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iSWM Post-Construction Water Quality

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North Central Texas Council of Governments

iSWM

Agenda

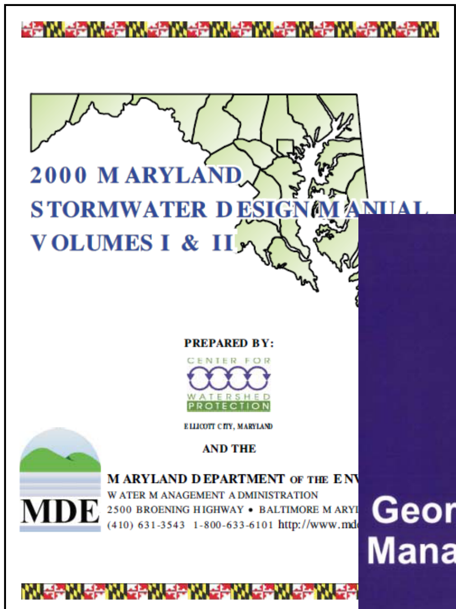
- **Overview of the iSWM Program**
- **Water Quality Options**
- **iSWM Applicability**
- **Stormwater Control Criteria**
- **BMPs in Use Around the Region**
- **Future Direction of Water Quality??**

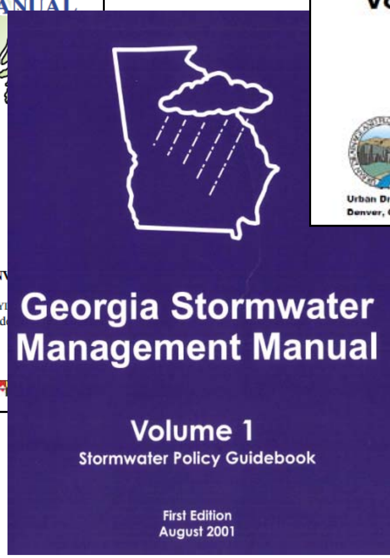
Why Do I Care About Water Quality?

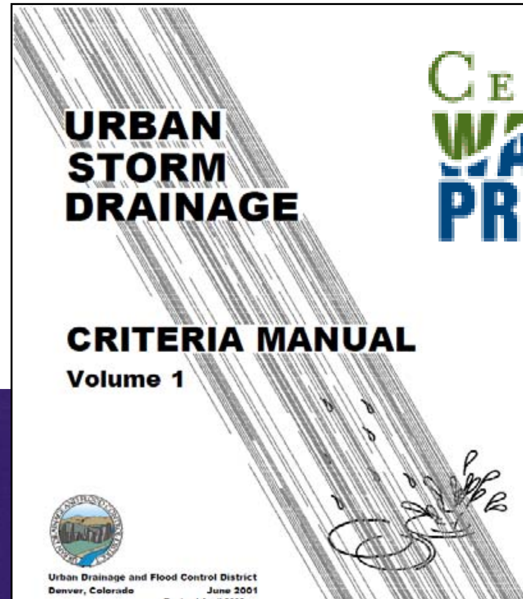
TCEQ

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

How Does iSWM Help?







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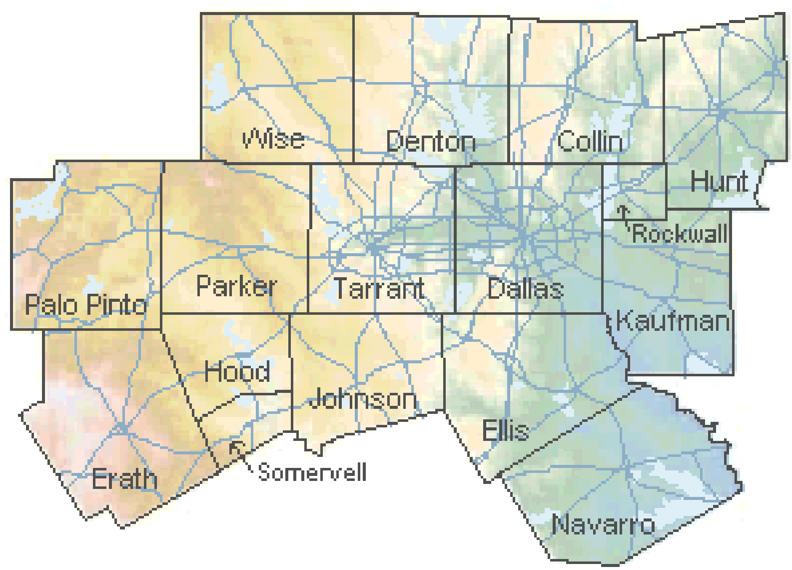


Overview of iSWM Program

NCTCOG

↓

FREESE AND NICHOLS TEAM*

iSWM Implementation Committee (IIC)

↓

iSWM

*Consultant Team included:

- Andy Reese
- Karen Walz
- Katrina Martich
- Jonathon Young
- Dr. James Caffey

Overview of iSWM Program

http://iswm.nctcog.org

iSWM Criteria Manual

iSWM Technical Manual

iSWM Program

iSWM Tools

iSWM Program Guidance

Overview of iSWM Program

Page 4 of Criteria Manual

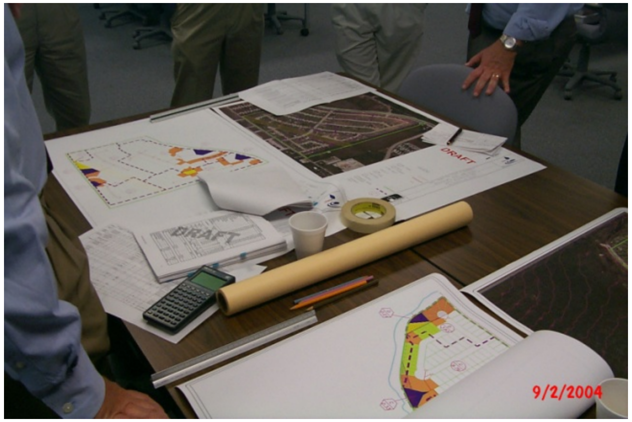
Site design should utilize an integrated approach to deal with **stormwater quality** protection, **streambank protection**, and **flood control** requirements.

Overview of iSWM Program

Page 8-13 and 69-79 of Criteria Manual

Development Process:

- Move the discussion of stormwater to the forefront of the process
  - Concept
  - Preliminary
  - Final



- Encourage innovative approaches
- Checklists generated and included in Criteria Manual

Overview of iSWM Program

Water Quality * Streambank Protection * Flood Control

Options:

1. Use *integrated* Site Design Practices. Measured with a point system based on the percentage of natural features on a site and the percentage of practice utilized.

2. Treat the runoff resulting from rainfalls of up to 1.5 inches (85th percentile storm).

3. Assist in implementing off-site community stormwater pollution prevention programs/activities.

Overview of iSWM Program

Page 6 of Criteria Manual

Water Quality * **Streambank Protection** * Flood Control

Options:

1. Reinforce/stabilize downstream conditions.

2. Install stormwater controls to maintain or improve existing downstream conditions.

3. Provide on-site controlled release of the 1-year, 24-hour storm event over a period of 24 hours.

Overview of iSWM Program

Page 6 of Criteria Manual

Water Quality * Streambank Protection * **Flood Control**

Options:

1. Provide adequate downstream conveyance systems.

2. Install stormwater controls on-site to maintain or improve existing downstream conditions.

3. Maintain existing on-site runoff conditions in lieu of a downstream assessment.

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Overview of iSWM Program

Page 5 and 26 of Criteria Manual

Downstream Assessments

Changes in flow timing must be considered when installing detention controls. If placed on the downstream end of a watershed may be holding back flows till the upstream peak reaches it. Study may show that detention is not necessary.

Where to study to?

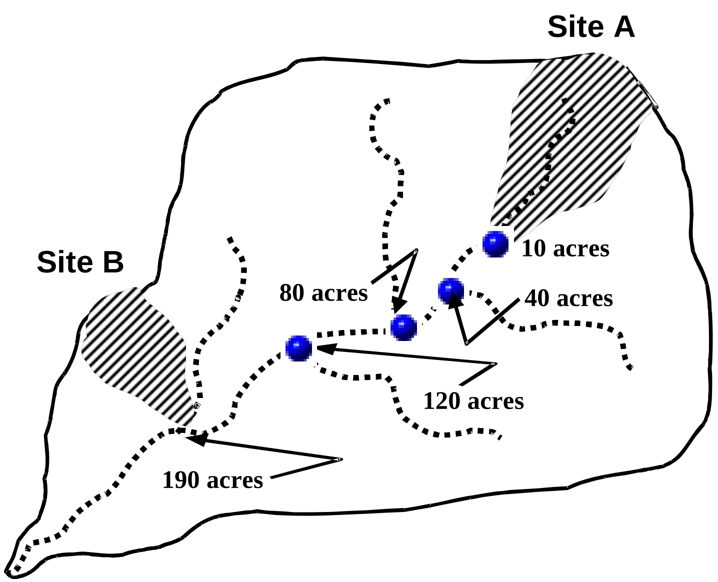
- Zone of Influence (10% Rule)
- Adequate Outfall

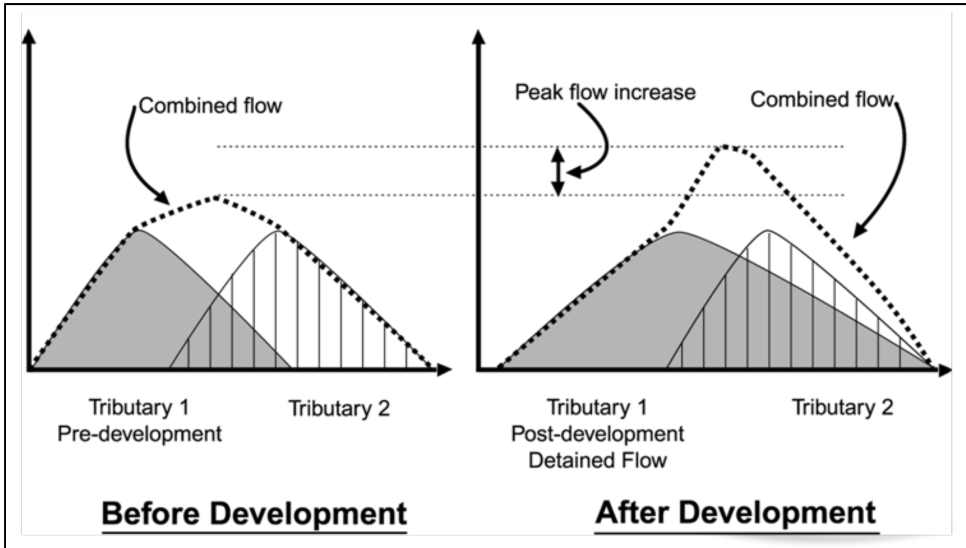
3 Storm events:

Streambank Protection: 1-yr

Conveyance Storm: 25-yr

Flood Mitigation Storm: 100-yr





Overview of iSWM Program

Page 25 of Criteria Manual

Table 3.6 Suitability of Stormwater Controls to Meet *integrated* Focus Areas

Category	*integrated* Stormwater Controls	TSS/ Sediment Removal Rate	Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control
Bioretention Areas	Bioretention Areas	80%	P	S	S	-
Channels	Enhanced Swales	80%	P	S	S	S
	Channels, Grass	50%	S	S	P	S
	Channels, Open	-	-	-	P	S
Chemical Treatment	Alum Treatment System	90%	P	-	-	-
Conveyance System Components	Culverts	-	-	-	P	P
	Energy Dissipation	-	-	P	S	S
	Inlets/Street Gutters	-	-	-	P	-
	Pipe Systems	-	-	P	P	P
Detention	Detention, Dry	65%	S	P	P	P
	Detention, Extended Dry	65%	S	P	P	P
	Detention, Multi-purpose Areas	-	-	P	P	P
	Detention, Underground	-	-	P	P	P
Filtration	Filter Strips	50%	S	-	-	-
	Organic Filters	80%	P	-	-	-
	Planter Boxes	80%	P	-	-	-
	Sand Filters, Surface/Perimeter	80%	P	S	-	-
	Sand Filters, Underground	80%	P	-	-	-
Hydrodynamic Devices	Gravity (Oil-Grit) Separator	40%	S	-	-	-
Infiltration	Downspout Drywell	80%	P	-	-	-
	Infiltration Trenches	80%	P	S	-	-
	Soakage Trenches	80%	P	S	-	-
Ponds	Wet Pond	80%	P	P	P	P
	Wet ED Pond	80%	P	P	P	P
	Micropool ED Pond	80%	P	P	P	P
	Multiple Ponds	80%	P	P	P	P
Porous Surfaces	Green Roof	85%	P	S	-	-
	Modular Porous Paver Systems	[2]	S	S	-	-
	Porous Concrete	[2]	S	S	-	-
Proprietary Systems	Proprietary Systems[1]	[1]	S/P	S	S	S
Re-Use	Rain Barrels	-	P	-	-	-
Wetlands	Wetlands, Stormwater	80%	P	P	P	P
	Wetlands, Submerged Gravel	80%	P	P	S	-

Controls can be used to meet multiple objectives.

P = Primary

S = Secondary

Water Quality Options in iSWM

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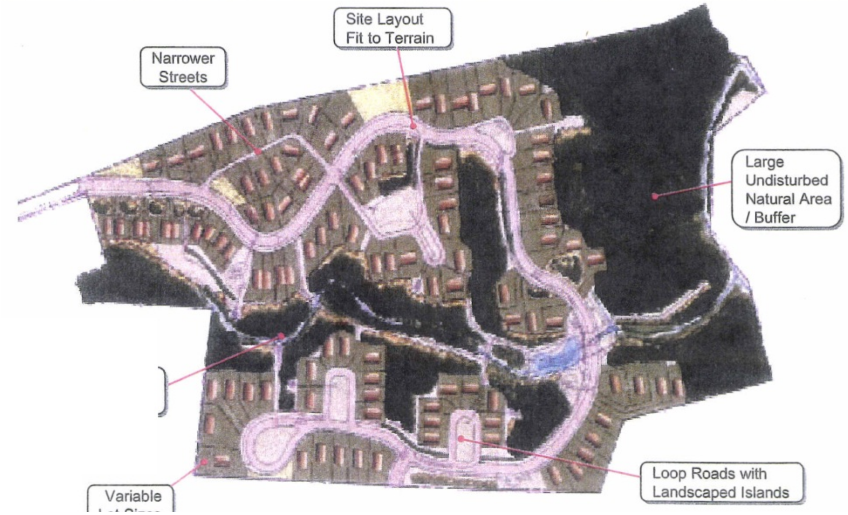
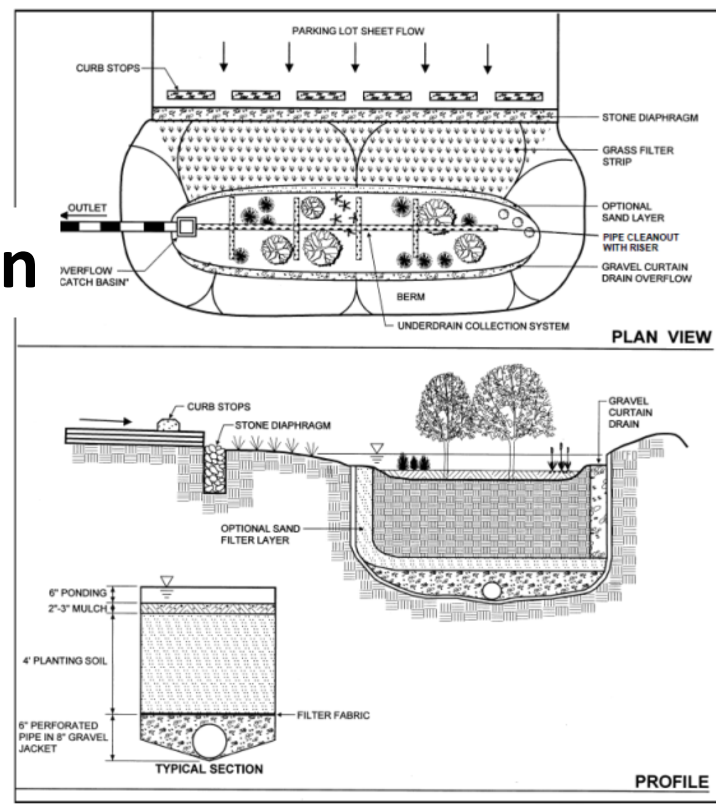
Options in iSWM

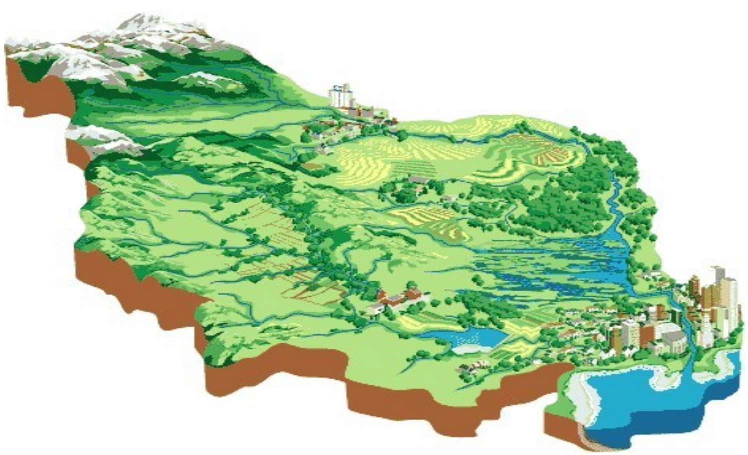
Option 1: Use *integrated* Site Design Practices



Option 2: Treat the WQ_v



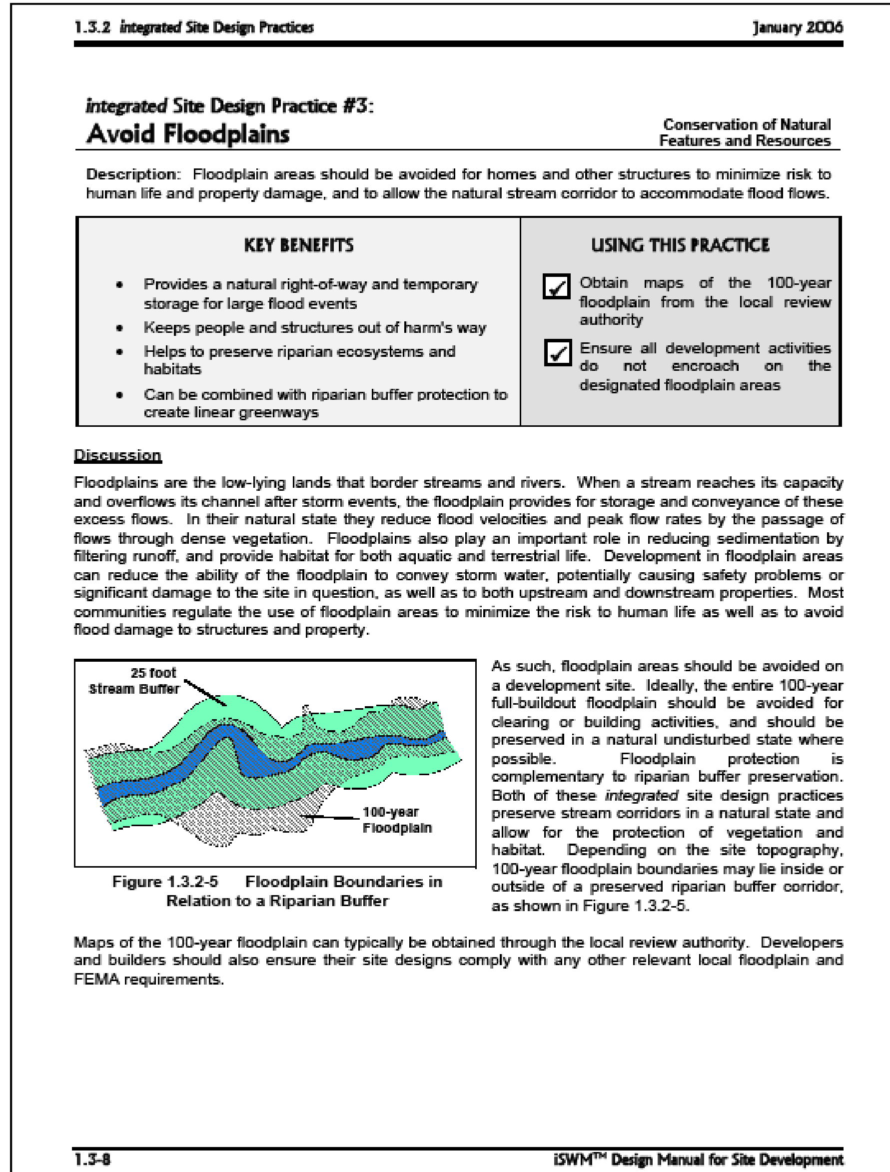
Option 3: Participate in Watershed Plan



Option 1: *integrated* Site Design

Page 17-22 of Criteria Manual

- Conservation of Natural Features and Resources
- Lower Impact Site Design Techniques
- Reduction of Impervious Cover
- Utilization of Natural Features for Storm Water Management



1.3.2 *integrated* Site Design Practices — January 2006

integrated Site Design Practice #3:
Avoid Floodplains

Conservation of Natural Features and Resources

Description: Floodplain areas should be avoided for homes and other structures to minimize risk to human life and property damage, and to allow the natural stream corridor to accommodate flood flows.

KEY BENEFITS	USING THIS PRACTICE
• Provides a natural right-of-way and temporary storage for large flood events • Keeps people and structures out of harm's way • Helps to preserve riparian ecosystems and habitats • Can be combined with riparian buffer protection to create linear greenways	☑ Obtain maps of the 100-year floodplain from the local review authority ☑ Ensure all development activities do not encroach on the designated floodplain areas

Discussion

Floodplains are the low-lying lands that border streams and rivers. When a stream reaches its capacity and overflows its channel after storm events, the floodplain provides for storage and conveyance of these excess flows. In their natural state they reduce flood velocities and peak flow rates by the passage of flows through dense vegetation. Floodplains also play an important role in reducing sedimentation by filtering runoff, and provide habitat for both aquatic and terrestrial life. Development in floodplain areas can reduce the ability of the floodplain to convey storm water, potentially causing safety problems or significant damage to the site in question, as well as to both upstream and downstream properties. Most communities regulate the use of floodplain areas to minimize the risk to human life as well as to avoid flood damage to structures and property.

