrated in Figure 115.1.

In order for an impervious area to be considered disconnected, runoff from the area must pass through a vegetative filter strip or other BMP meeting the requirements set forth in this section.

For determining the amount of impervious area, the following assumptions shall apply in the absence of more detailed data:

Single Family Lots

Average roof area:	2500 square feet
Average drive area:	800 square feet
Average impervious area per lot:	3500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Duplexes and Patio Homes

Average roof area:	2500 square feet
Average drive area:	1600 square feet
Average impervious area per lot:	4500 square feet

If gutter downspouts are directed to drain toward lawn areas, seventy-five percent (75%) of the roof area shall be considered disconnected.

Multi-Family, Commercial and Other Areas

The amount of impervious area contained in multi-family, commercial, office and manufacturing developments shall be determined based upon the site plan for the development.

115.4.3 Vegetative Filter Strips

Vegetative filter strips consist either of areas of undisturbed vegetation in good condition, including trees, grass, sod or other vegetative cover which meets the objectives for this BMP, or areas where new vegetation has been established. Vegetative filter strips shall be provided in areas of sheet flow only. The hydraulic loading for filter strips shall not exceed 0.05 cfs per lineal foot of filter strip length for the fifty percent (50%) AEP (2-year) storm (equal to the runoff per unit width from a four hundred feet (400') length of impervious area).

The minimum width of the filter strip shall not be less than twenty percent (20%) of the length of the sheet flow from the upstream impervious surface, and in no case shall be less than six feet (6'). The slope along the width of the filter strip shall not exceed 4:1 (25%).

Typical details for vegetative filter strips are shown in Figure 115.2.

#### 115.4.4 Grass Swales

Grass swales may be provided to convey runoff from vegetative filter strips and impervious areas to BMP's designed for capture and temporary storage of runoff. Design criteria for grass swales shall be as follows:

Maximum side slopes: 4:1.

Maximum longitudinal slope: 5%.

Minimum longitudinal slope: 1%.

Maximum velocity: 2 feet per second for peak flow from the 50% AEP (2-year) storm.

Roughness coefficients for use in the design of grass swales shall be determined as set forth in Section 111.4.2.

Grass swales shall be lined with sod or seeded and covered with suitable erosion control blanket and mulch.

Typical details for grass swales are shown in Figure 115.3.

#### 115.4.5 Extended Dry Detention Basins

Extended dry detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended dry detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., "off-line") where possible.

Design criteria for extended dry detention basins shall be as follows:

Volume: Minimum volume shall be one hundred and twenty-five percent (125%) of the required water quality capture volume (WQCV). Detention basins for water quality may be combined with detention basins for flood control. Effects of the WQCV may be considered in the design for flood control.

Drain time: The WQCV shall be released over a minimum period of forty (40) hours and a maximum period of seventy-two (72) hours.

Outlet structure: Outlet structures shall consist of a perforated riser pipe, outlet pipe and gravel filter material as shown in Figures 115.4 and 115.5. The minimum allowable riser pipe diameter is eight inches (8"). The riser pipe shall be connected to an outlet pipe of equal or greater diameter. The outlet pipe shall have adequate capacity to carry the maximum rate of flow from the riser pipe. Material for the riser pipe shall be Schedule 40 PVC, ductile iron, or corrugated, galvanized metal.

A removable cap shall be provided at the top of the riser pipe. The cap shall have a one inch (1") diameter hole for air relief.

The outlet pipe shall be bedded in firmly compacted clay, free of stones. For dams exceeding ten feet (10') in height, an anti-seep collar shall be provided around the pipe.

Number of rows of perforations, number of perforations per row and diameter of perforations for the riser pipe shall be specified on the plans. Perforation pattern shall be determined based upon orifice calculations to provide for release of the WQCV over the specified time. Perforations shall meet the following requirements:

Minimum perforation diameter:	1/4 inch
Maximum perforation diameter:	1 inch
Minimum number of holes per row:	4
Maximum number of holes per row:	8
Minimum row spacing:	4 inches
Maximum row spacing:	12 inches

Freeboard: Where the basin is to be utilized as a water quality BMP only, twelve inches (12") minimum freeboard shall be provided above the WCQV.

Forebay: It is preferred that a forebay be provided to dissipate energy from incoming flows and to trap settleable sediment entering the basin. The forebay should be separated from the remainder of the basin by an earth dike meeting the requirements of Section 112.6.2. The top of the dike shall be set six inches (6") above the stage of the WQCV. Outflow from the forebay to the basin shall be through a gravel filter meeting the requirements of Section 114.5.2 (Figure 114.07A). The top of the gravel filter shall be set equal to the stage of the WQCV.

The volume of the forebay shall be a minimum of ten percent (10%) and a maximum of twenty percent (20%) of the WQCV. The volume of the forebay is considered to be part of the required WQCV, not additional volume.

General construction requirements: The optimal length to width ratio for a water quality detention basin is four (4). The length to width ratio should be no less than two (2). The minimum allowable length to width ratio is one (1). Side slopes, dams or dikes, and retaining walls shall meet the requirements of Section 112.6.

Overflow spillways: Where the basin is to be utilized as a water quality BMP only, a spillway or outlet structure meeting the requirements of Section 112.6.5 and capable of passing the peak flow from a 1% AEP (100-year) storm for the drainage area upstream of the basin, shall be provided. The lowest point on the spillway or outlet structure shall be set at the top of the WCQV.

Trickle channels: Trickle channels shall be provided to provide grade control and to minimize chronic wet areas. Trickle channels shall be constructed of six inch (6") stone or other porous medium. A typical trickle channel cross section is shown in Figure 115.6.

A typical plan and section for extended dry detention basins are shown in Figure 115.7.