Figure 1.3.2-5 Floodplain Boundaries in Relation to a Riparian Buffer

As such, floodplain areas should be avoided on a development site. Ideally, the entire 100-year full-buildout floodplain should be avoided for clearing or building activities, and should be preserved in a natural undisturbed state where possible. Floodplain protection is complementary to riparian buffer preservation. Both of these *integrated* site design practices preserve stream corridors in a natural state and allow for the protection of vegetation and habitat. Depending on the site topography, 100-year floodplain boundaries may lie inside or outside of a preserved riparian buffer corridor, as shown in Figure 1.3.2-5.

Maps of the 100-year floodplain can typically be obtained through the local review authority. Developers and builders should also ensure their site designs comply with any other relevant local floodplain and FEMA requirements.

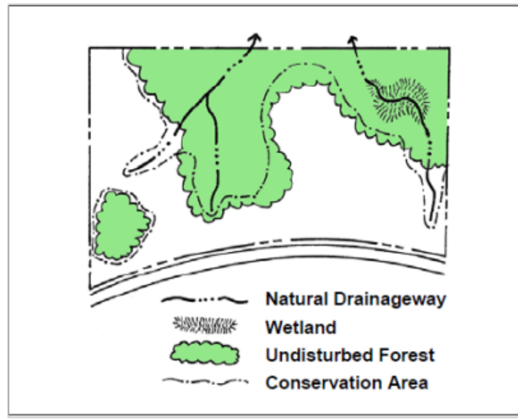
1.3-8 — iSWM™ Design Manual for Site Development

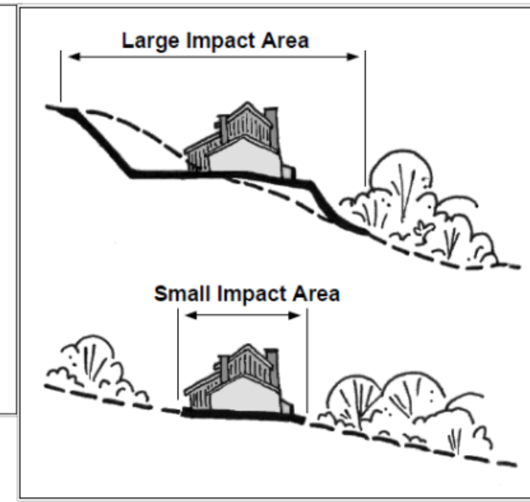
Option 1: *integrated* Site Design

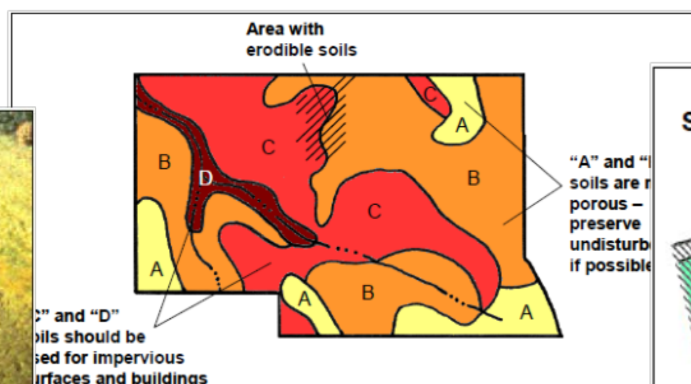
Page 17-22 of Criteria Manual

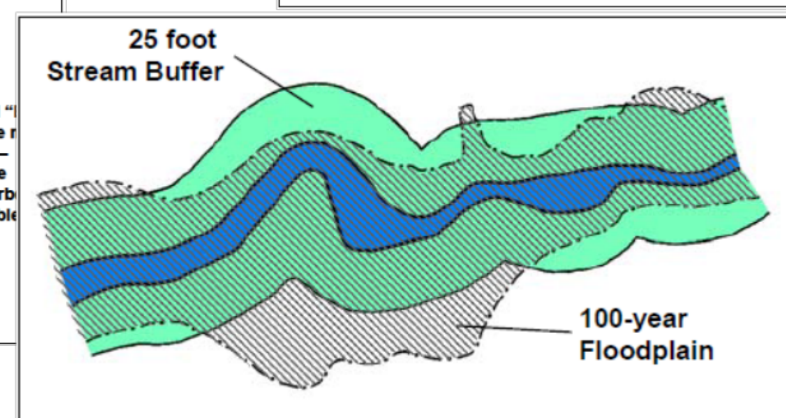
Conservation of Natural Features and Resources

- Preserve undisturbed natural areas
- Preserve riparian buffers
- Avoid floodplains
- Avoid steep slopes
- Minimize siting on porous soil





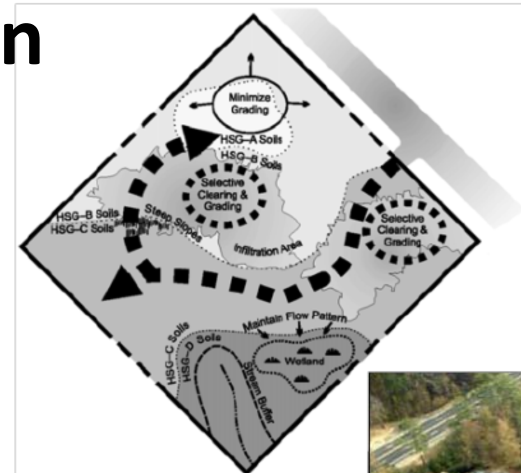


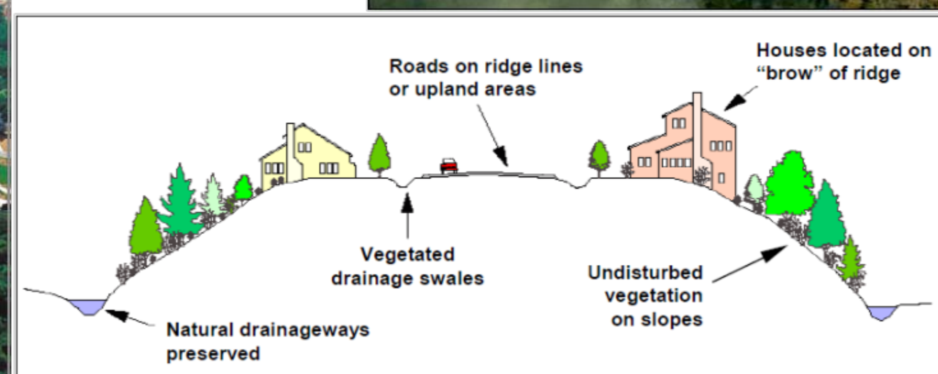


Option 1: *integrated* Site Design

Lower Impact Site Design

- Fit design to terrain
- Locate development in less sensitive area
- Reduce limits of clearing and grading
- Utilize open space development
- Consider creative designs



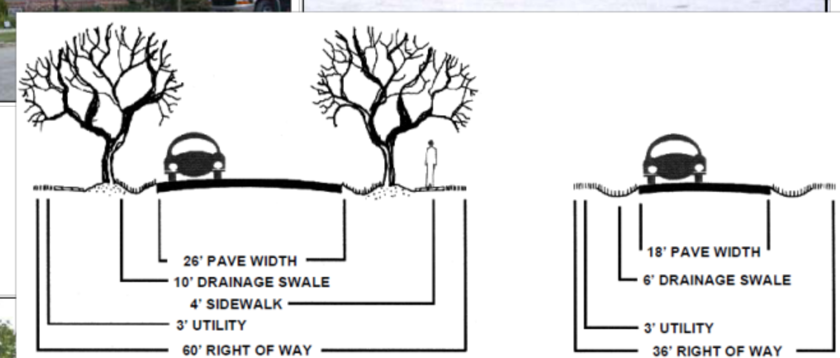


Option 1: *integrated* Site Design

Page 17-22 of Criteria Manual

Reduction of Impervious Cover

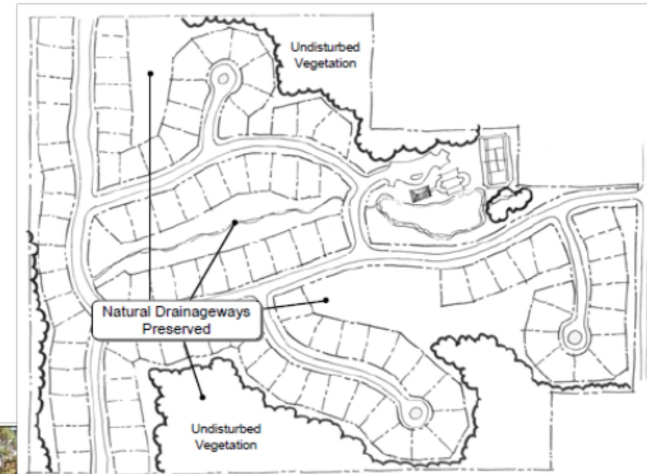
- Reduce roadway lengths and widths
- Reduce building footprints
- Reduce the parking footprint
- Reduce setbacks and frontages
- Use fewer or alternative cul-de-sacs
- Create parking lot “stormwater” islands

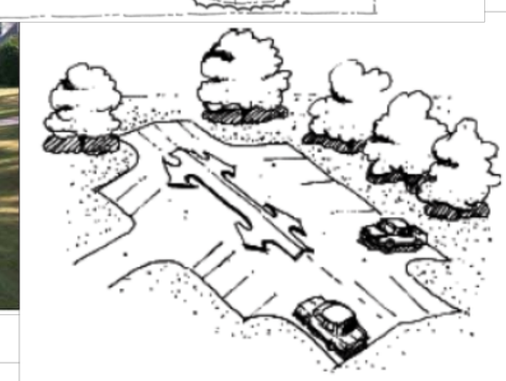


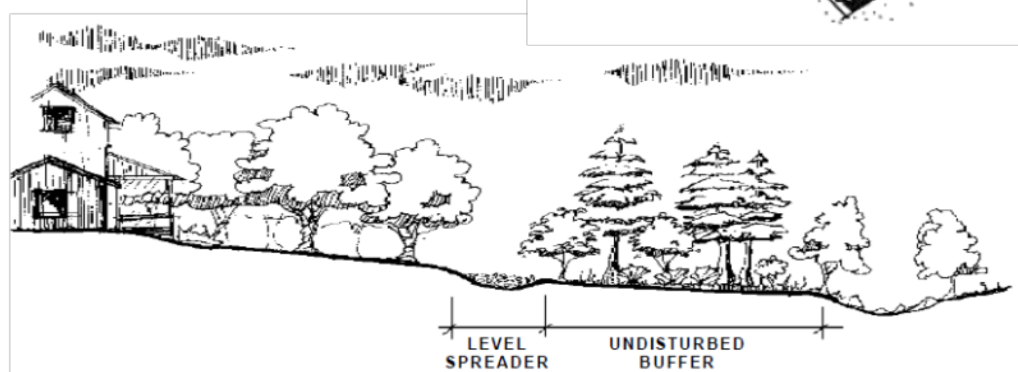
Option 1: *integrated* Site Design

Utilization of Natural Features

- Use buffers and undisturbed natural areas
- Use natural drainageways instead of storm sewers
- Use vegetated swales instead of curb and gutter
- Drain rooftop runoff to pervious areas.







Option 1: *integrated* Site Design

Page 17-22 of Criteria Manual

- Setting Criteria to Site Design Practices

Table 3.4 *integrated* Site Design Point Requirements		
Percentage of Site(by Area) with Natural Features Prior to Proposed Development	**Minimum Required Points for Water Quality Protection (WQP)**	**Additional Points Above WQP for Development Incentives**
> 50%	50	10 points each
20 - 50%	30	10 points each
< 20%	20	10 points each

Natural Features:

- Unfilled floodplain
- Stand of trees, forests
- Established vegetation
- Steep sloped terrain
- Creeks, gullies, and other natural stormwater features
- Wetland areas and ponds

Table 3.5 Point System for *integrated* Site Design Practices

iSWM Practice No.	Practice	Percent of Eligible Area Using Practice	Maximum Points	Actual Points Earned (% practice used * max. points)
Conservation of Natural Features and Resources				
1	Preserve/Create Undisturbed Natural Areas		8	
2	Preserve or Create Riparian Buffers Where Applicable		8	
3	Avoid Existing Floodplains or Provide Dedicated Natural Drainage Easements		8	
4	Avoid Steep Slopes		3	
5	Minimize Site on Porous or Erodible Soils		3	
Lower Impact Site Design				
6	Fit Design to the Terrain		4	
7	Locate Development in Less Sensitive Areas		4	
8	Reduce Limits of Clearing and Grading		6	
9	Utilize Open Space Development		8	
10	Incorporate Creative Design (e.g. Smart Growth, LEED Design, Form Based Zoning)		8	
Reduction of Impervious Cover				
11	Reduce Roadway Lengths and Widths		4	
12	Reduce Building Footprints		4	
13	Reduce the Parking Footprint		5	
14	Reduce Setbacks and Frontages		4	
15	Use Fewer or Alternative Cul-de-Sacs		3	
16	Create Parking Lot Stormwater "Islands"		5	
Utilization of Natural Features				
17	Use Buffers and Undisturbed Areas		4	
18	Use Natural Drainageways Instead of Storm Sewers		4	
19	Use Vegetated Swale Design		3	
20	Drain Runoff to Pervious Areas		4	
	Subtotal – Actual site points earned		**100**	
	Subtract minimum points required (Table 3.4)		-	
	Points available for development incentives			
	Add 1 point for each 1% reduction of impervious surface		+	
	Total Points for Development Incentives			

Option 1: *integrated* Site Design

- Common Issues with Site Design Practices
  - Defining natural features
  - Counting double for points
  - Less points available for redevelopment
  - Does new development get points for reducing impervious area? Reduction from what?
  - Changing ordinances to allow practices to be used

Option 1: *integrated* Site Design

Page 17-22 of Criteria Manual

- Preferred Method So Incentives Given Where Minimum Points Are Exceeded
  - Narrower pavement width for minor arterials
  - Use of vegetated swales in lieu of curb and gutter
  - Reduced ROW requirements
  - Increased density in buildable area
  - Expedited plan reviews
  - Waiver or reduction of fees
  - Waiver of maintenance, public maintenance

Option 1: *integrated* Site Design

- Incentives in Practice
  - Requires a lot of editing to existing ordinances
  - Could possibly require variances
- Other incentives
  - Reduction in stormwater utility fee based on impervious area draining to BMP
  - Up to 10% reduction in minimum parking requirements
  - Allowing up to 50% of interior landscaping requirements to be moved to the perimeter

Option 1: *integrated* Site Design

Things to consider when implementing Option 1

- Do you have GIS data that can quantify natural features?
- Are there any point system items that need to be removed or replaced?
- Do your ordinances allow the use of incentives or the site design practices to be implemented?

Option 1: *integrated* Site Design

integrated Site Design Exercise

Click here for the Training Exercise on application of *integrated* Site Design Point System

Option 2: Treat the WQ_v

Page 22-25 of Criteria Manual

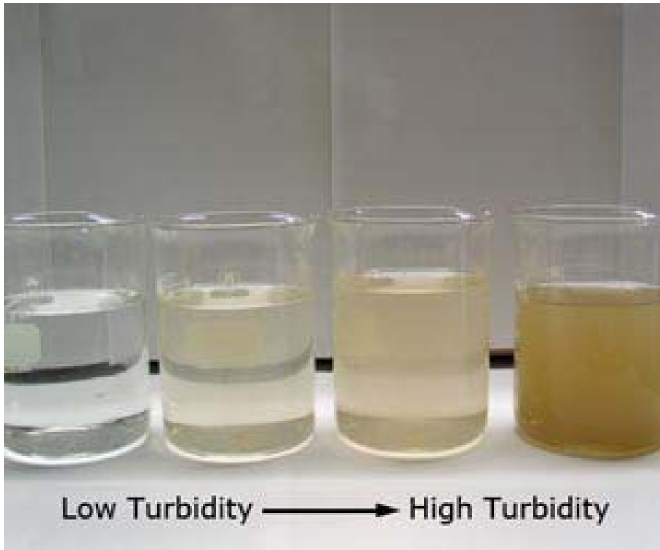
Treating the Water Quality Protection (WQv) Volume

- Use Site Development (stormwater) controls to treat the runoff resulting from a rainfall of 1.5 inches (85th percentile storm)
- Why 85th Percentile?
  - Several entities nation wide chose the 85th percentile storm. It indicates the runoff volume from a storm event that is greater than 85% of the storms that occur in an average year.
- How was 1.5" calculated?
  - In 2003 precipitation data for North Texas was obtained from NOAA and the 85th percentile was calculated as 1.5 inches.

Option 2: Treat the WQ_v

Page 22-25 of Criteria Manual

- Site Development controls are used to reduce pollutants in runoff
  - **Total Suspended Solids (TSS)**
  - Total Phosphorus (TP)
  - Total Nitrogen (TN)
  - Bacteria
  - Metals



Option 2: Treat the WQ_v

Page 22-25 of Criteria Manual

- Pollutant Reduction Goals
  - The most commonly used measure of treatment effectiveness is TSS.
  - EPA guidance and other local and statewide agencies have set a TSS reduction goal of 80%.
  - All “Primary” Site Development controls in iSWM achieve a TSS reduction rate of 80% or more.

Option 2: Treat the WQ_v

Page 22-25 of Criteria Manual

- iSWM Technical Manual contains design criteria, schematic drawings & maintenance info for Site Development controls
  - Bioretention
  - Enhanced swales
  - Filter strips
  - Detention basins
  - Wet ponds
  - Porous surfaces
  - Green Roofs
  - Others

Option 2: Treat the WQ_v

- How to Calculate the Water Quality Protection Volume

1. Calculate the volumetric runoff coefficient

$$R_v = 0.05 + 0.009(I)$$

where I = percent of impervious cover (%)

2. Calculate the water quality volume (WQ_v)

$$WQ_v = \frac{1.5\, R_v\, A}{12}$$

where:

WQ_v = water quality protection volume (acre-feet)

R_v = volumetric runoff coefficient

A = total drainage area (acres)

Option 2: Treat the WQ_v

- How to Calculate the Water Quality Peak Discharge (Q_{wq}) for Off-Line Controls

The equation to calculate the water quality peak discharge is shown below (Q_{wq})

$$Q_{wq} = q_u * A * Q_{wv}$$

where:

q_u = unit peak discharge (cfs/mi^2/in) (Figure 1.10 of Hydrology Manual)

A = drainage area (mi^2)

Q_{wv} = water quality volume in inches (in) = 1.5 * R_v

Option 2: Treat the WQ_v

- To calculate q_u, need I_a

1. Calculate the corresponding curve number (CN)

$$CN = 1000/[10 + 5P + 10Q_{wv} - 10(Q_{wv}^2 + 1.25Q_{wv}P)^{1/2}]$$

where:
P = rainfall in inches (1.5)
Q_{wv} = water quality volume in inches (in) = 1.5 * R_v

2. Calculate the maximum potential abstraction (S) using CN

$$S = 1000/CN - 10$$

3. Calculate the initial abstraction (I_a) in inches

$$I_a = 0.2 * S$$

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Option 2: Treat the WQ_v

How to use Figure 1.10:

1. Calculate Time of Concentration
2. Calculate I_a/P
   - where P = 1.5 inches
3. Interpolate graph if necessary to determine q_u

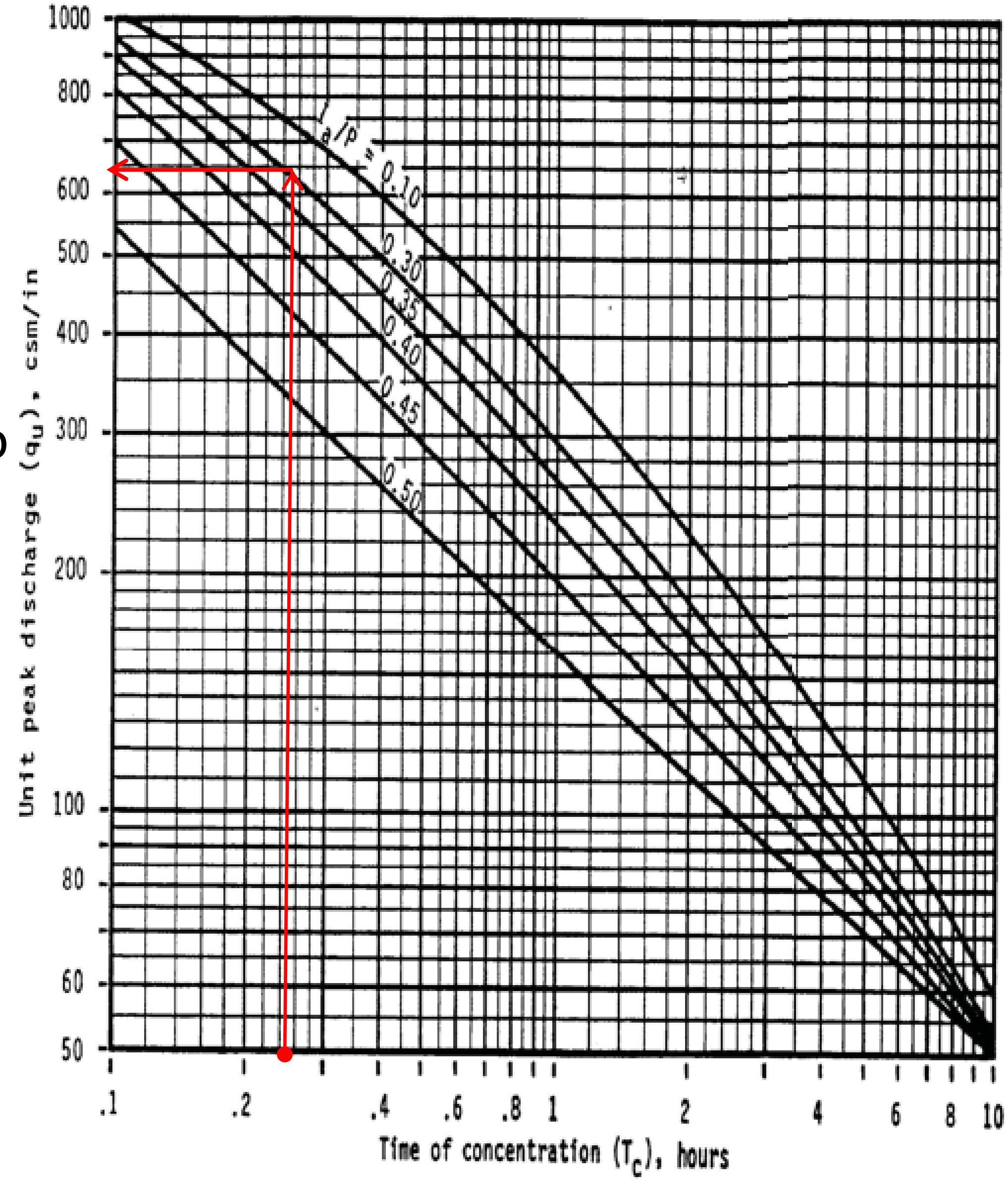
Example:

Tc = 15 min. (0.25 hrs)

Ia/P = 0.30

q_u = 645 cfs/mi²/in

$$Q_{wq} = q_u * A * Q_{wv}$$



Option 2: Treat the WQ_v

Water Quality Protection Volume Exercise

Click here for the Training Exercise on calculation of the WQ_v

Option 2: Treat the WQ_v

Pros and Cons of Option 2

Pro

- Quantifiable, easy to calculate requirements
- Can set treatment requirement based on city's needs

Con

- Limited flexibility
- Future maintenance issues
- Lack of design experience in the region

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Option 3: Off-Site Activities

Page 26 of Criteria Manual

- Goal of this option is to allow developers to assist with off-site pollution prevention programs if available.
- Off-site programs can be useful in treating intensely urbanized areas.