#### 115.4.6 Extended Wet Detention Basins

Extended wet detention basins may be provided to capture and provide temporary storage for the required water quality capture volume. Extended wet detention basins shall be placed outside of the primary watercourses which allow off-site flows to pass through the development (i.e., "off-line") where possible.

Design criteria for extended wet detention basins shall be the same as for extended dry detention basins, with the following exceptions:

The volume of the permanent pool should not be less than 1.0 to 1.5 times the WQCV.

A bench area (littoral zone) with a width of ten feet (10') shall be provided as shown in Figure 115.8. It is preferred that emergent aquatic vegetation be provided in this zone.

It is recommended that a minimum of twenty-five percent (25%) of the WQCV be provided in the upper eighteen inches (18") of depth. A maximum of fifty percent (50%) of the permanent pool volume shall be provided in the upper eighteen inches (18") of depth.

Depth of the principal portion of the permanent pool shall be a minimum of four feet (4').

It is preferred that a forebay meeting the same requirements as specified for dry detention basins, be provided.

Where perforated riser pipes are not encased in gravel, only corrugated metal or ductile iron pipe may be used.

Typical details for extended wet detention basins are shown in Figure 115.8.

#### 115.4.7 Sand Filters

Runoff from fueling plazas, vehicle maintenance areas, solid waste storage or transfer areas, and other areas having potentially high concentrations of contaminants shall be passed through a sand filter prior to discharge to receiving waters.

Total impervious area draining to a sand filter will generally be one (1) acre or less. Sand filters shall be provided with a sedimentation chamber and a filtration chamber. Design of sand filters shall be based upon the Austin, Texas first flush filtration basin (full sedimentation design) as described in Debo and Reese pp. 596-598 (Reference 115.7). A schematic cross section of a sand

filter is shown in Figure 115.9.

#### 115.4.8 Other Structural BMPs

Constructed wetlands, porous pavements and other structural BMPs for which detailed design criteria can be documented in generally accepted literature can be provided in addition to, or in lieu of, the BMPs described above, provided the objectives of this section can be met. The use of infiltration basins and trenches is discouraged due to possible adverse impacts on groundwater.

### **115.5 OPERATION AND MAINTENANCE**

Greene County provides no maintenance of water quality BMPs located on private property. Maintenance must be provided by the owner of the property upon which the BMP is located.

Extended detention basins and wetlands or other “capture and storage” BMPs shall be located within a single lot or property, within a designated drainage easement. Where BMPs are located in common areas or adjoining off-site areas, the property upon which the BMP is located shall remain in the ownership of the developer or property owners’ association.

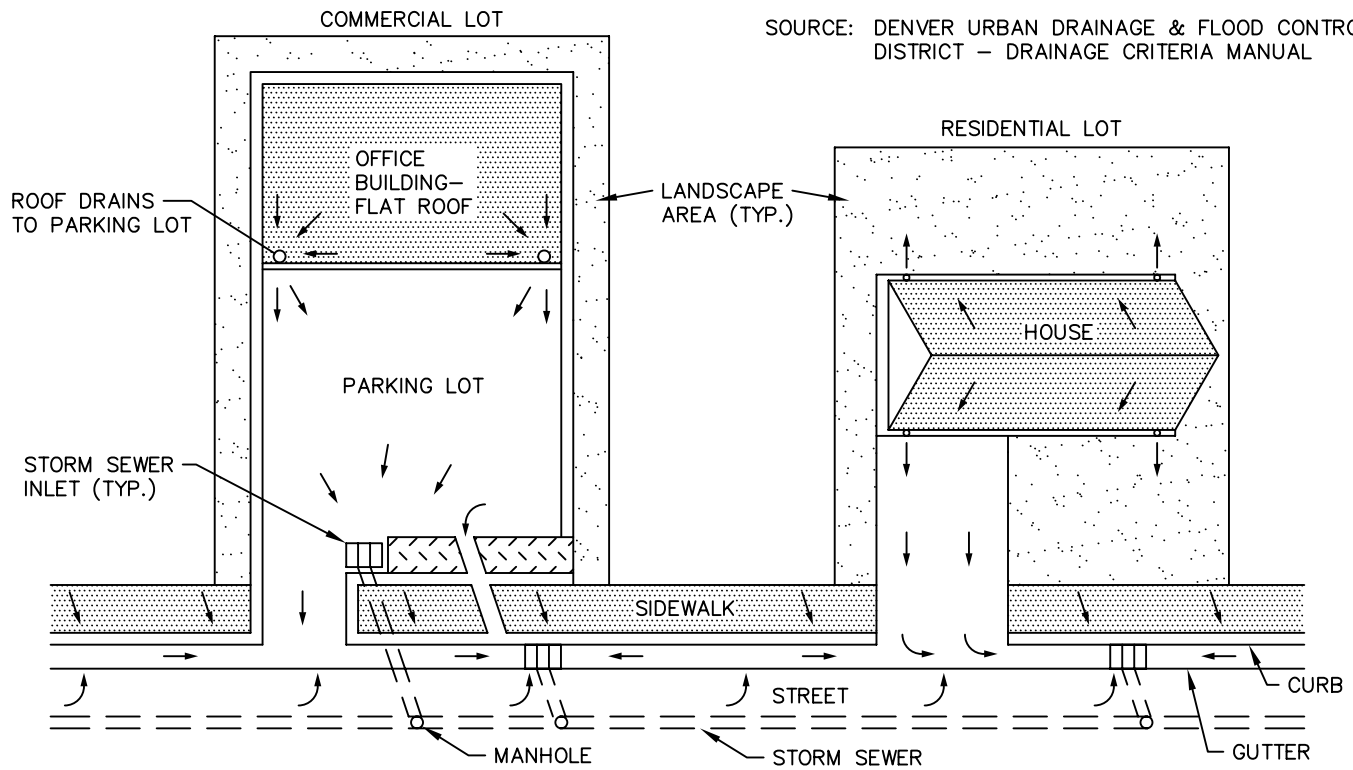
Where a property owners’ association is formed, restrictive covenants which provide for collection of fees for maintenance of the BMPs shall be filed in the office of the Greene County Recorder of Deeds. Restrictive covenants must be approved by the County legal counselor prior to filing of the final plat.