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Option 3: Off-Site Activities

- Not many cities in the state have an organized watershed based water quality plan.
- Water Quality Master Plans will be required in the future for cities to use this plan.
- Other Alternative
  - Some cities without a plan have chosen to allow multiple sites to participate in a collective water quality plan to provide more options.

Option 3: Off-Site Activities

- Around the Country
  - WQ "Banking" of volume for treatment
    e.g. City creates excess capacity to sell or bank of available projects to buy into
  - Public-private partnerships
    e.g. City donates ROW and developer builds structure
  - Incentives for private investment for a public good
    e.g. Grants and credits if capacity created to meet a public compliance requirement or help impaired stream
  - Off-site within a sub-watershed without a plan
    e.g. Simple treatment volume calculation trade

Option 3: Regional Approach

Pros and Cons of Option 3

Pro

- Can help City pay for watershed water quality plans
- Useful in intensely urbanized areas

Con

- Few cities have developed watershed plan
- Will take significant funds to create a water quality master plan

Option Overview

Water Quality Option	Pro	Con
Option 1: Use Site Design Practices	• Promotes better site design • Reduces size requirements of controls	• Possible subjectivity in point system • Existing ordinances will need to be modified • Can be difficult for redevelopment
Option 2: Treat 1.5" Rainfall	• Easy to calculate requirements • Can set treatment requirement based on city's needs	• Limited flexibility • Future maintenance burdens • Lack of design experience in the region
Option 3: Participate in Regional Plan	• Can help City pay for regional water quality plans • Useful in intensely urbanized areas	• Few cities have developed a regional plan • Will take significant funds to create a water quality master plan

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iSWM Applicability

North Central Texas Council of Governments

iSWM

Who is Applicable?

Page 2 of Criteria Manual

- iSWM Applicability

Table 1.1 iSWM Applicability	
Applicable for iSWM Site Design:	**Applicable for iSWM Construction:**
Land disturbing activity of 1 acre or more **OR** land disturbing activity of less than 1 acre where the activity is part of a common plan of development that is one acre or larger.	Land disturbing activity of 1 acre or more **OR** land disturbing activity of less than 1 acre where the activity is part of a common plan of development that is one acre or larger.

- New Development vs. Redevelopment
  - Redevelopment not specifically defined in Criteria Manual.

New Development

- Applicability of 1 acre land disturbing activity or common plan of development matches requirement set by TCEQ
- Must decide the basis of the volume of water quality that will be addressed
  - All land area that is disturbed
  - Only impervious area
  - Pre-hydrology conditions

New Development

- What is considered "existing conditions"?
  - Important for Option 1 to define when talking about existing natural features or existing impervious cover to prevent loopholes.

1. Historic aerials
2. Certain time frame
   - Criteria Manual states "If an existing site has been cleared and graded, but not developed, within **five years** of the date of the developer's initial application submittal, the developer must consider the land conditions prior to the clearing and grading to be the existing site conditions."

Redevelopment

- Based on 2006 land use maps, 25% of the North Central Texas region is developed
- Many communities are almost fully built-out; therefore any water quality benefits will come from redevelopment requirements
- Important question to ask yourself:

Do you want to make water quality better or just not make it any worse?

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Redevelopment

- **1 acre Applicability Options for Redevelopment**
  - At a minimum, 1 acre of land disturbing activity
  - Certain percentage of impervious area increase on a 1 acre lot
  - 1 acre lot and add any impervious area
- **What water quality requirements will be required?**
  - Is Option 1 available for redevelopment? May require local revisions due to limited availability of natural features.
  - Is only added impervious area subject to water quality requirements or all impervious area or all disturbed area?
  - Different requirements for redevelopment sites that have been completely scraped?

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Site Development (Stormwater) Controls Criteria and Design

North Central Texas Council of Governments

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Stormwater Control Criteria

- Primary vs. Secondary Control designation
  - For Water Quality Protection, controls are “Primary” if TSS removal rates greater than or equal to 80%

Table 3.6 Suitability of Stormwater Controls to Meet *integrated* Focus Areas

Category	*integrated* Stormwater Controls	TSS/ Sediment Removal Rate	Water Quality Protection	Streambank Protection	On-Site Flood Control	Downstream Flood Control
Bioretention Areas	Bioretention Areas	80%	P	S	S	-
Channels	Enhanced Swales	80%	P	S	S	S
	Channels, Grass	50%	S	S	P	S
	Channels, Open	-	-	-	P	S
Chemical Treatment	Alum Treatment System	90%	P	-	-	-
Conveyance System Components	Culverts	-	-	-	P	P
	Energy Dissipation	-	-	P	S	S
	Inlets/Street Gutters	-	-	-	P	-
	Pipe Systems	-	-	P	P	P
Detention	Detention, Dry	65%	S	P	P	P
	Detention, Extended Dry	65%	S	P	P	P
	Detention, Multi-purpose Areas	-	-	P	P	P
	Detention, Underground	-	-	P	P	P
Filtration	Filter Strips	50%	S	-	-	-
	Organic Filters	80%	P	-	-	-
	Planter Boxes	80%	P	-	-	-
	Sand Filters, Surface/Perimeter	80%	P	S	-	-
	Sand Filters, Underground	80%	P	-	-	-
Hydrodynamic Devices	Gravity (Oil-Grit) Separator	40%	S	-	-	-
Infiltration	Downspout Drywell	80%	P	-	-	-
	Infiltration Trenches	80%	P	S	-	-
	Soakage Trenches	80%	P	S	-	-
Ponds	Wet Pond	80%	P	P	P	P
	Wet ED Pond	80%	P	P	P	P
	Micropool ED Pond	80%	P	P	P	P
	Multiple Ponds	80%	P	P	P	P
Porous Surfaces	Green Roof	85%	P	S	-	-
	Modular Porous Paver Systems	[2]	S	S	-	-
	Porous Concrete	[2]	S	S	-	-
Proprietary Systems	Proprietary Systems [1]	[1]	S/P	S	S	S
Re-Use	Rain Barrels	-	P	-	-	-
Wetlands	Wetlands, Stormwater	80%	P	P	P	P
	Wetlands, Submerged Gravel	80%	P	P	S	-

Stormwater Control Criteria

- Factors for choosing a stormwater control
  - Ability to treat water quality
  - Desired specific pollutant removal rates
  - Drainage area
  - Space required
  - Slope
  - Minimum head
  - Construction cost
  - Maintenance burden
  - Physiographic factors
  - Soils
  - Special watershed considerations

See Screening Matrix

Common Questions

- **Common questions**
  - Isn't the soil in the region too impervious to use infiltration controls?

Soil Type	% of North Central Texas Region	Maximum Infiltration Rate	24-hr infiltration losses	Minimum Infiltration Rate
A	1.1%	NA	NA	0.45 in/hr.
B	15.1 %	5 in/hr.	9.743 in	0.3 in/hr.
C	24.3%	3 in/hr.	4.430 in	0.1 in/hr.
D	55.5%	1 in/hr.	0.769 in	0.02 in/hr.

Storm Water Management Model User's Manual, EPA, 1988
Section 438 Technical Guidance, App. A, EPA, 2009

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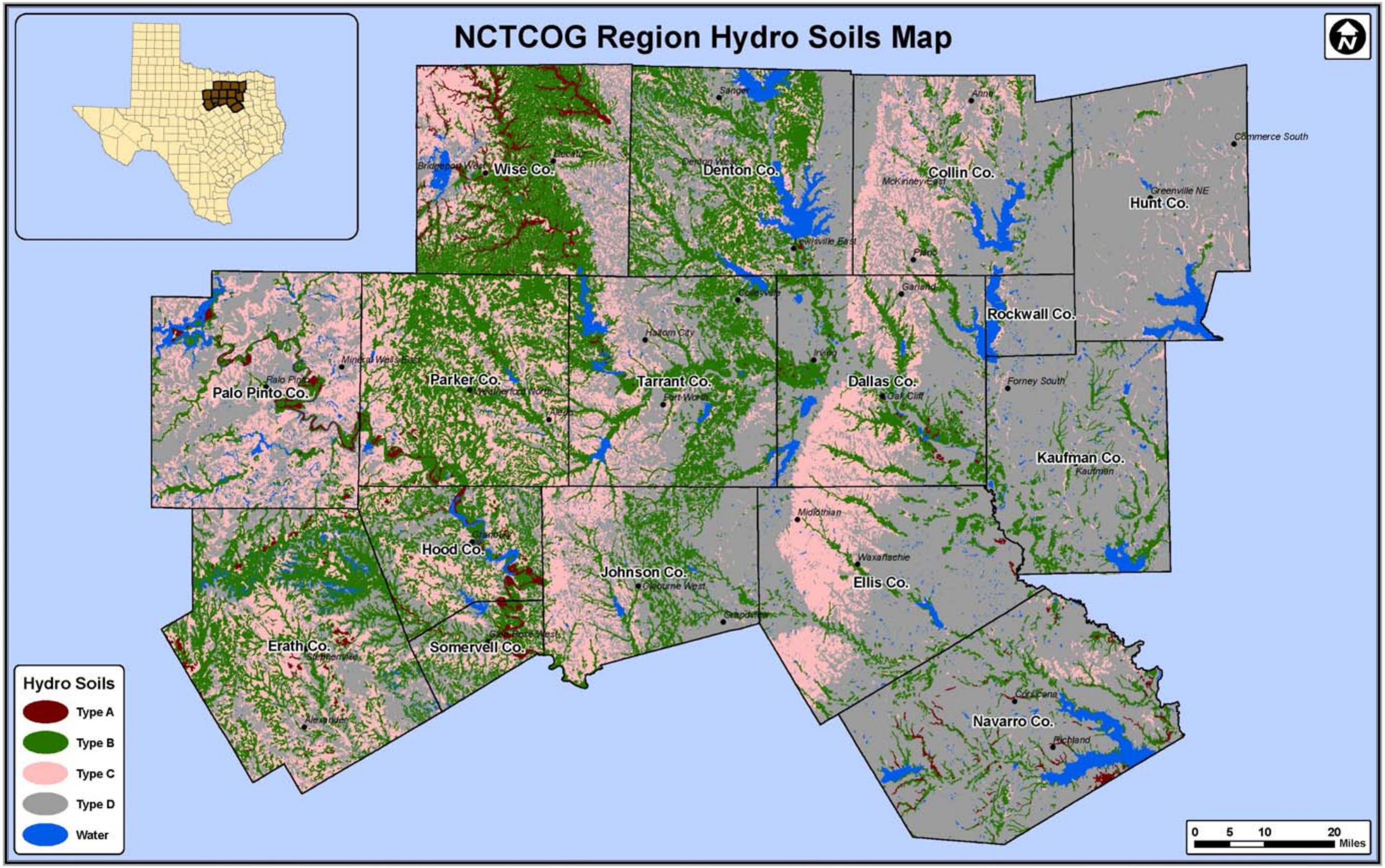
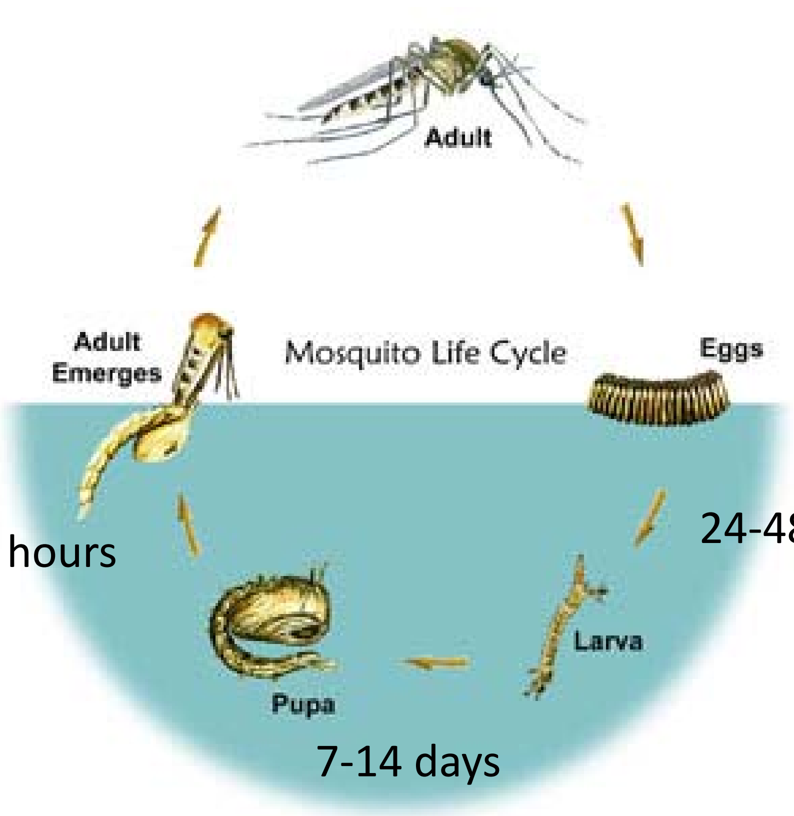
Common Questions



Common Questions

- **Common questions**
  - Will using stormwater controls such as bioret create breeding grounds for mosquitos?



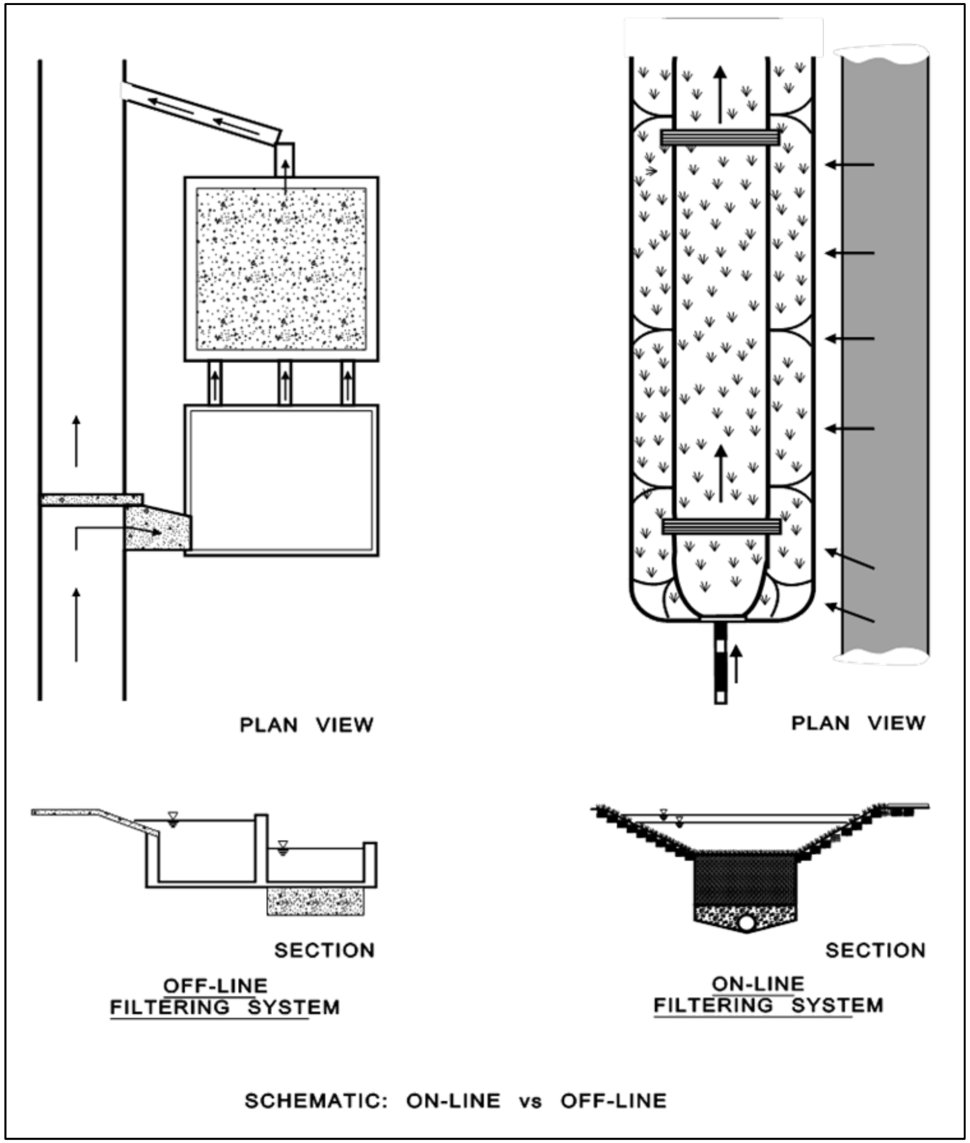
- Mosquito eggs and larva are aquatic, need water to survive.
- If water dries out, eggs die.
- The required drawdown rates of most BMPs is 24-48 hours.

Common Questions

- **Common questions**
  - What is the difference between off-line vs. online?

Online receives all runoff from an area but does not treat it all.

Off-line receive only a specified flow rate by using flow regulators



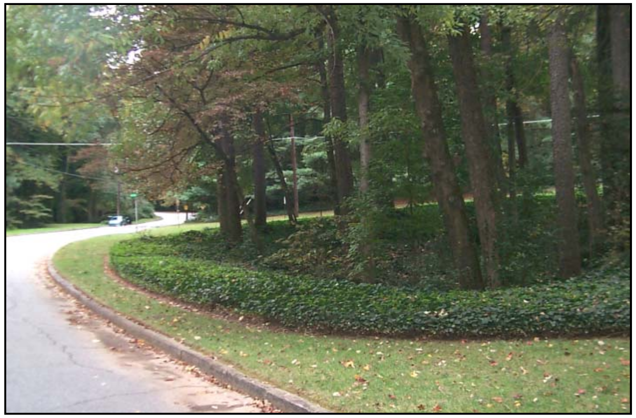
Common Questions

- **Common questions**
  - How to set stormwater control specifications?

Some additional specifications may be desired by your City. Multiple departments (Engineering, Planning, Landscaping, Maintenance, etc.) should review design criteria and discuss concerns. Set additional criteria to meet those concerns.