### **115.6 REFERENCES**

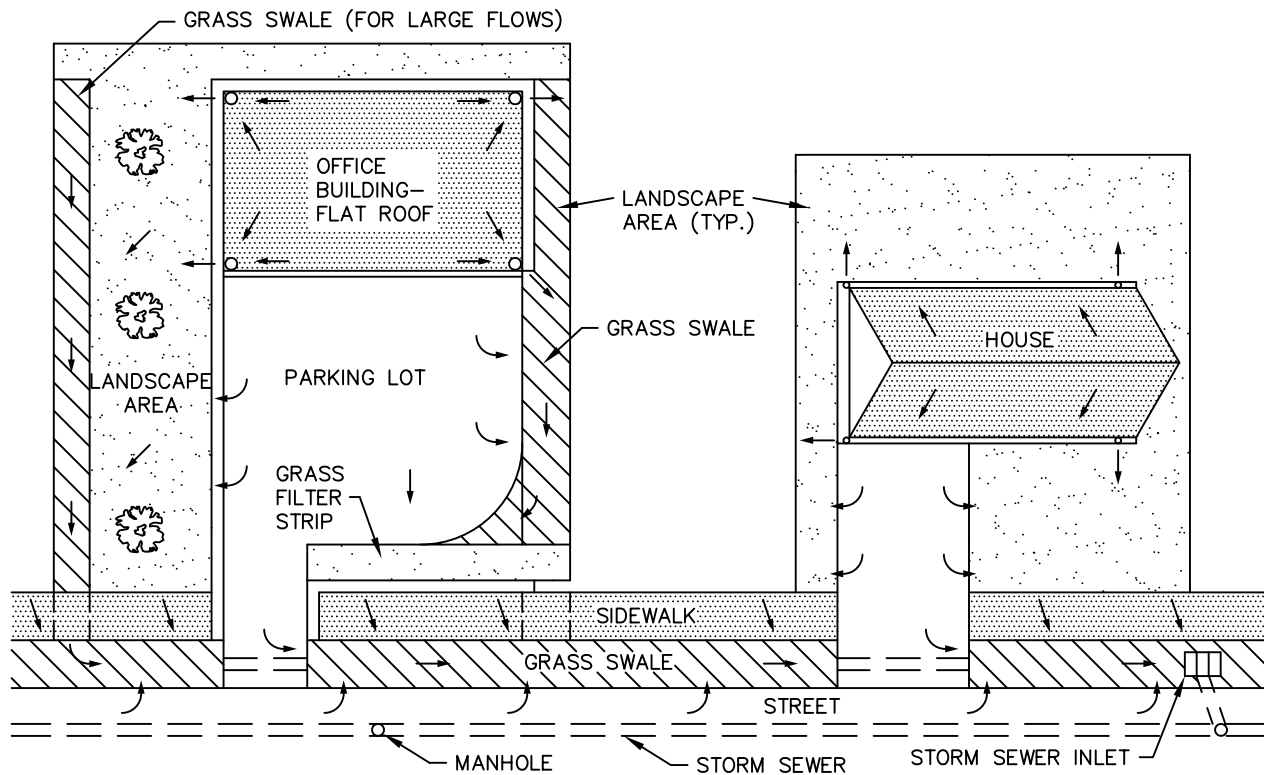
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10. U.S. Environmental Protection Agency, *Final Report of the Nationwide Urban Runoff Program, Executive Summary*, Water Planning Division, USEPA, Washington, DC, 1983.

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*TRADITIONAL SITE & STREET DRAINAGE DESIGN*