Stormwater Control Criteria

Bioretention



Main design features:

- Ponding area with vegetation and planting soil bed
- Organic/mulch layer
- Pea gravel layer with possible permeable filter fabric
- Underdrain system

Main design criteria:

- Length to width ratio of 2:1
- Drainage area of 0.5 to 2 acres (5 acres max)
- Drain time of less than 48 hours
- Maximum ponding depth of 6 inches
- A flow regulator must be sized to divert the WQ_v to the bioretention area and high flow overflow downstream

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Bioretention

Design Steps:

1. Determine WQ_v
   - If offline, determine water quality peak discharge (Q_{wq}) and size diversion structure
2. Use Darcy's Law equation to determine the required ponding area

$$A_f = \frac{(WQ_v)(d_f)}{[(k)(h_f + d_f)(t_f)]}$$

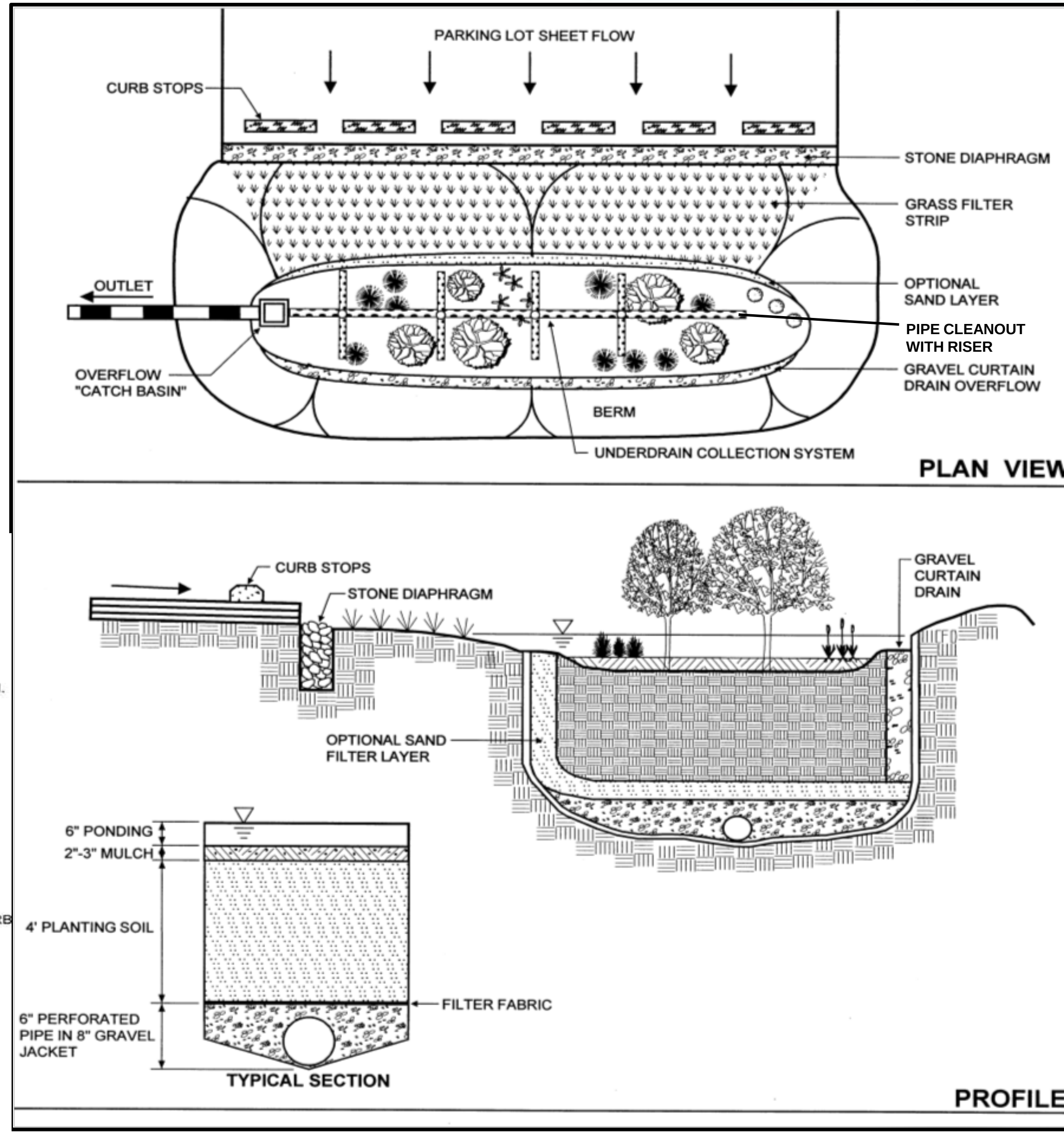
Where:
A_f = surface area of ponding area (ft^2)
WQ_v = water quality volume (ft^3) (1acre feet = 43,560 cubic feet)
d_f = filter bed depth (2.5 to 4 ft)
k = coefficient of permeability of filter media (0.5 ft./day for bioretention soil)
h_f = average height of water above filter bed (ft) (typically half of max depth)
t_f = design filter bed drain time (days) (2 days or 48 hours recommended)

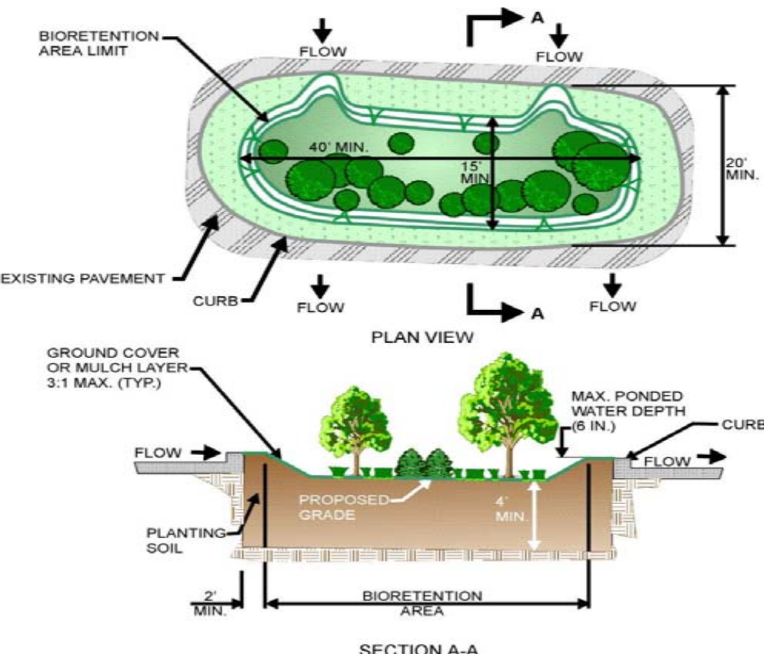
Stormwater Control Criteria

Bioretention

EPA Cost Estimate = $7.30 * V^{0.99}$

where: V = bioretention volume in cubic feet





Bioretention Exercise

Click here for the Training Exercise on Bioretention Design

Stormwater Control Criteria

Enhanced Swales

Main design features:

- Can be a wet or dry swale
- Wet swales have berms or check dams installed perpendicular to flow to promote settling and infiltration
- Dry swales consist of permeable soil, filter fabric, gravel and underdrain system

Main design criteria:

- Longitudinal slopes between 1 and 2% with non-erosive velocities ranging from 3 to 6 fps
- Drop structures may be used to reduce slopes and velocities, at least 50 ft apart
- Drainage area of 5 acres max
- Side slopes of 4:1 recommended (2:1 max)
- Bottom width of 2 to 8 feet
- Max WQ_v downstream depth of 18 in, average 12 in depth

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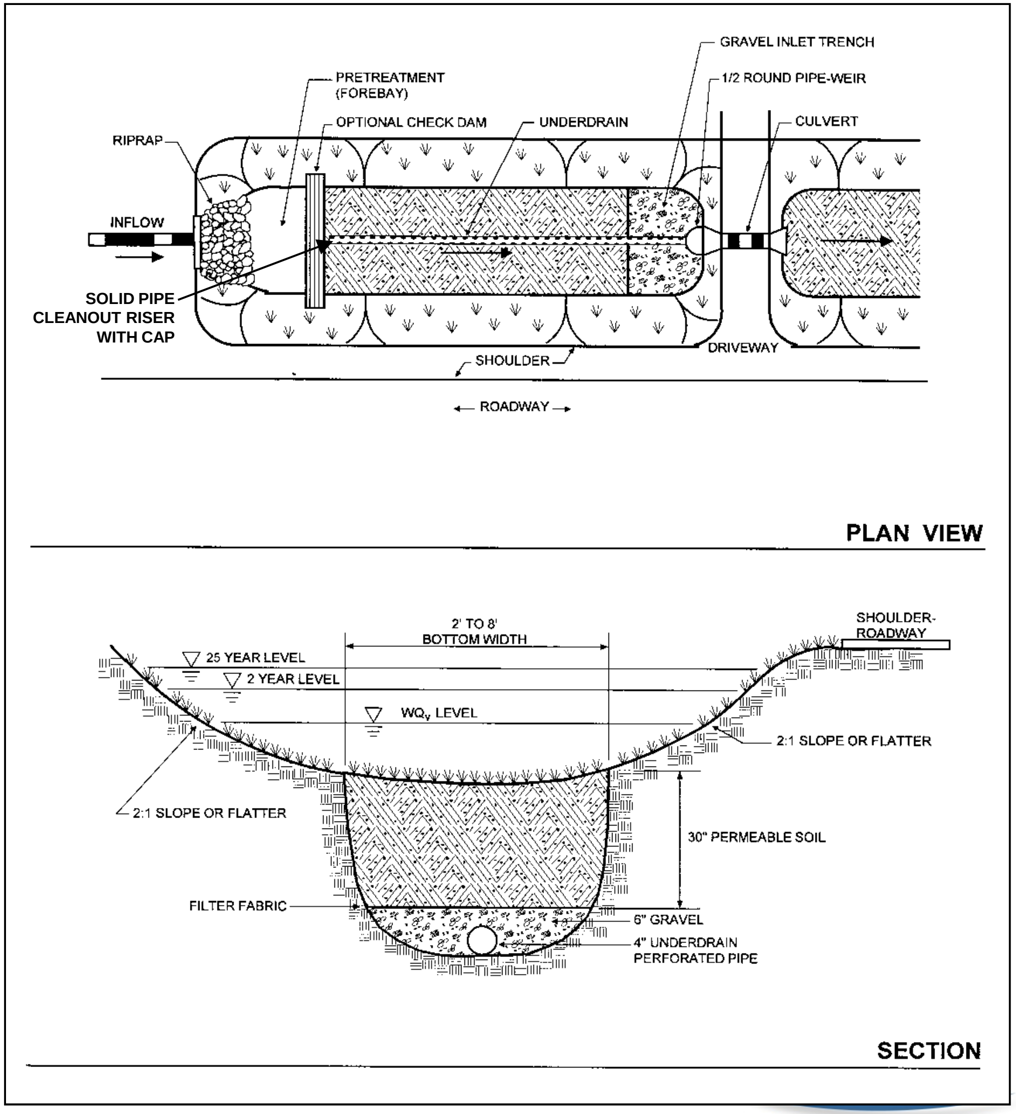
Stormwater Control Criteria

Enhanced Swales: Dry Swales

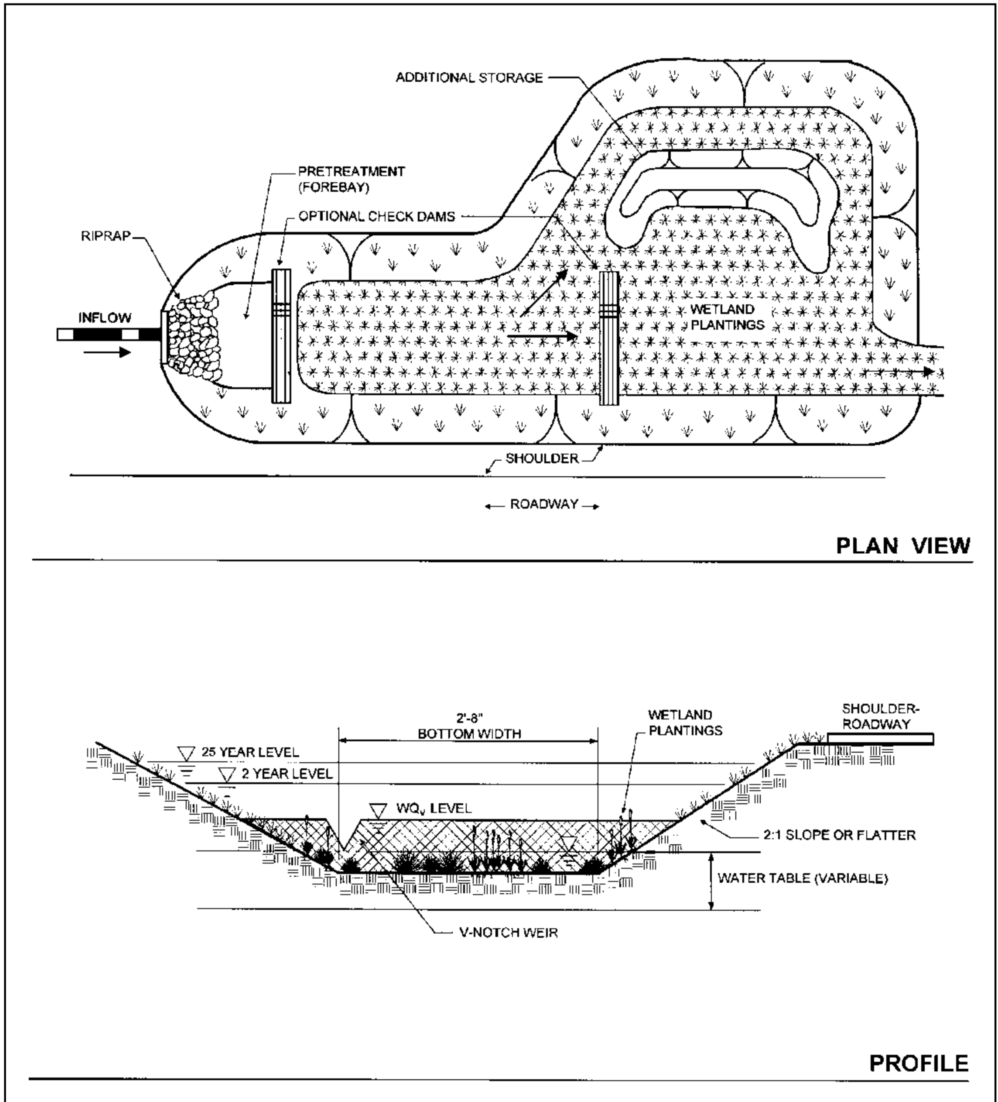
- Dry Swales uses filter bed of engineered soil over an underdrain system that filters and infiltrates the entire WQ_v. High pollutant removal rates due to filtration.
    - Maximum ponding time of 48 hours, 24 hours recommended
    - Bottom and sides of excavated trench removed of large roots and scarified before placement of gravel and soil
    - Maintain a grass height of 4 to 6 inches



Stormwater Control Criteria

Enhanced Swales: Wet Swales

- Wet Swales retain water through poorly drained soils and act as linear shallow wetlands with berms or check dams to create multiple wetland “cells”. Most pollutant removal rate comes from sediment accumulation and biological removal.
  - If wet swale does not intercept the groundwater table a water balance calculation should be performed to ensure adequate water budget for wetland species.



Stormwater Control Criteria

Enhanced Swales

Design Steps:

1. Determine WQ_v and the total conveyance volume
2. Size the swale to store the WQ_v with a depth less than 18 inches at the downstream end.
   - For Dry Swales: Use Darcy's Law equation to determine the required infiltration area. Planting soil should pass 1 to 1.5 ft./day and filter the WQ_v within 48 hours.
   - For Wet Swales: Swale must contain the full WQ_v
3. Compute and place check dams if needed
4. Check velocities, freeboards, inlets, etc.
5. Prepare landscaping plan

Stormwater Control Criteria

Filter Strips

Main design features:

- Provides Secondary water quality protection
- Flow is evenly distributed as sheet flow across a vegetated area
- Does NOT require engineered soils
- Permeable berm is optional

Main design criteria:

- Flow must enter as sheet flow, flow spreader required
- Slopes shall be between 2 and 6%
- Flow path must be at least 15 feet
- Depth for WQ_V should be kept to 1 or 2 inches
- Travel time across filter strip should be at least 5 minutes

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Stormwater Control Criteria

Filter Strips

Design Steps:

1. Determine maximum discharge loading per foot of filter strip width (q)

$$q = \frac{0.023}{n} Y^{\frac{5}{3}} S^{\frac{1}{2}}$$

Where:
q = discharge per foot of width of filter strip (cfs/ft.)
Y = allowable depth of flow (inches)
S = slope of filter strip (percent)
n = Manning's "n" roughness coefficient
  0.15 for medium grass
  0.25 for dense grass
  0.35 for Bermuda-type grass

2. Determine minimum width of the filter strip

$$W_{fmin} = \frac{Q_{wq}}{q}$$

where:
Q_{wq} = water quality peak flow rate (cfs)
W_{fmin} = min. filter strip width perpendicular to flow (ft.)

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Stormwater Control Criteria

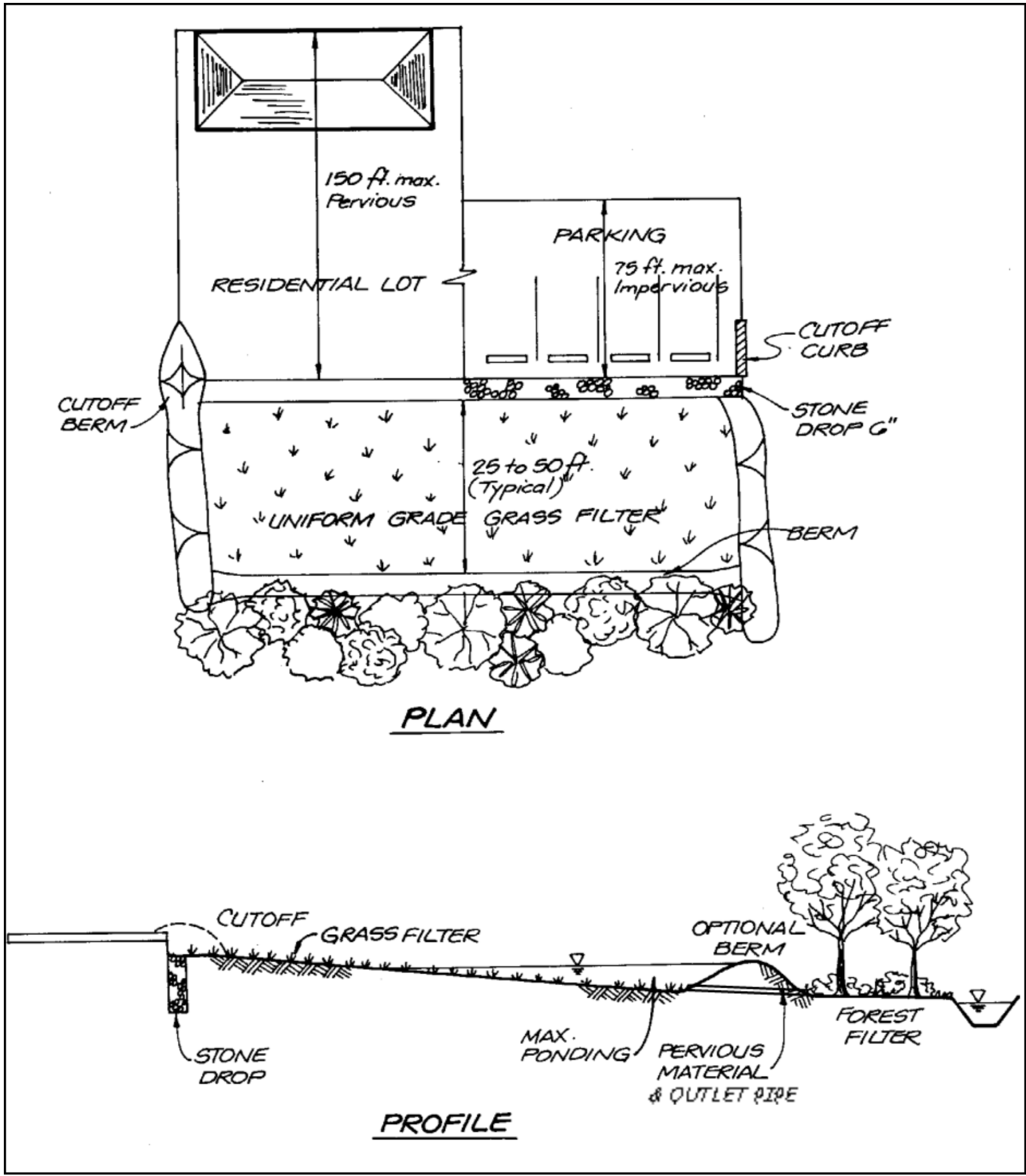
Filter Strips

Design Steps:

3. Determine length of filter strip

$$L_f = \frac{(T_t)^{1.25} (P_{2-24})^{0.625} (S)^{0.5}}{3.34 * n}$$

L_f = length of filter strip parallel to flow (ft.)
T_t = travel time through filter strip (min)
P_{2-24} = 2-yr, 24-hr rainfall depth (in)
S = slope of filter strip (percent)
n = Manning's "n" roughness coefficient



Filter Strips

Other Design Considerations:

a) Filter Strips with Berm

- Size outlet pipes to drain area in 24 hours
- Berm material should encourage grass cover
- Maximum berm height should be 12 inches

b) Filter Strips for Pretreatment

- See Table for sizing guide

Table 13.1 Bioretention Filter Strip Sizing Guidance

Parameter	Impervious Areas				Pervious Areas (Lawns, etc)			
Maximum inflow approach length (feet)	35		75		75		100	
Filter strip slope (max = 6%)	< 2%	> 2%	< 2%	> 2%	< 2%	> 2%	< 2%	> 2%
Filter strip minimum length (feet)	10	15	20	25	10	12	15	18

(Source: Claytor and Schueler, 1996)

Filter Strip Exercise

Click here for the Training Exercise on Filter Strip Design

Stormwater Control Criteria

Stormwater Ponds: Wet Ponds

Main design features:

- A sediment forebay or equivalent pretreatment must be provided
- Has a permanent pool of water through out the year with overlying zone where flood control volumes are stored.
- An aquatic bench along the edge of the permanent pool acts as biological filter.

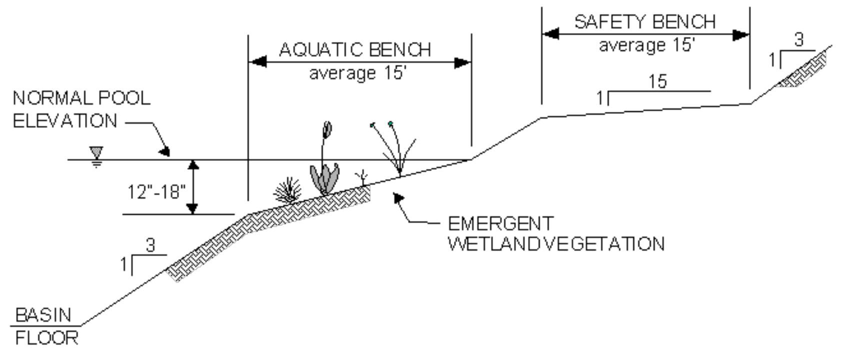
Main design criteria:

- Minimum drainage area of 25 acres
- Minimum length to width ratio of 1.5:1, ideally 3:1
- Maximum depth of 8 feet, minimum depth of 3-4 ft
- Side slopes not to exceed 3:1
- Underlying soils should be C or D or have a liner. Permeability tests are required.