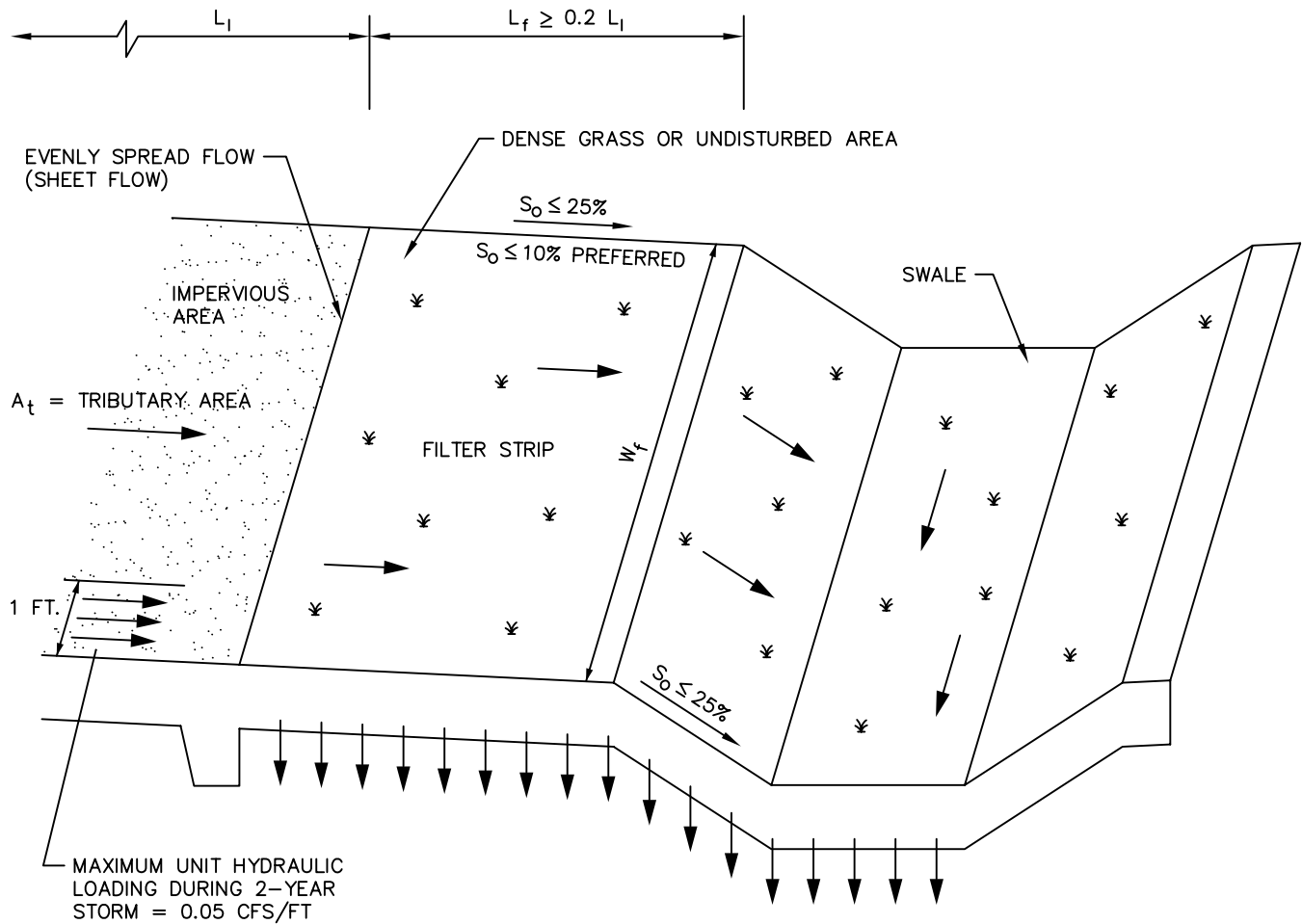
*MINIMIZING DIRECTLY CONNECTED IMPERVIOUS AREAS*

**GREENE COUNTY MISSOURI - STORM WATER DESIGN STANDARDS**

EXAMPLES OF MINIMIZING DIRECTLY  
CONNECTED IMPERVIOUS AREAS

FIGURE 115.1

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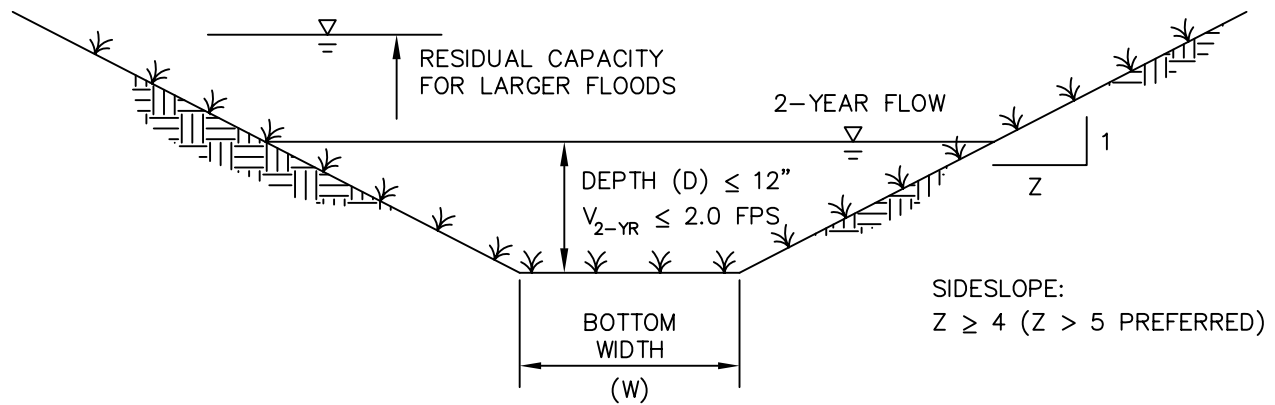
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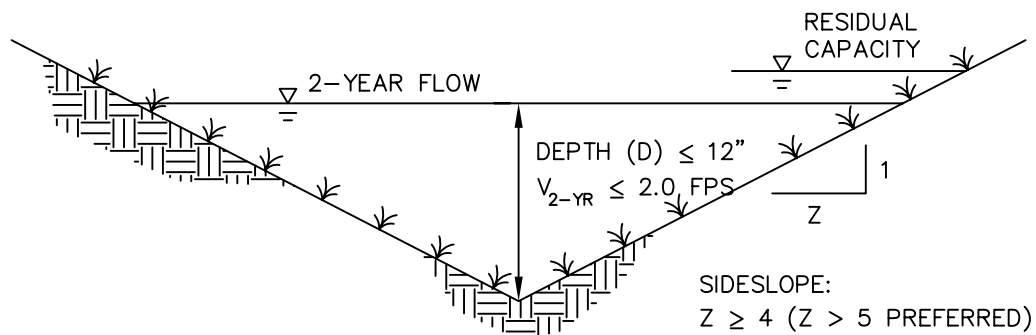
VEGETATIVE FILTER STRIP  
WATER QUALITY BMP

FIGURE 115.2

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*TRAPEZOIDAL GRASS-LINED SWALE SECTION*