Stormwater Control Criteria

Stormwater Ponds: Wet Ponds

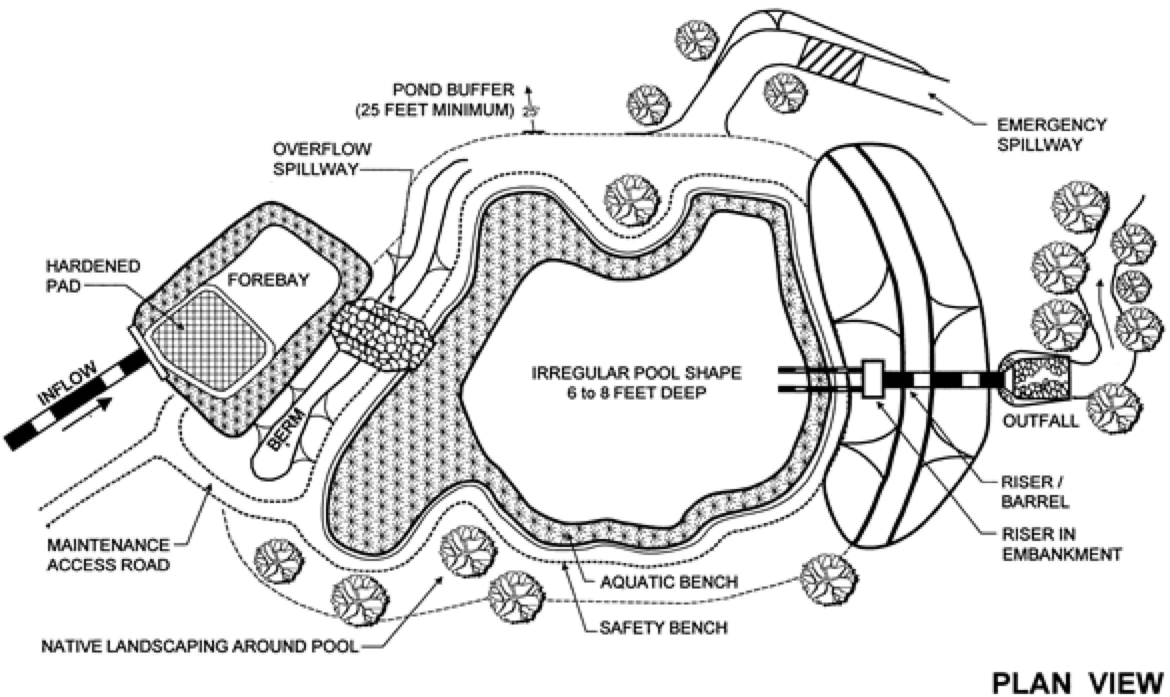
- **Wet Pond** – Permanent pool is equal to the water quality volume
- **Wet ED Pond** – Water quality volume split between permanent pool and ED storage above the permanent pool that is released over 24 hours. Consumes less space.
- **Micropool ED Pond** – A small micropool is maintained at the outlet to the pond with a volume approximately 0.1 inches of runoff per impervious acre.
- **Multiple Pond System** – Multiple ponds store water quality volume in 2 or more cells.



- Cannot be located within a stream or navigable waters of the U.S.
- Minimum setback requirements; 10 ft from property line and 100 ft from a private well.

Stormwater Ponds: Wet Ponds

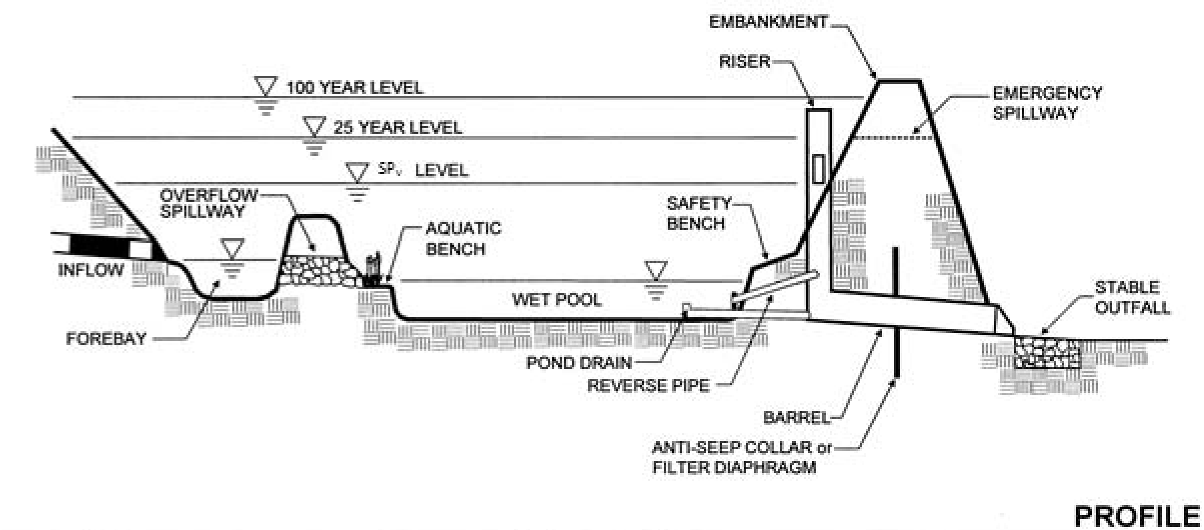
- Length to width ratios help avoid short-circuiting or an unequal distribution of inflow.
- Wedge-shaped when possible so flow enters gradually.
- Baffles, pond shaping, or islands increase the flow path.
- Safety bench may be waived if slopes are 4:1 or gentler.
- Irregular contours and shapes provide a more natural landscaping effect.



Stormwater Control Criteria

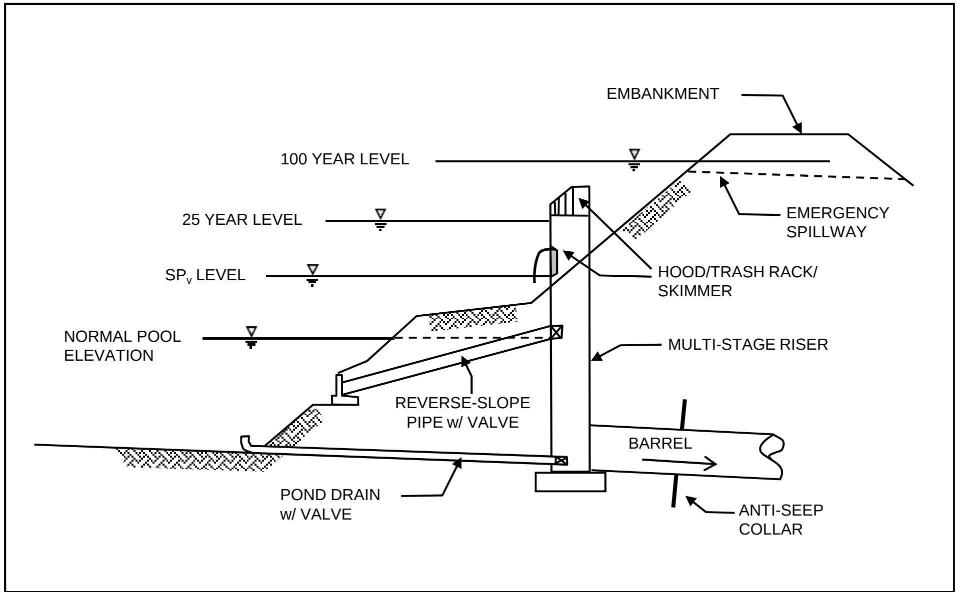
Stormwater Ponds: Wet Ponds

- Forebay should be at each inlet unless the inlet provides less than 10% of the total inflow.
- Forebay should be sized to contain 0.1 inches per impervious acre of contributing drainage area. Volume may be extracted from total WQ_v for permanent pool sizing.
- Forebay should be 4 to 6 feet deep.
- Install sediment depth marker to measure sediment deposition over time.
- Bottom of forebay may be concrete to make sediment removal easier.



Stormwater Ponds: Wet Ponds

- Outlet flow control typically accomplished with use of riser and barrel.
- Riser should be located within the embankment.
- Embankments 6 feet or higher are subject to TCEQ guidelines for Dam Safety.
- Orifices and weirs at varying levels release runoff from larger storm events. If the pond is off-line and providing only water quality treatment then a simple weir is all that is required.
- Anti-seep collars on the outlet barrel reduce the potential for pipe failure.
- A bottom drain pipe should be able to drain the permanent pool in 24 hours.



Stormwater Ponds: Wet Ponds

Design Steps:

1. Determine WQ_v and the total design volume. **Design volumes for extended detention ponds should be increased by 15%**
2. Determine sediment forebay volume.
   - Sized to contain 0.1 inches per impervious acre of drainage area
   - Should be 4 to 6 feet deep
   - Forebay storage may be subtracted from WQ_v requirement
3. Determine permanent pool volume
   - Wet Pond: $1.0*WQ_v$
   - ED Wet Pond: $0.5*WQ_v$
   - ED Micropool Pond: 25 to 30% of WQ_v
4. Determine pond location and preliminary geometry
   - Initial grading and stage-storage relationships
   - Size orifices and outlets
5. Set up a stage-storage-discharge relationship for the pond

Wet Pond Exercise

Click here for the Training Exercise on Wet Pond Design

Stormwater Control Criteria

Green Roofs (Extensive)

Main design features:

- Two types: intensive and extensive
- Intensive green roofs have a greater diversity of plants but require deeper soil, increased load bearing capacity, and more maintenance,
- Extensive green roof plants are limited to short grasses. Require less soil depth and minimal maintenance

Benefits:

- reduced discharges
- reduce the temperature of runoff
- reduce “heat island” effect
- insulates the building
- protects roof from weather
- reduce noise
- longer roof lifespan

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Stormwater Control Criteria

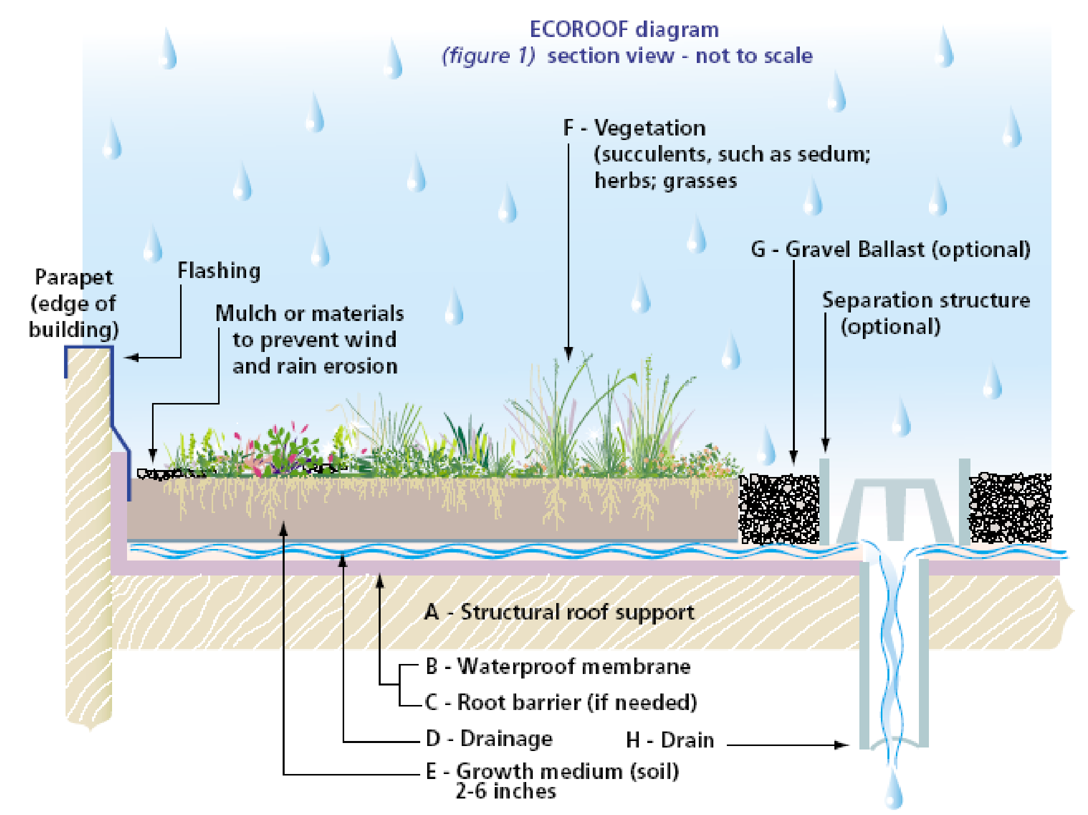
Green Roofs (Extensive)

Design Considerations

- Structural engineer must be consulted to determine if structural support is adequate. Generally roof must hold an additional 10 to 25 psf.
- Can be installed on flat or pitch roofs up to 40%

Green Roof Layers

- Waterproof membrane (synthetic rubber, reinforced PVC, modified asphalts, etc.)
- Possible Root barrier (dense materials, treated with copper to prevent root penetration)
- Drainage layer (plastic sheeting, gravel, or growth medium)
- Growth medium (sand, gravel, crushed brick, peat, etc.). Portland uses 1/3 topsoil, 1/3 compost, and 1/3 perlite.



Green Roofs (Extensive)

Vegetation Selection

The UTA Life Science Center Green Roof, established in 2008, tested 29 varieties of plants. Their highly recommended plants are listed below:

- Side Oats Grama
- Blue Grama
- Box Bud Primrose, Sundrops
- Damianita
- Dove Weed, Prairie Tea
- Red Yucca
- Blackfoot Daisy
- Russian Sage
- Texas Frogfruit
- Wooly Stemodia
- Four Nerve Daisy
- Zexmenia
- Palisades Zoysiagrass

More detailed information from UTA's study can be found at http://www.uta.edu/sustainability/initiatives/Green%20Roof%20Report.pdf

Installation costs run from $10 to $25 per square foot. Conventional roofs run $3 to $20 per square foot.

Stormwater Control Criteria

Modular Porous Pavers

Main design features:

- Structural units with void areas to create load bearing pavement surfaces.
- Void spaces filled with pervious materials to allow infiltration.
- Many different types provided by a range of manufacturers.

Main design criteria:

- Soil infiltration of 0.5 in/hr. or greater required
- Must drawdown runoff capture within 24 to 48 hours
- Slopes less than 2%
- Soil clay content must be < 30%
- Ratio of impervious drainage area to porous paver surface should be no greater than 3:1

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Modular Porous Pavers

- Prevent large sediment loads from draining to porous pavers, could cause clogging.
- Place in low traffic areas
- Should be placed 10 feet down gradient from buildings
- Minimum of 40% open void space
- Gravel base course should be designed to store the WQ_v. A minimum thickness of 9 inches should be used. Gravel layer depth can be calculated with equation below.

$$d = \frac{WQ_v}{A} * n$$

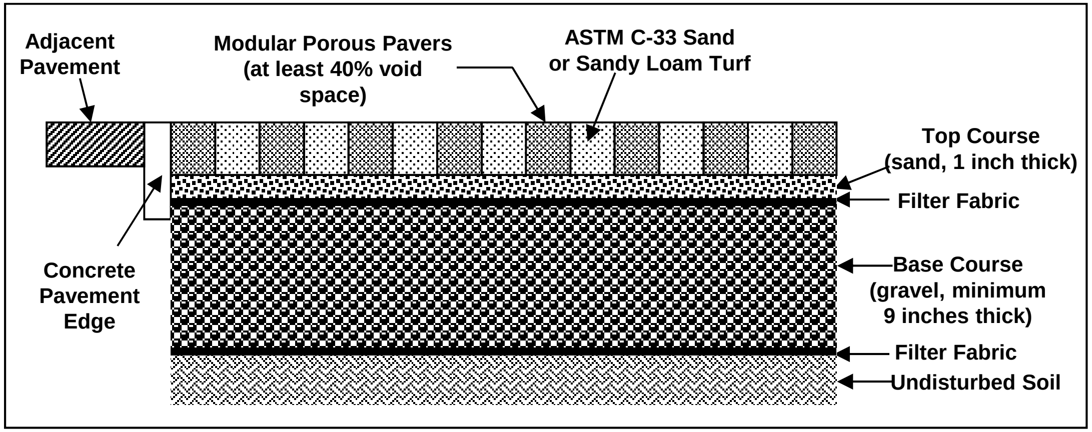
where:

d = gravel layer depth (ft)

WQ_v = water quality volume

A = surface area (ft^2)

n = porosity (use 0.32)

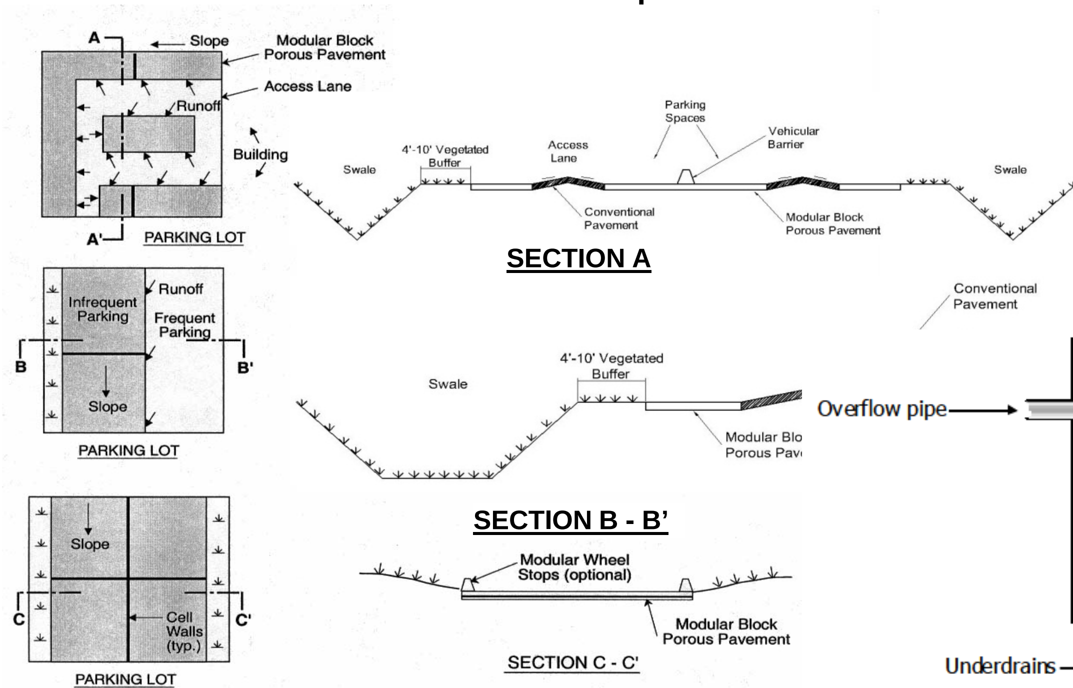


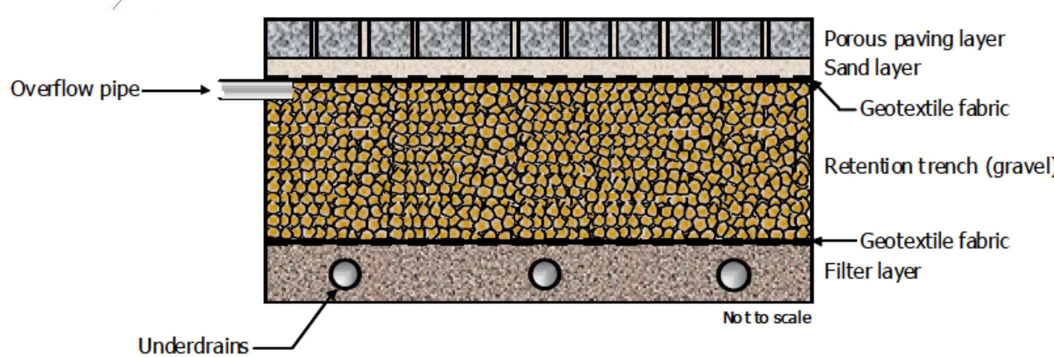
Stormwater Control Criteria

Modular Porous Pavers

Other Considerations

- Options to convey larger storm events include using inlets set slightly above the pavement elevation.
- Porous paver surfaces are assumed to be 35% impervious.
- Underdrains are also an option is soils do not meet 0.5 in/hr. infiltration rate.





Stormwater Control Criteria

Proprietary Devices

Main design features:

- A variety of commercially available proprietary stormwater structural controls are out there.
- Important to have general guidelines in regards to performance data and testing

Types of proprietary devices:

- Hydrodynamic systems (gravity and vortex separators)
- Filtration systems
- Catch basin media inserts
- Chemical treatment systems
- Package treatment plants
- Prefabricated detention structures

Proprietary Devices

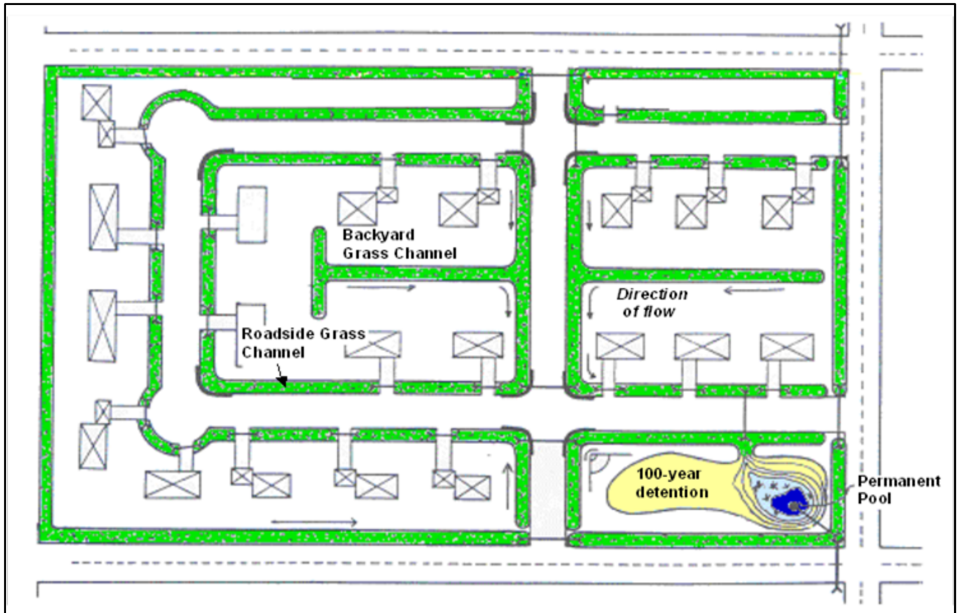
Guidelines for using proprietary systems:

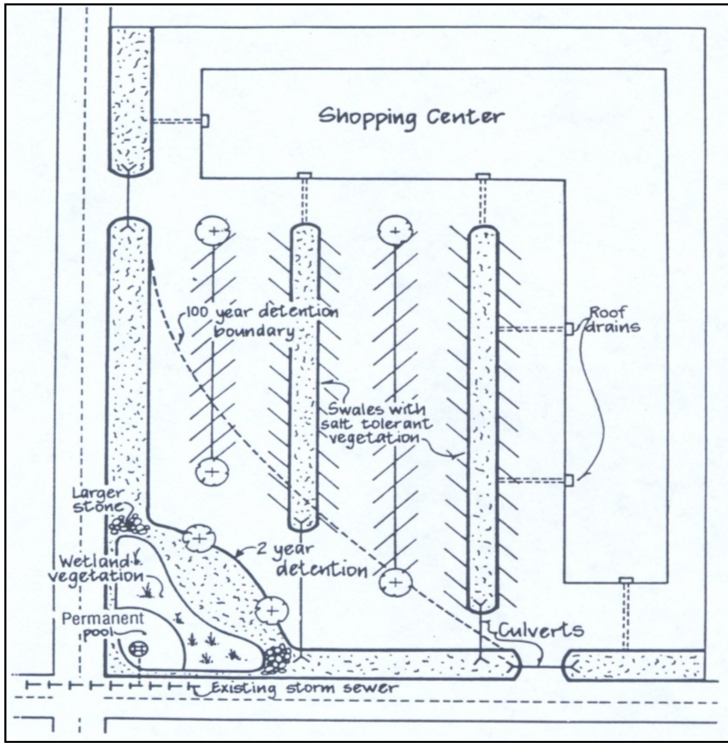
- Independent third-party scientific verification of the proprietary device to meet water quality objectives.
    - At least 15 storms must be sampled
    - Study must be independent or independently verified
    - Study must be conducted in the field
    - Field monitoring must require proportional sampling both upstream and downstream
    - Concentrations reported must be flow-weighted
    - Proprietary device must have been in place at least 1 year at time of monitoring
- Proven record of longevity in the field
- Proven ability to function in North Central Texas conditions
- Maintainability – Documented procedures for required maintenance

Stormwater Control Criteria

Treatment Trains

- Pollutant removal rates are not additive.
- The dirtier the water, the higher the percentage of pollution removed. Hence, removal rate for second BMP is less than that of the first.





Stormwater Control Criteria

Treatment Trains

- Rules for calculating treatment train efficiency
  - If Primary control is downstream from another Primary control, use 50% of removal rate for second control
  - If Primary control is downstream from a Secondary control, use 75% of removal rate for second control
  - If Secondary control is upstream from Primary control, use 100% of removal rate for second control

Final Pollutant Removal = (Total Load * Control1 removal rate) + (remaining load * Control2 removal rate) + … for other controls in series

Stormwater Control Criteria

Treatment Trains

- Assumptions
  - Two Secondary controls in series
    - Equivalent treatment efficiency, use Primary to Primary rule that second control has 50% the typical removal rate
  - Primary upstream of a Secondary
    - Primary would capture majority of pollutants. Use the largest reduction in efficiency rating, 50%.

Final Pollutant Removal = (Total Load * Control1 removal rate) + (remaining load * Control2 removal rate) + … for other controls in series

Stormwater Control Criteria

Treatment Train Example

- A commercial device that has a 20% removal rate is upstream of two separate stormwater ponds, each with an 80% removal rate. What is the total removal rate of the treatment train?

Control 1 = 20%
Control 2 = 80% (1.0 *design removal rate)
Control 3 = 40% (0.5*design removal rate)

Start with 100 “units”
100*20% = 20 units removed; 100-20 = 80
80*80% = 64 units removed; 80-64 = 16
16*40% = 6 units removed; 16-6 = 10
100-10 = **90% removal rate**

BMPs Around the Region

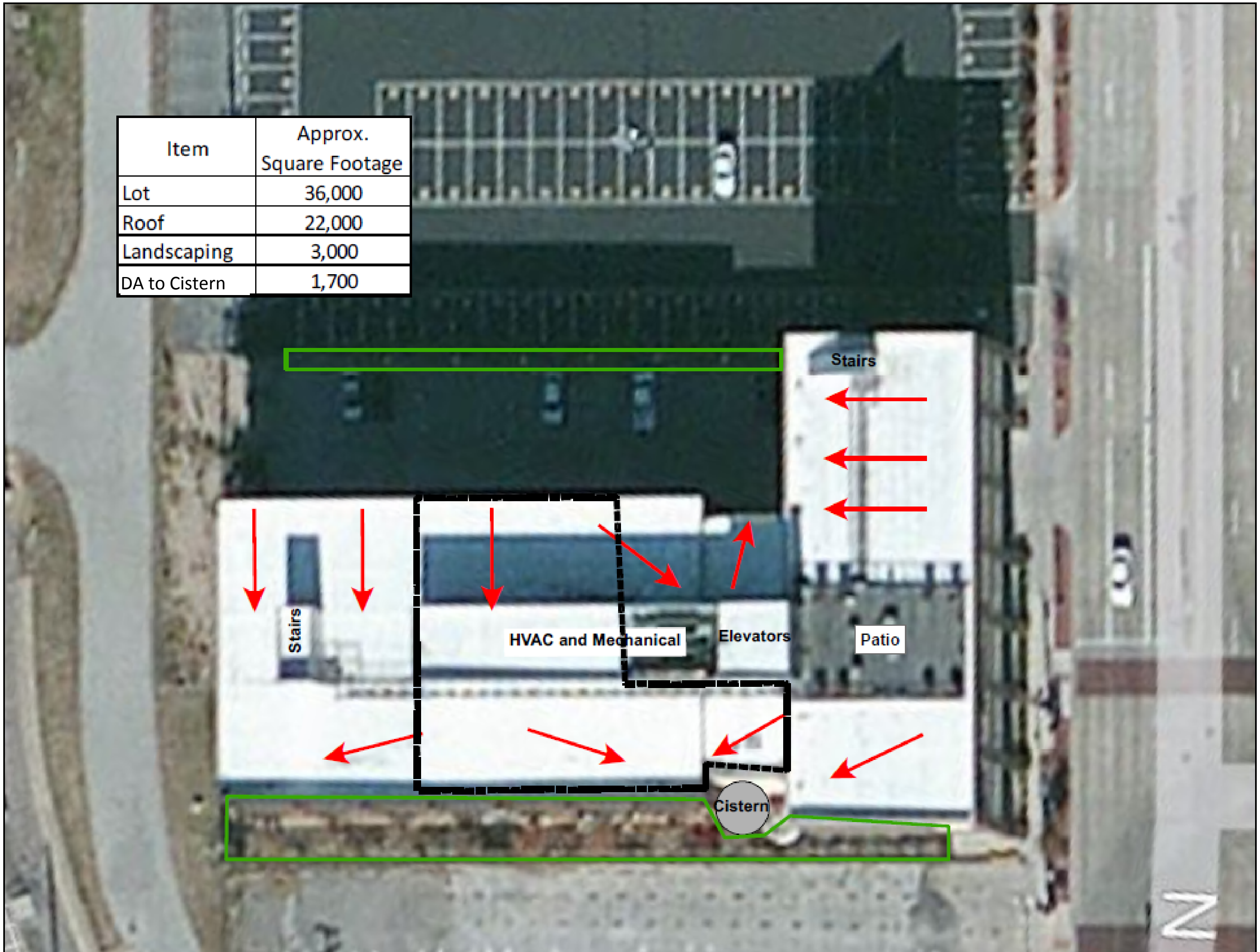
North Central Texas
Council of Governments

Corgan Assoc. Building, Dallas

- Downtown at the corner of Houston and Ross
- Retrofits to historic building made in February 2007
- Certified LEED Silver
- Rain harvesting cistern measuring 10’ in diameter and 10’ tall
- Cistern used for irrigation of property landscaping

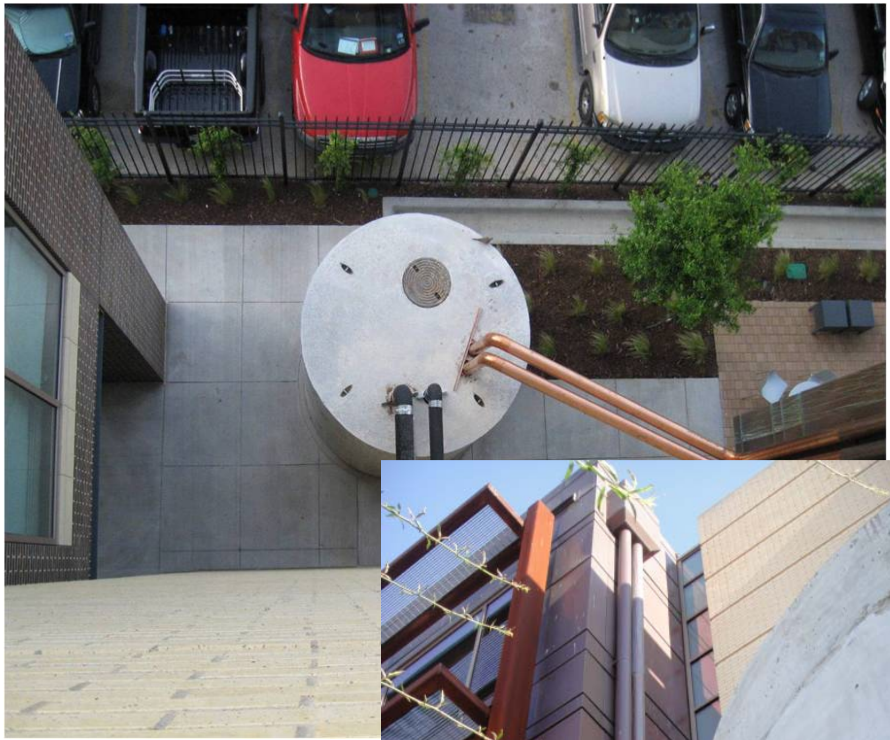
Corgan Assoc. Building, Dallas

Item	Approx. Square Footage
Lot	36,000
Roof	22,000
Landscaping	3,000
DA to Cistern	1,700



Corgan Assoc. Building, Dallas

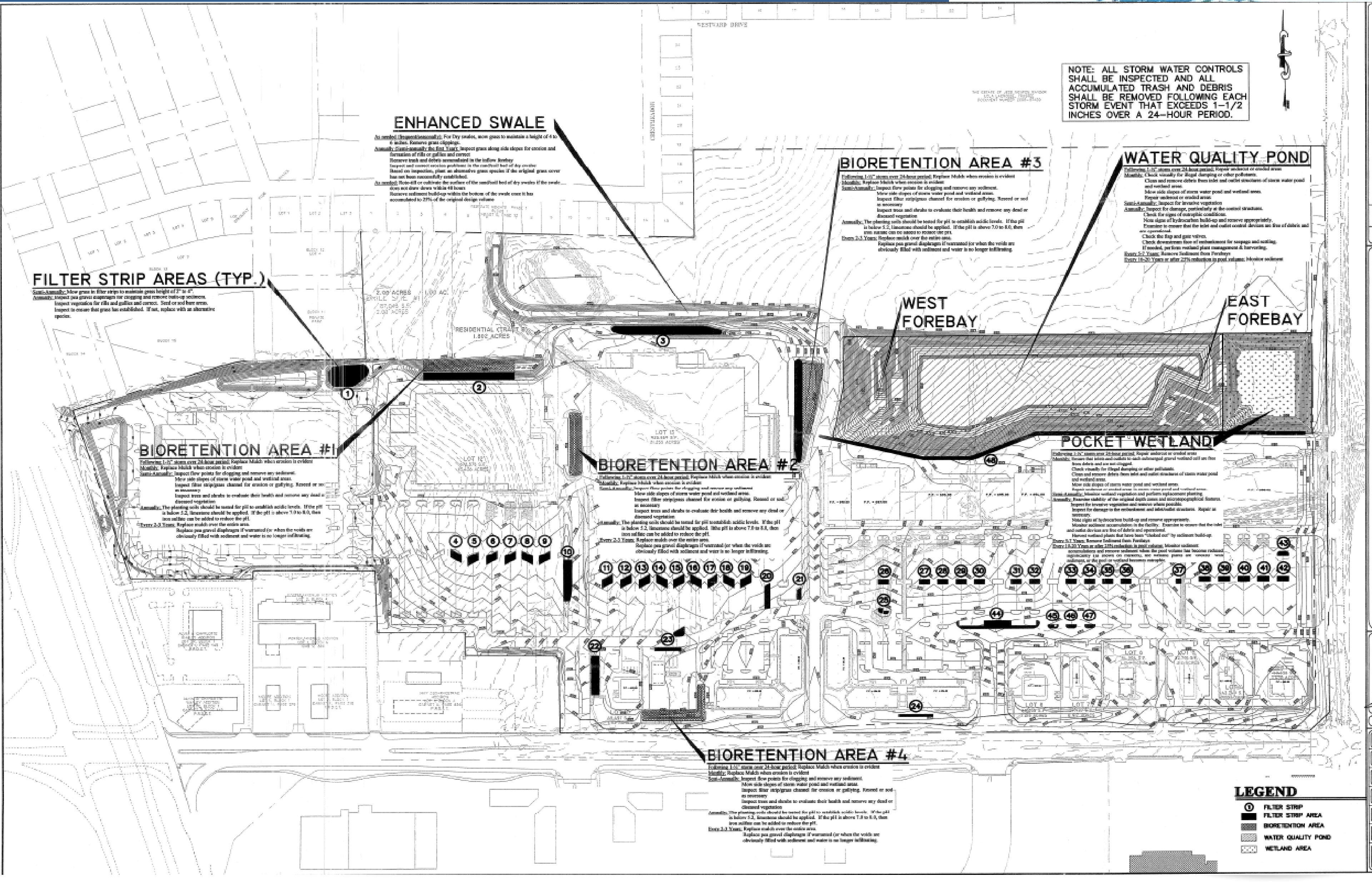
- Approx. 5,800 gallons of storage
- Site is 36,000 sq ft
- Roof DA makes up 1,700 sq ft
  - 1.5” rainfall would produce 1,590 gallons
  - The 5,800 gallons would store a 5.5” rainfall event
- Landscaping covers 3,000 square feet which would require 3,900 gallons in irrigation in an average month.
- 3rd party cleans out once annually
- Originally 2 in design but only 1 constructed
- Overflows in heavy rain events; spillway conveys overflow off the site



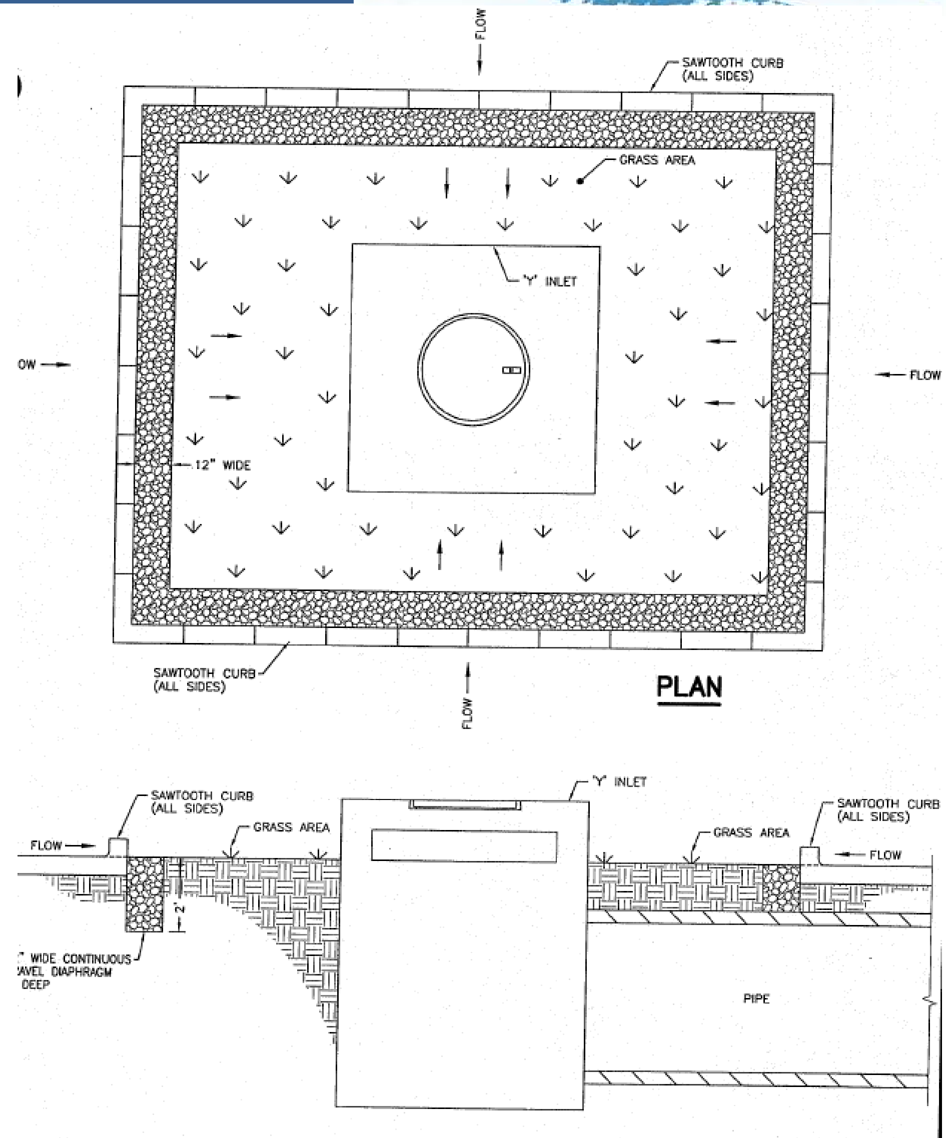
Rayzor Ranch, Denton

- Designed using iSWM Criteria
- 410 acre Mixed Use Development

Rayzor Ranch, Denton

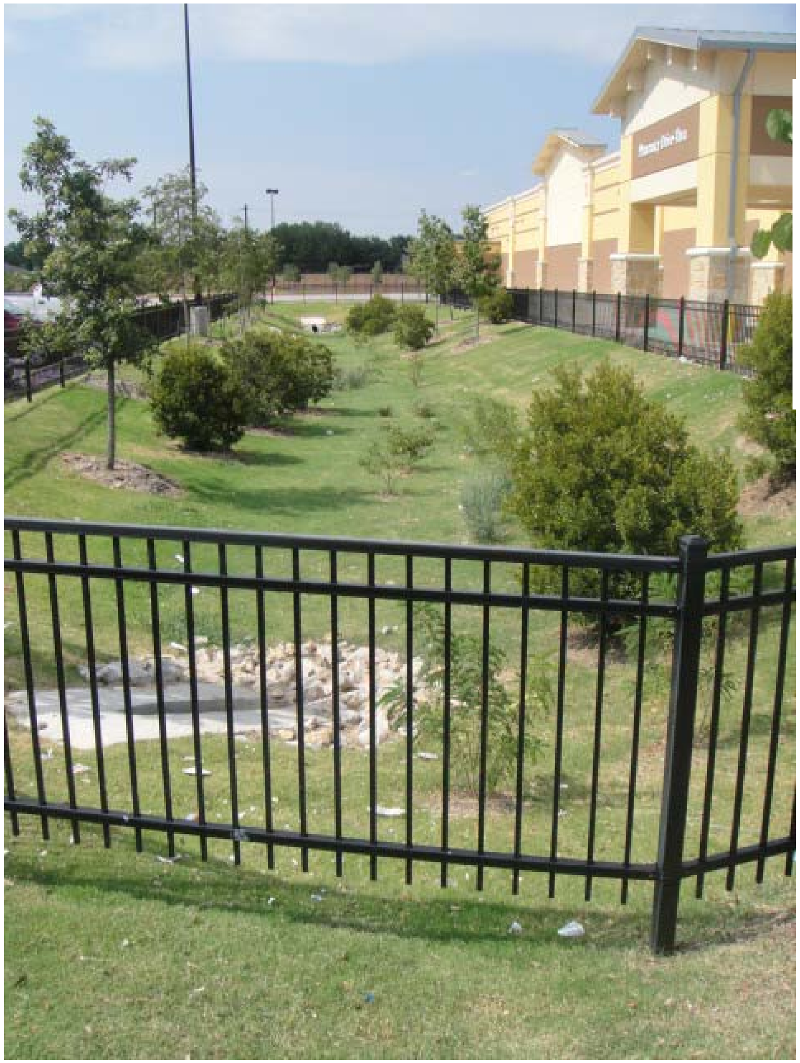


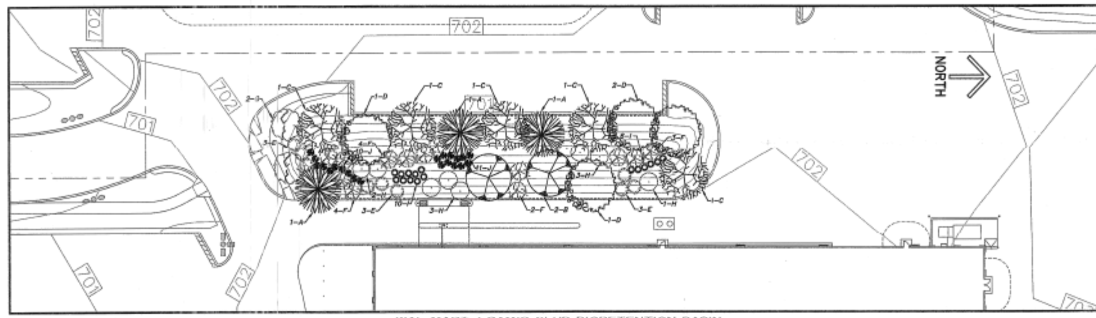
Rayzor Ranch, Denton



TYPICAL PARKING ISLAND FILTER STRIP

Rayzor Ranch, Denton





WAL-MART / SAM'S CLUB BIORETENTION BASIN

PLANT MATERIAL LIST			FULLY ROOT NEWLY STEPPED PLANTS NOT ACCEPTABLE		THIS CHART IS FOR REFERENCE ONLY. CONTRACTOR SHOULD VERIFY QUANTITIES AS SHOWN ON PLAN.			
SYMBOL	KEY	COMMON/SCIENTIFIC NAME	QUANTITY	CALIPER	HEIGHT	SPREAD	ROOT	REMARKS
	A.	BALD CYPRESS Taxodium distichum	13	2"	9'–12'	4'–6'	CONTAINER	SINGLE TRUNK
	B.	RED OAK Quercus shumardii	20	2"	9'–12'	4'–7'	CONTAINER	SINGLE OR MULTI TRUNK
	C.	CEDAR ELM Ulmus crassifolia	26	2"	9'–12'	4'–7'	CONTAINER	SINGLE OR MULTI TRUNK
	D	BUR OAK Quercus macrocarpa	16	2"	9'–12'	4'–7'	CONTAINER	SINGLE TRUNK
	E	FALSE INDIGO Amorpha fruticosa	71	N/A	2'–4'	2'–3'	* 5 gal.	
	F	WAX MYRTLE Myrica cerifera	65	N/A	3'–6'	4'–6'	CONTAINER	MULTI TRUNK
	G	RED BUD Cercis canadensis	19	1"–2"	6'–8'	4'–5'	CONTAINER	SINGLE OR MULTI TRUNK
	H	BUTTONBUSH Cephalanthus occidentalis	32	N/A	N/A	N/A	* 5 GAL.	
	I	BUSHY BLUESTEM Andropogon glomeratus	194	N/A	N/A	N/A	* 1 GAL.	
	J	SWITCHGRASS Panicum virgatum	224	N/A	N/A	N/A	* 1 GAL.	
	K	GRASS (See note below)	–					

* Size substitutions will be permitted based on availability

Grassing Note: Entire bioretention basin shall be grassed with Bamert Seed Company (www.bamertseed.com) "Deluxe Prairie Blend" seed at a rate of 20 lbs/acre. Prior to seed application the bioretention basin shall be mulched with shredded hardwood mulch 3 inches thick.