*TRIANGULAR GRASS-LINED SWALE SECTION*

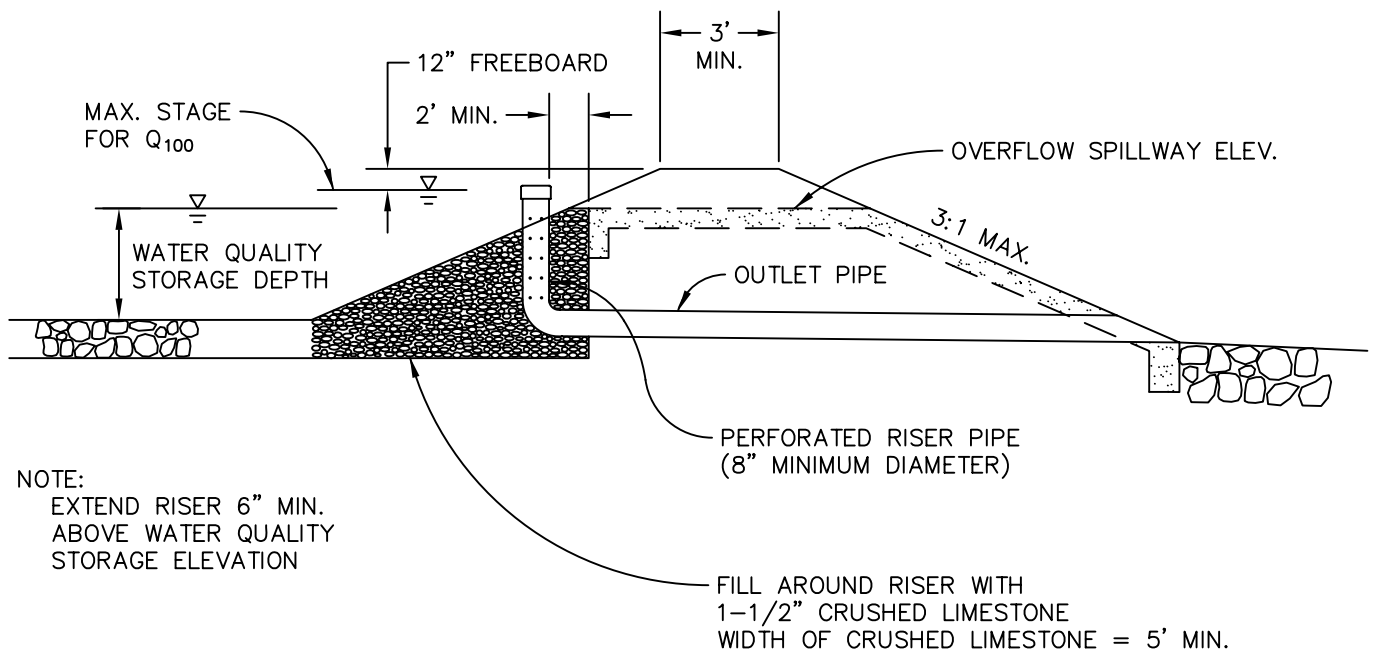
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**GREENE COUNTY MISSOURI – STORM WATER DESIGN STANDARDS**

GRASS SWALE  
 WATER QUALITY BMP

**FIGURE 115.3**

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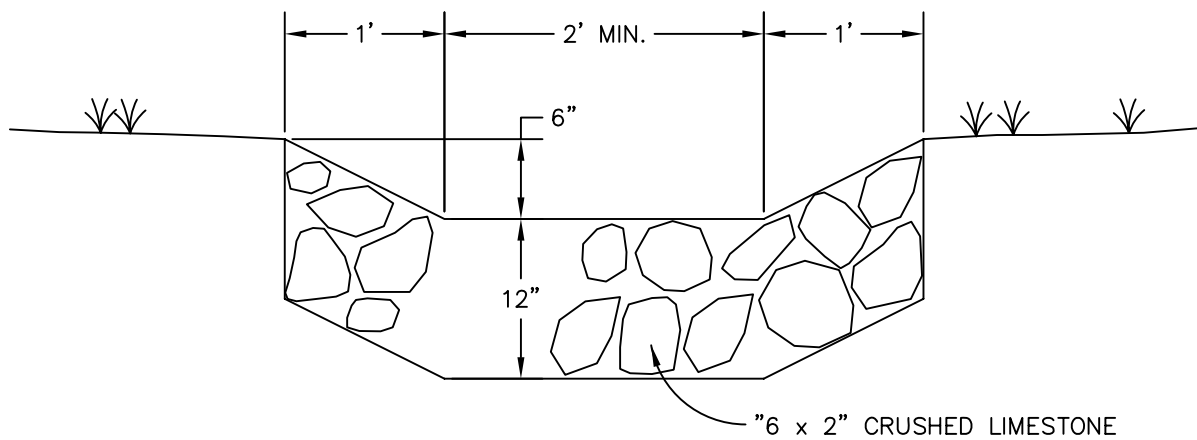