Rayzor Ranch, Denton

WATER QUALITY POND

Following 1-½" storm over 24-hour period: Repair undercut or eroded areas

Monthly: Check visually for illegal dumping or other pollutants.
Clean and remove debris from inlet and outlet structures of storm water pond and wetland areas.
Mow side slopes of storm water pond and wetland areas.
Repair undercut or eroded areas

Semi-Annually: Inspect for invasive vegetation

Annually: Inspect for damage, particularly at the control structures.
Check for signs of eutrophic conditions.
Note signs of hydrocarbon build-up and remove appropriately.
Examine to ensure that the inlet and outlet control devices are free of debris and are operational.
Check the flap and gate valves.
Check downstream face of embankment for seepage and settling.
If needed, perform wetland plant management & harvesting.

Every 5-7 Years: Remove Sediment from Forebays

Every 10-20 Years or after 25% reduction in pool volume: Monitor sediment

iSWM

319 Grant Projects, Denton

Recently received a Section 319 Grant to proceed with a number of projects

- Swales and dry detention at firehouse
- Bioretention system at treatment plant

BMPs at Dog Park

Bioretention at Denton Municipal Airport

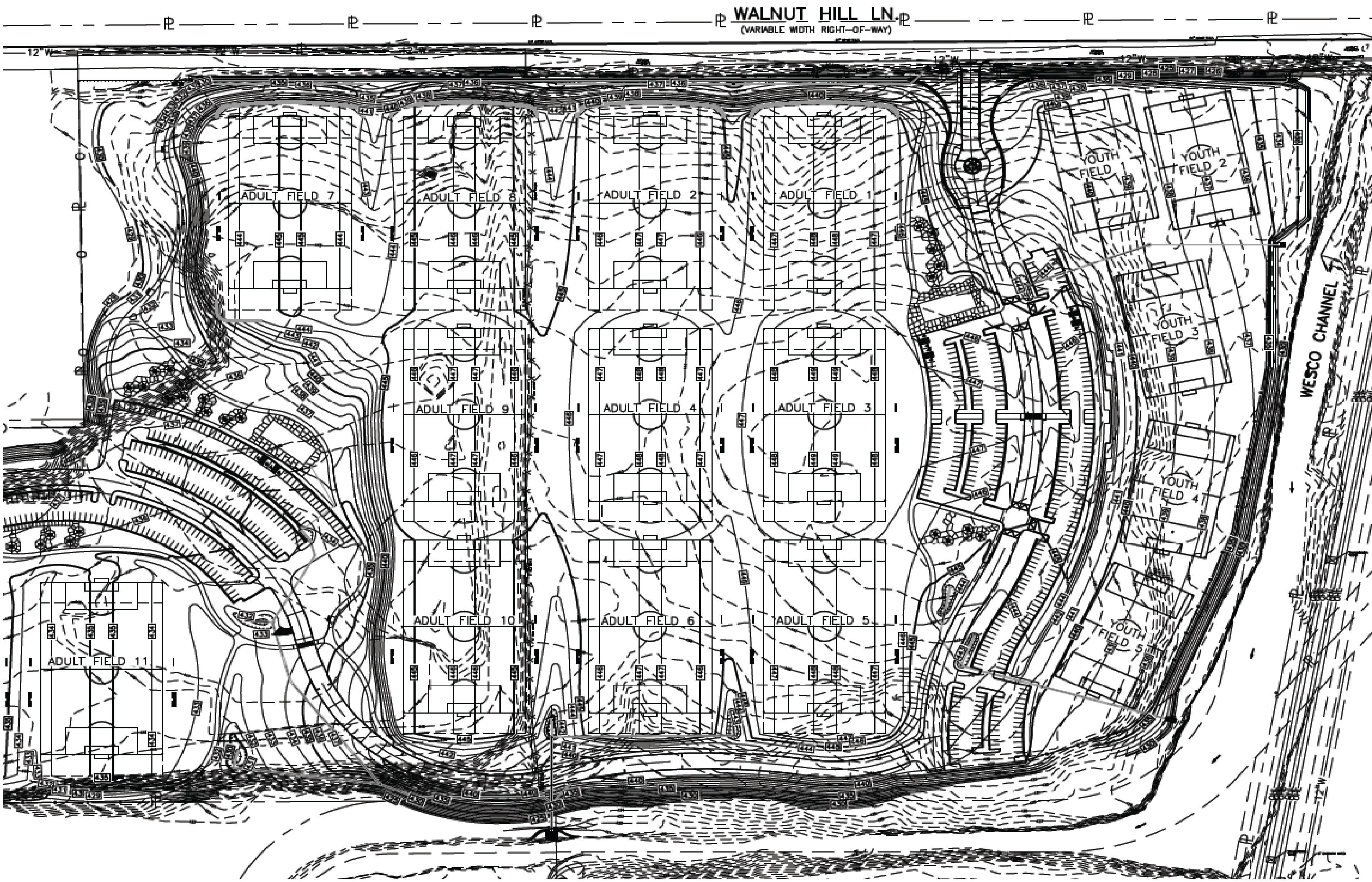
University of Texas at Dallas

- Updated entrance way as part of a central campus redesign
- Entrance includes a larger filter strip between two roads on University Parkway from Campbell Road
- Alternative cul-de-sac design

PWP LANDSCAPE ARCHITECTURE

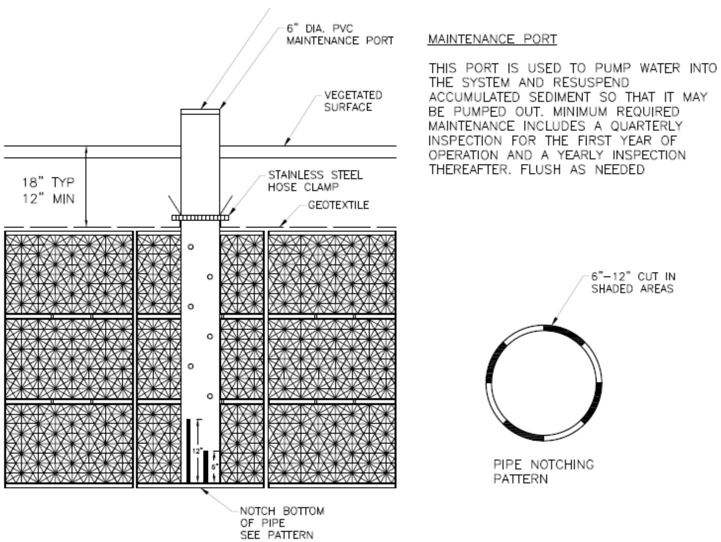
University of Texas at Dallas

Elm Fork Complex, Dallas

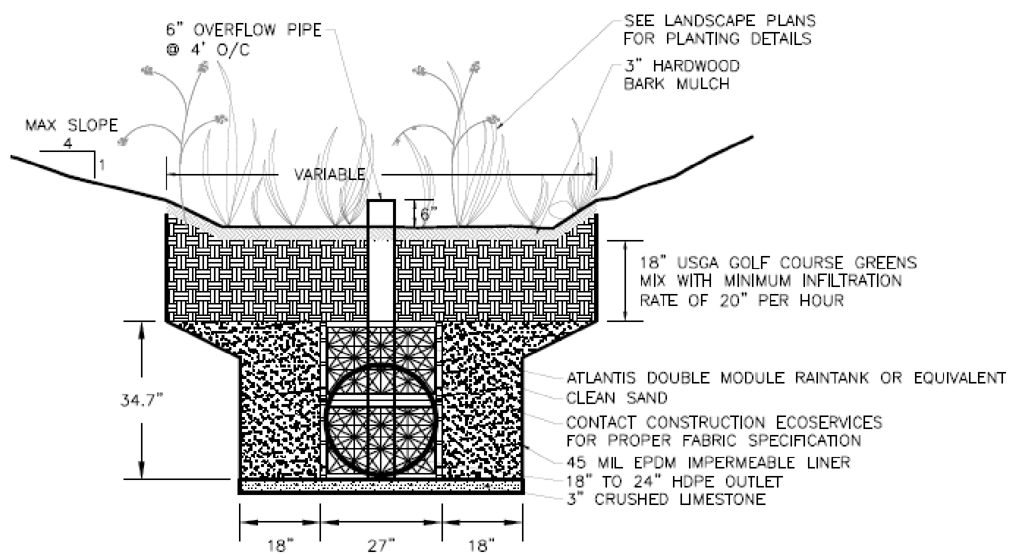


Elm Fork Complex, Dallas

Water Quality Volume Calculations											
	Area	% Impervious, I	Runoff Coeffecient, C	Volumetric Runoff Coefficient, Rv	Water Quality Volume, WQv	Filter Bed Depth (df)	Coefficient of Permeability, k	Average height of water above filter bed, hf	Design Filter Bed Drain Time, tf	Ponding Surface Area, Af
Area	ac	%	–	–	ft3	ft	ft/day	ft	days	ft2
3	1.58	0.70	0.80	0.0563	484.35	4.39	10.00	0.25	0.50	91.65
4	2.45	0.70	0.50	0.0563	751.06	4.39	10.00	0.25	0.50	142.12
6	2.66	0.50	0.50	0.0545	789.36	4.39	10.00	0.25	0.50	149.37
8	4.21	0.35	0.35	0.05315	1218.38	4.39	10.00	0.25	0.50	230.55
11	4.57	0.35	0.35	0.05315	1322.57	4.39	10.00	0.25	0.50	250.26
12	4.80	0.50	0.50	0.0545	1424.41	4.39	10.00	0.25	0.50	269.53
14	3.34	0.50	0.50	0.0545	991.15	4.39	10.00	0.25	0.50	187.55
16	4.13	0.50	0.40	0.0545	1225.59	4.39	10.00	0.25	0.50	231.91

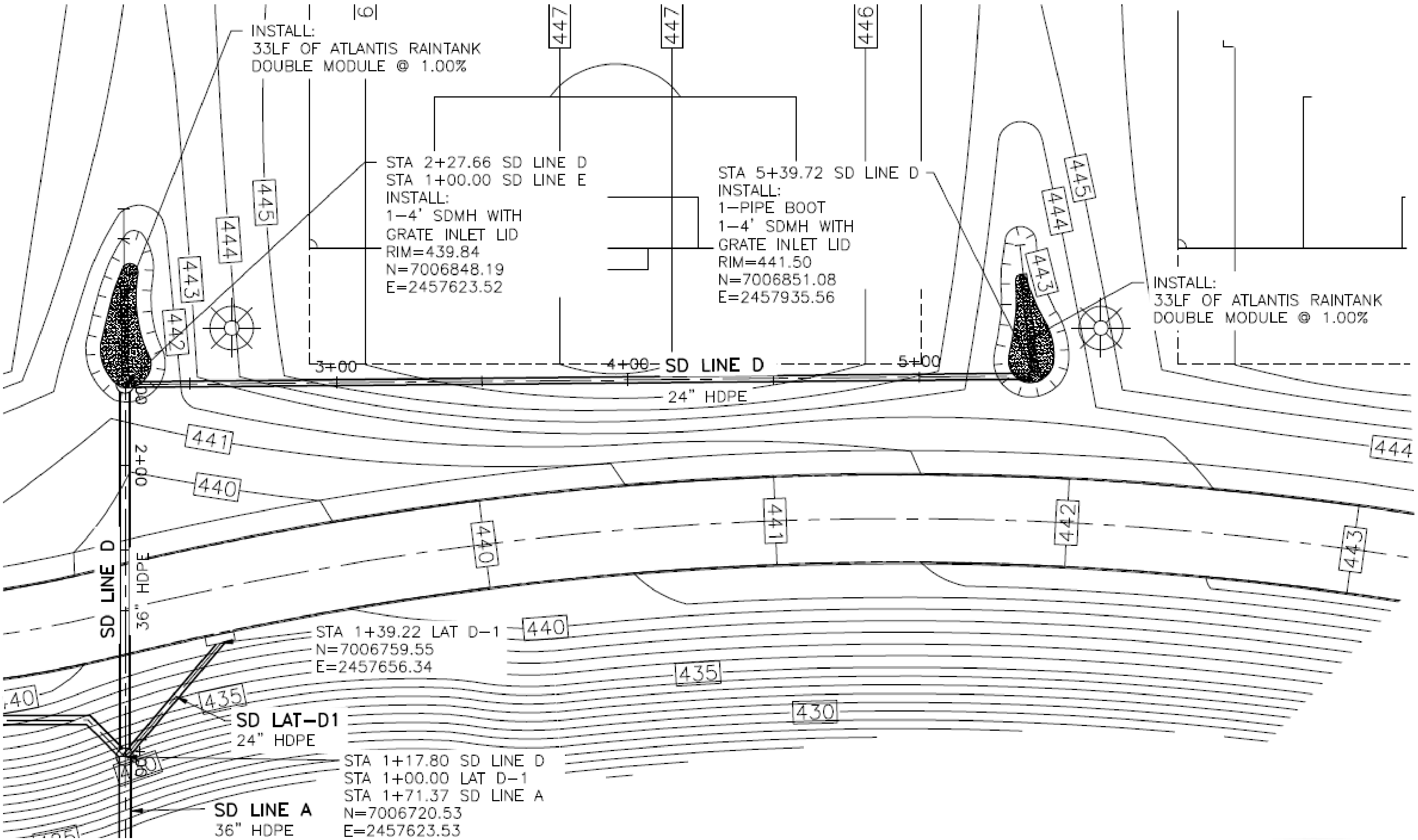


4 OVERFLOW PIPE
NOT TO SCALE

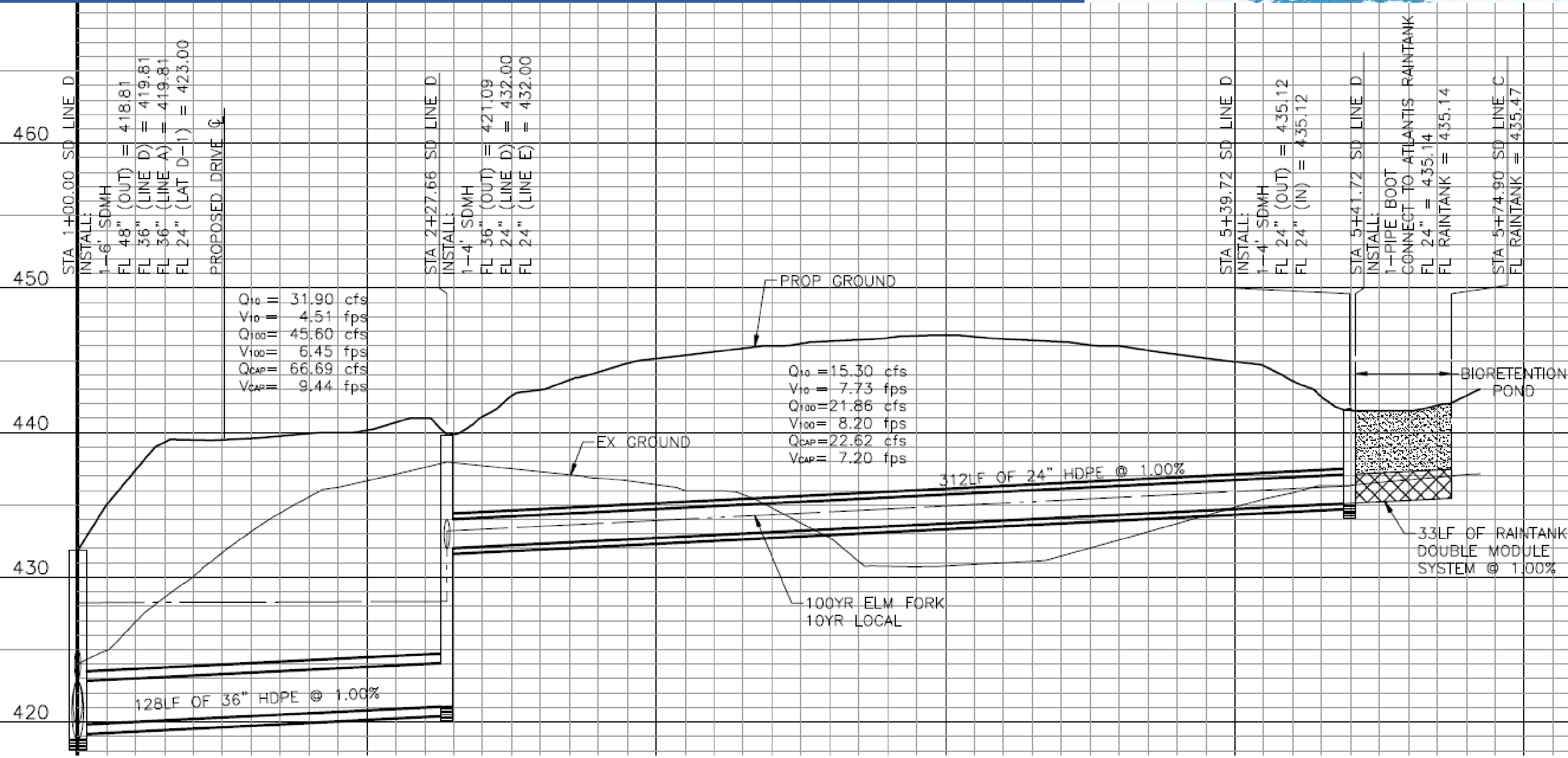


1 BIORETENTION CELL
NOT TO SCALE

Elm Fork Complex, Dallas

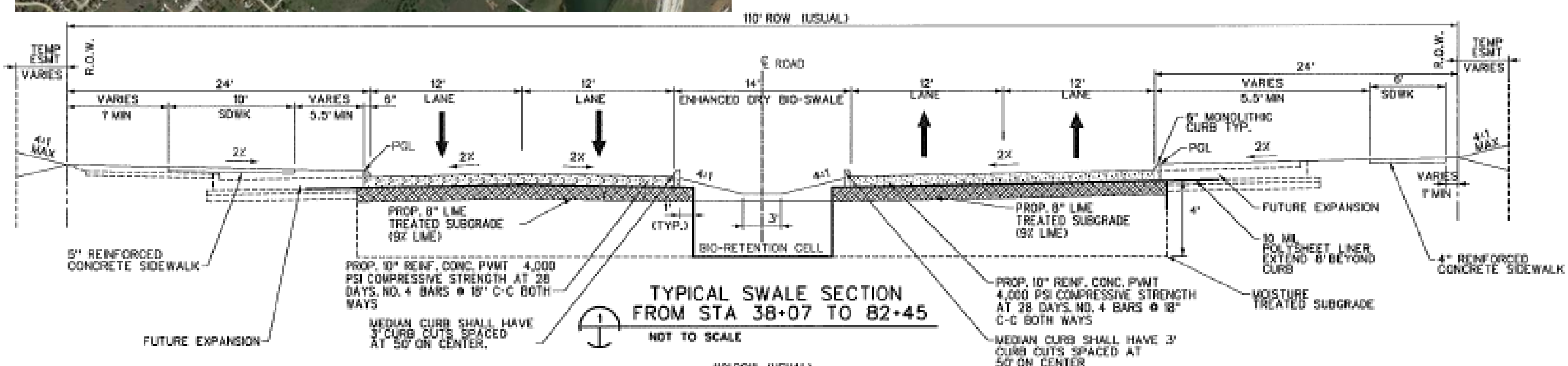


Elm Fork Complex, Dallas

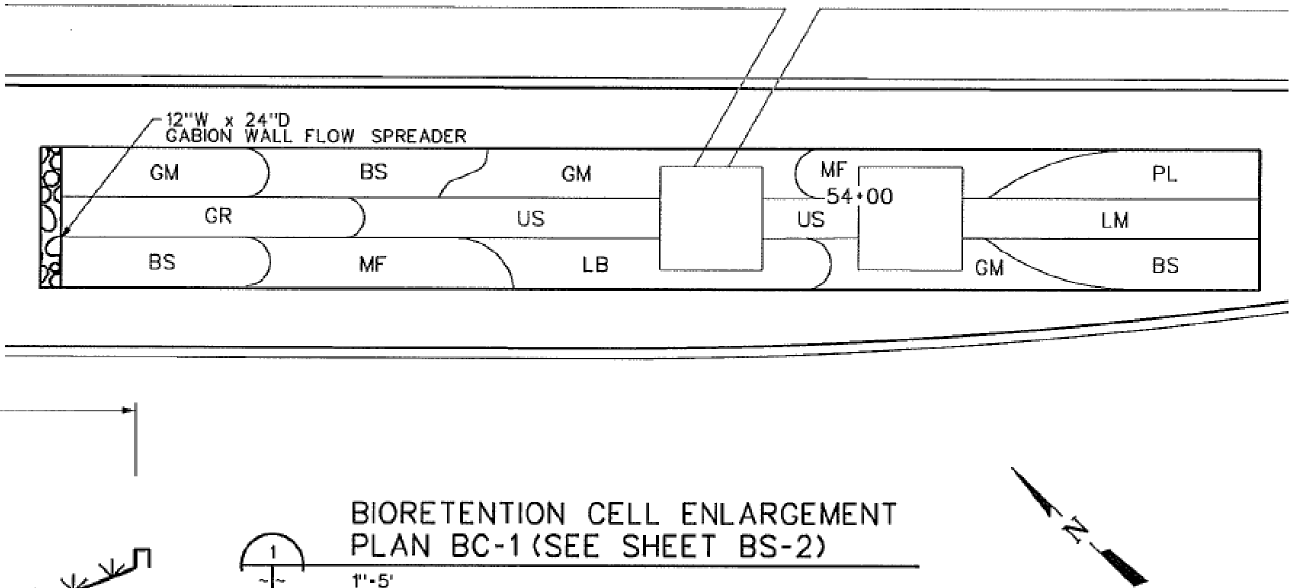


Merritt Road, Rowlett

- Approx. 9,070 foot roadway project
- Approx. 3,600 feet of bioretention swales
- Between Liberty Grove Road and Pleasant Valley Road
- To be constructed Fall 2011 to Spring 2013