**GREENE COUNTY MISSOURI – STORM WATER DESIGN STANDARDS**

EXTENDED DRY DETENTION  
DAM & OUTLET CONFIGURATION  
WATER QUALITY BMP

**FIGURE 115.4**

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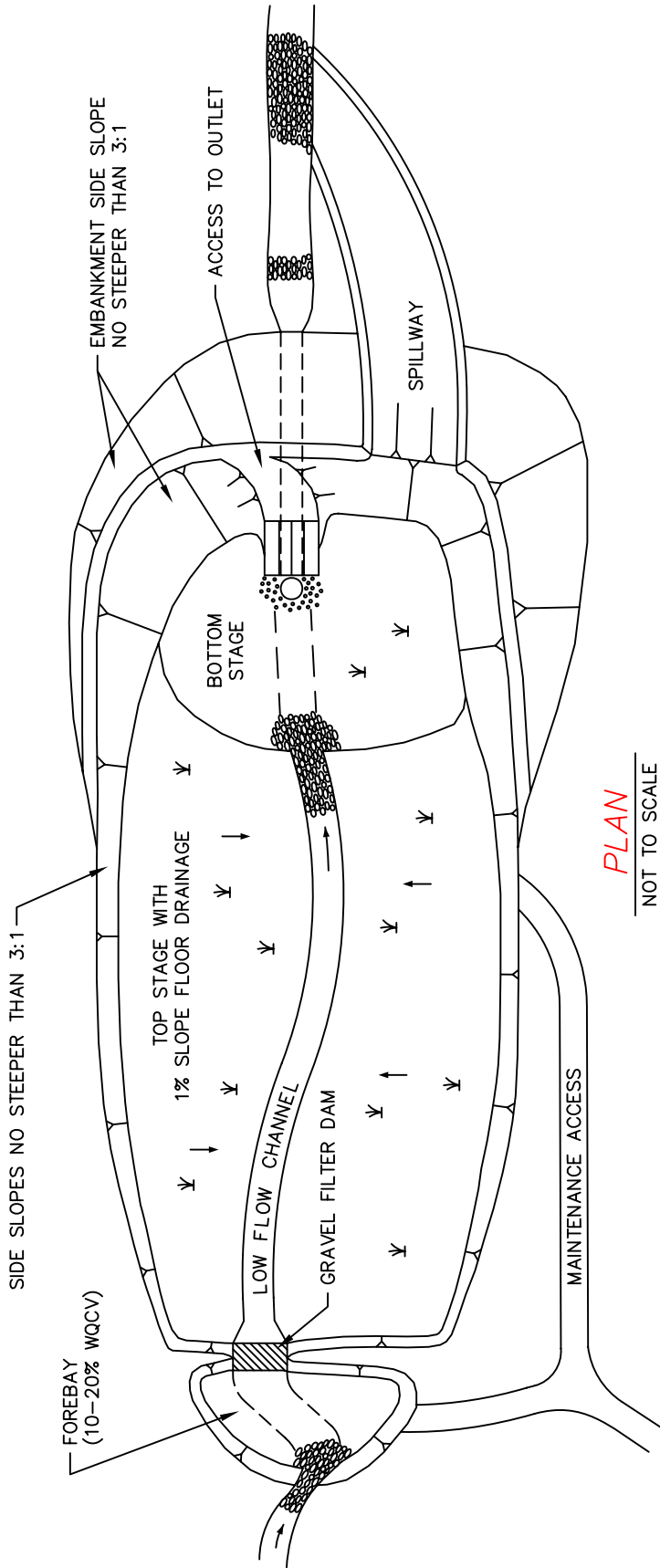
**GREENE COUNTY MISSOURI – STORM WATER DESIGN STANDARDS**

TRICKLE CHANNEL FOR EXTENDED DRY  
 DETENTION BASINS – TYPICAL CROSS-SECTION  
 WATER QUALITY BMP

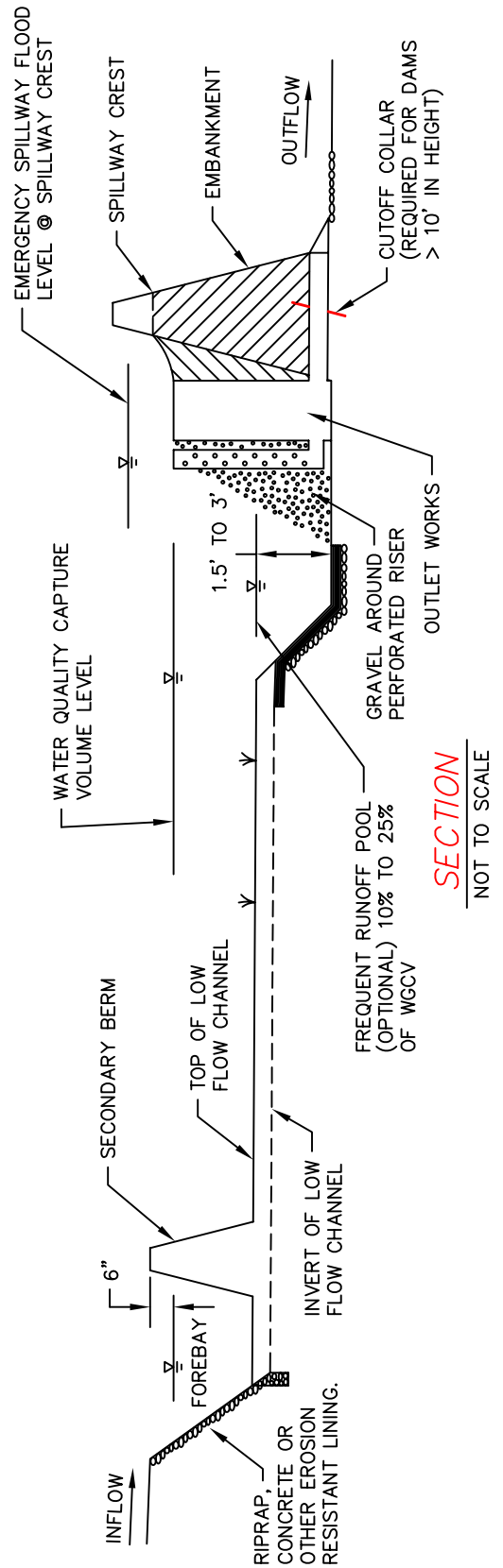
**FIGURE 115.5**

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**SECTION**  
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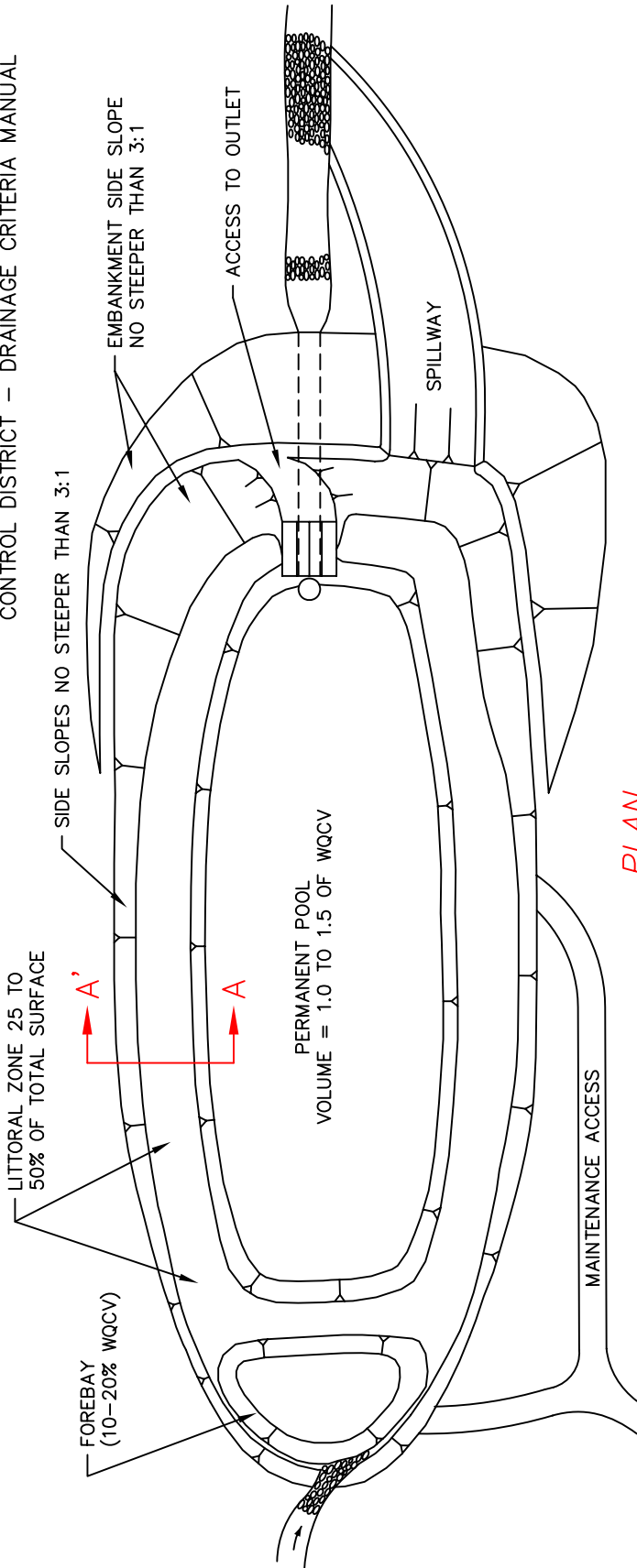
**GREENE COUNTY MISSOURI - STORM WATER DESIGN STANDARDS**

SCHMATIC PLAN AND SECTION OF A DRY EXTENDED DETENTION BASIN

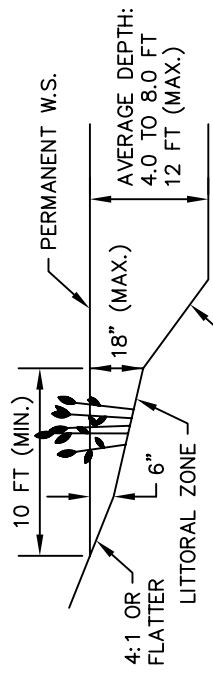
**FIGURE 115.6**

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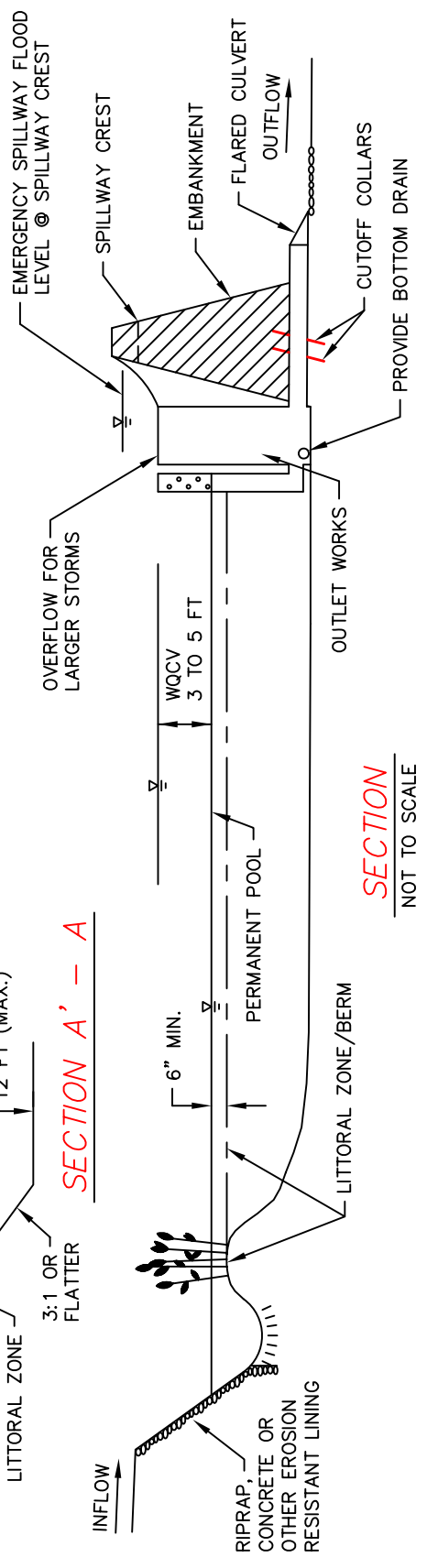
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**SECTION A' - A**



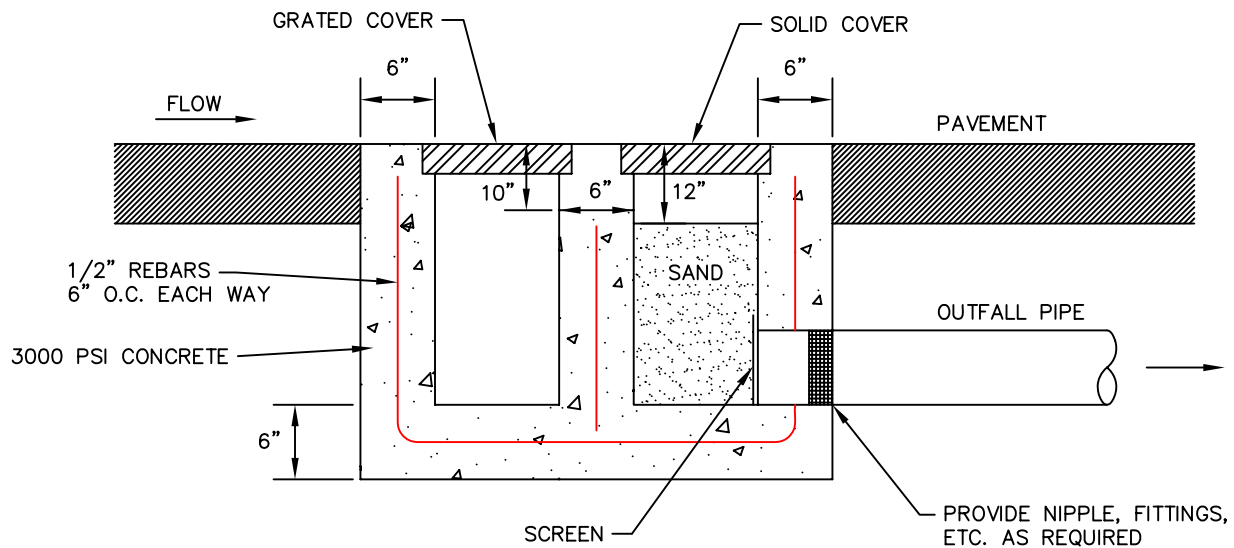
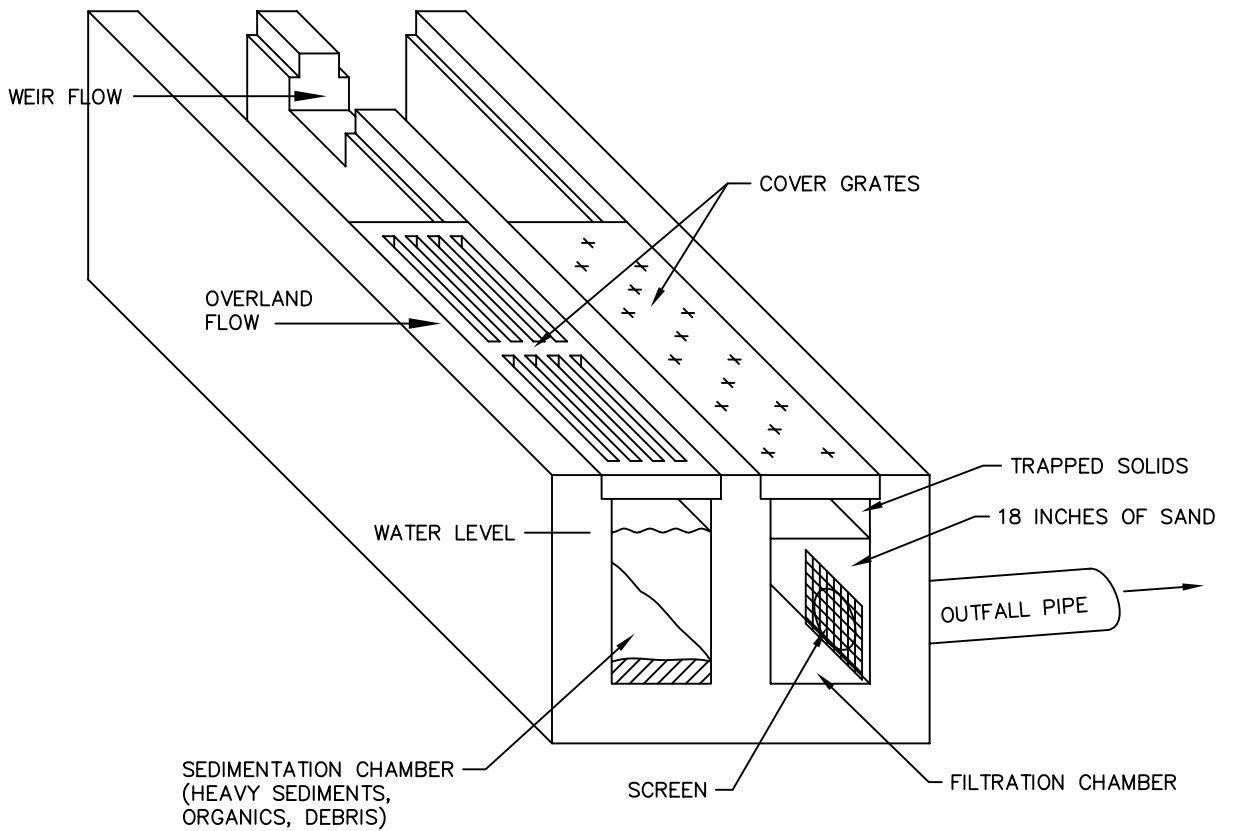
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**GREENE COUNTY MISSOURI - STORM WATER DESIGN STANDARDS**

SCHMATIC PLAN AND SECTION OF A WET EXTENDED DETENTION BASIN

**FIGURE 115.7**

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**GREENE COUNTY MISSOURI – STORM WATER DESIGN STANDARDS**

**SAND FILTER SCHEMATIC**

**FIGURE 115.8**

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