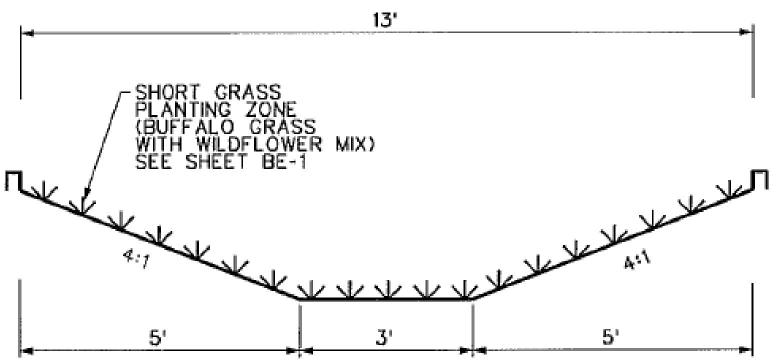


Merritt Road, Rowlett



BIORETENTION CELL ENLARGEMENT PLAN BC-1 (SEE SHEET BS-2)

1"-5'

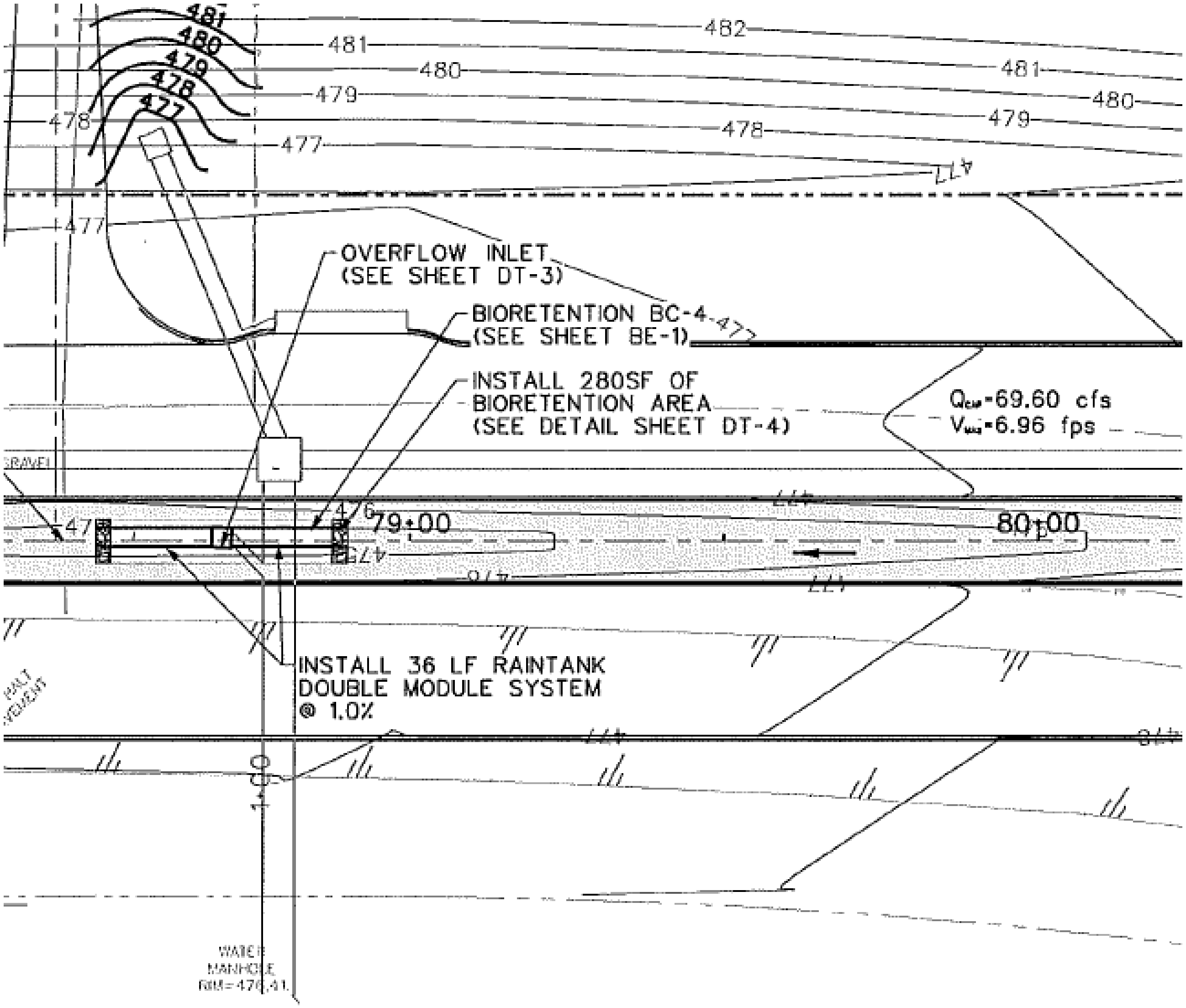


TYPICAL MEDIAN SWALE WIDTH

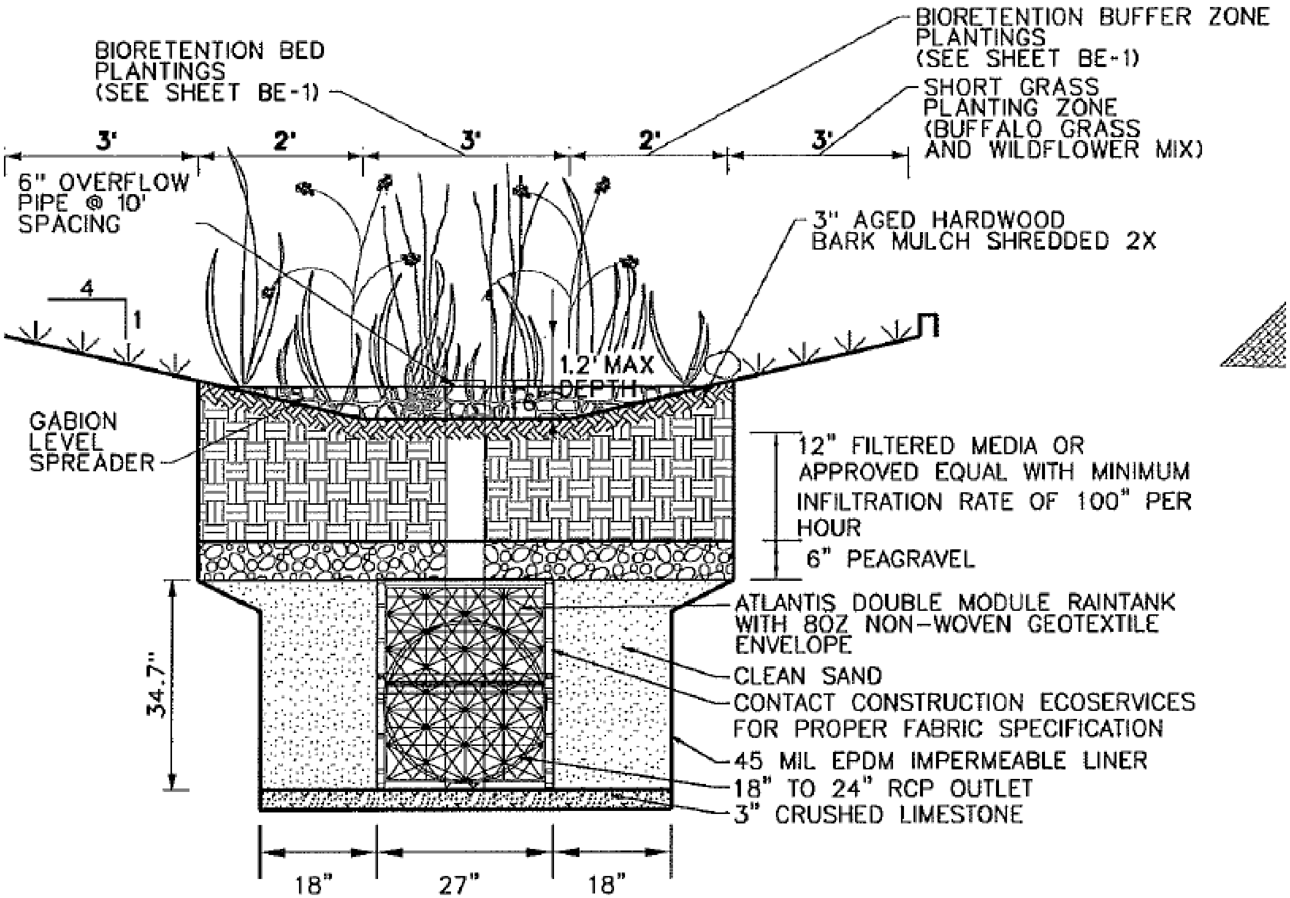
NOT TO SCALE

BASE BID - BIOSWALE & BIORETENTION CELL PLANT SCHEDULE				
ABBREV.	PLANT NAME	SIZE	REMARKS	QTY
SHRUBS AND GRASSES				
BS	BLACK-EYED SUSAN *RUDBECKIA HIRTA*	3 GAL. MIN.	CONTAINER, 24" O.C., 0.28 PLANTS/SF	56
US	UPLAND SWITCHGRASS *PANICUM VIRGATUM*	3 GAL. MIN.	CONTAINER, 36" O.C., 0.12 PLANTS/SF	10
LB	LITTLE BLUESTEM *SCHIZACHYRIUM SCOPARIUM*	3 GAL. MIN.	CONTAINER, 36" O.C., 0.12 PLANTS/SF	10
MF	MEXICAN FEATHER GRASS *NASSELLA TENUISSIMA*	3 GAL. MIN.	CONTAINER, 18" O.C., 0.50 PLANTS/SF	70
LM	LINDHEIMER MUHLY *MUHLENBERGIA LINDHEIMERI*	3 GAL. MIN.	CONTAINER, 36" O.C., 0.12 PLANTS/SF	8
GM	GULF MUHLY *MUHLENBERGIA CAPILLARIS*	3 GAL. MIN.	CONTAINER, 36" O.C., 0.12 PLANTS/SF	22
PL	PRAIRIE LARKSPUR *DELPHINIUM CAROLINIANUM*	3 GAL. MIN.	CONTAINER, 18" O.C., 0.50 PLANTS/SF	60

Merritt Road, Rowlett



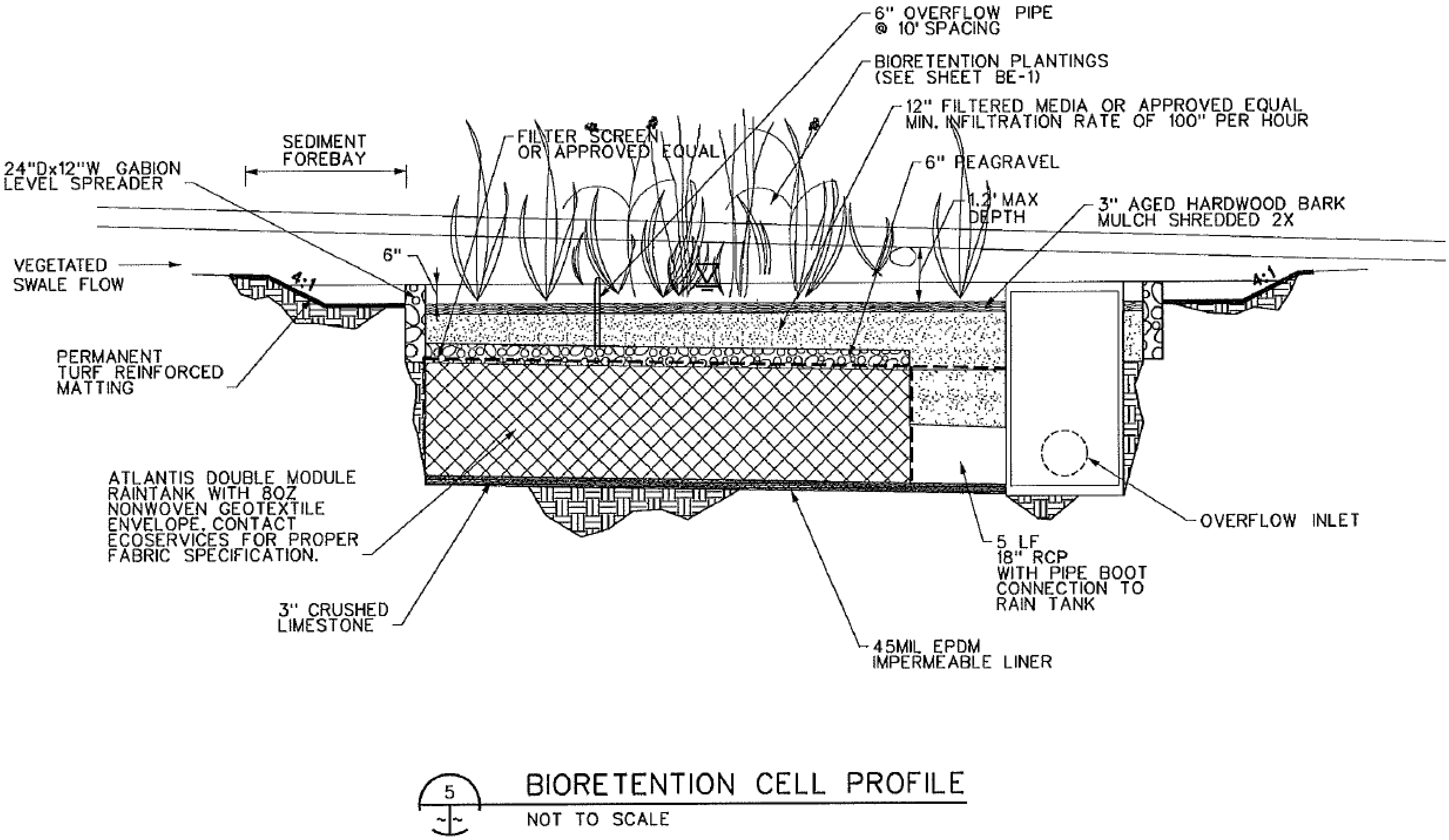
Merritt Road, Rowlett



BIORETENTION CELL

NOT TO SCALE

Merritt Road, Rowlett



FREESE AND NICHOLS

Future Direction of Water Quality

North Central Texas Council of Governments

iSWM

Sure - I can tell you exactly where things are going… now let me see…


What we’re doing
is not working!

The primary regulatory driver today is shifting toward <u>volume mimicry</u>

How much rainfall did nature keep from running off?

OK do that.

New EPA Direction – Numeric Volume-Based Standard

- Retain all runoff up to a specified percentile rainfall event – 85% to 95% - or depth – approx. 1" to 1.5"
- On-site practices must either infiltrate, evapotranspire, or reuse required volume of stormwater
- Might require impervious area treatment numbers
- Currently being implemented through:
  - Section 438 of EISA
  - Washington DC MS4 permit
  - Chesapeake Guidance document
  - Potential in new Post-construction rule
  - About 10-15new state permits

In a nutshell…

For the regulator community, and thus for us, this sort of boils down to:

❶ ❷ ❸

“For <u>our program</u> the

<u>right volume</u> must be <u>retained</u>

on site”

Or treated… or on another site…

or pay up

iSWM

Why should I Retain ?

"For our program…"

What are your drivers?

- **Regulatory Mandate – comply (of course!)**
- Reuse – pricing for reuse vs. normal supply
- Water Supply – can Green Infrastructure enhance water conservation?
- Groundwater Replenishment – mimic nature, restore falling table
- Pollution removal – capture enough to meet targets

iSWM

How much should I retain ?

"…the right volume…"

For regulatory programs, what kind of volumes are we talking about?

1. Federal Facilities & Chesapeake Bay – 95% storm
2. Washington DC draft MS4 – 90% storm
3. West Virginia – 85% storm (≈1”)
4. Then a mishmash of first flush, first “X” from directly connected impervious area, flow duration, etc.

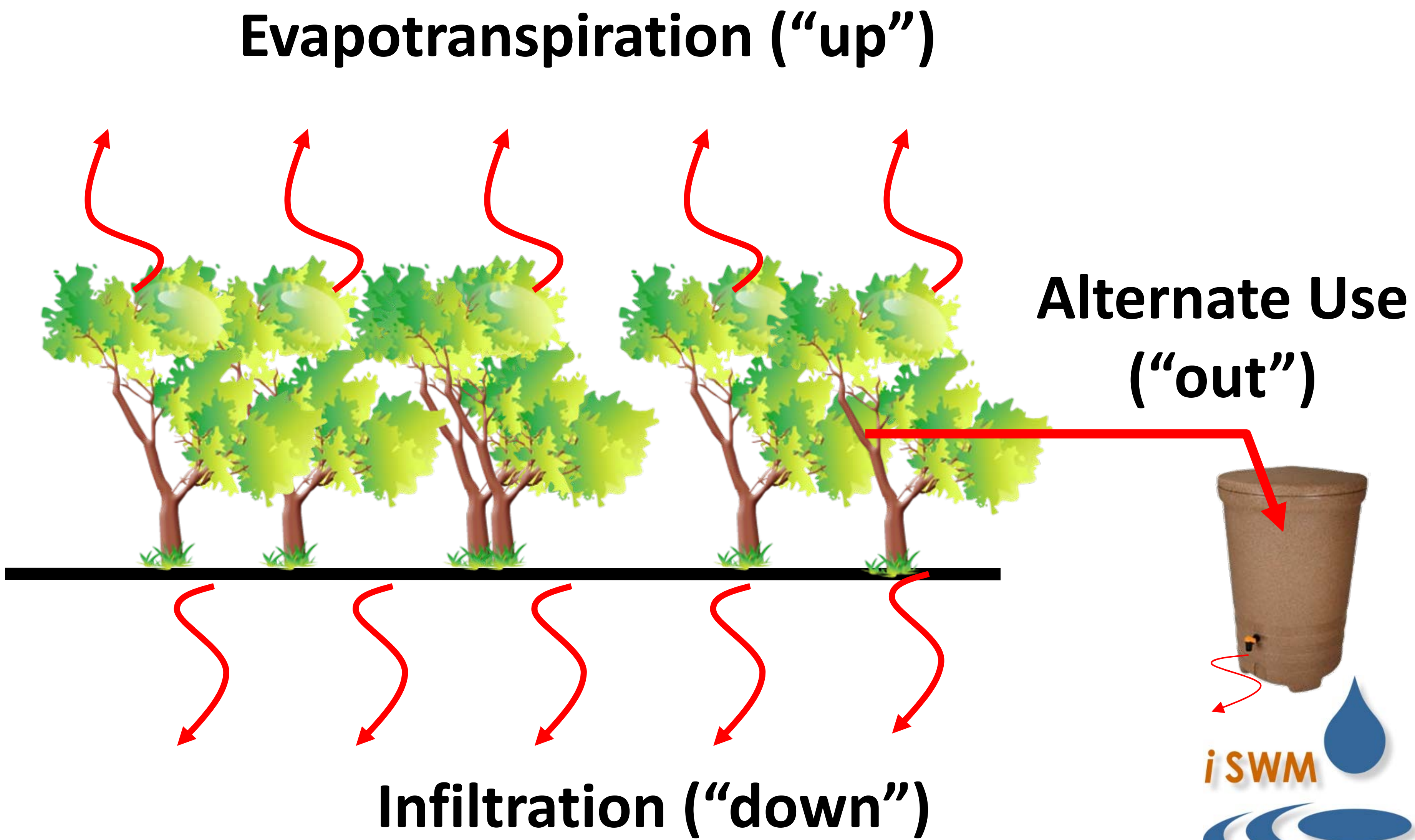
Is 1.5” the “right volume” for Texas retention?

iSWM

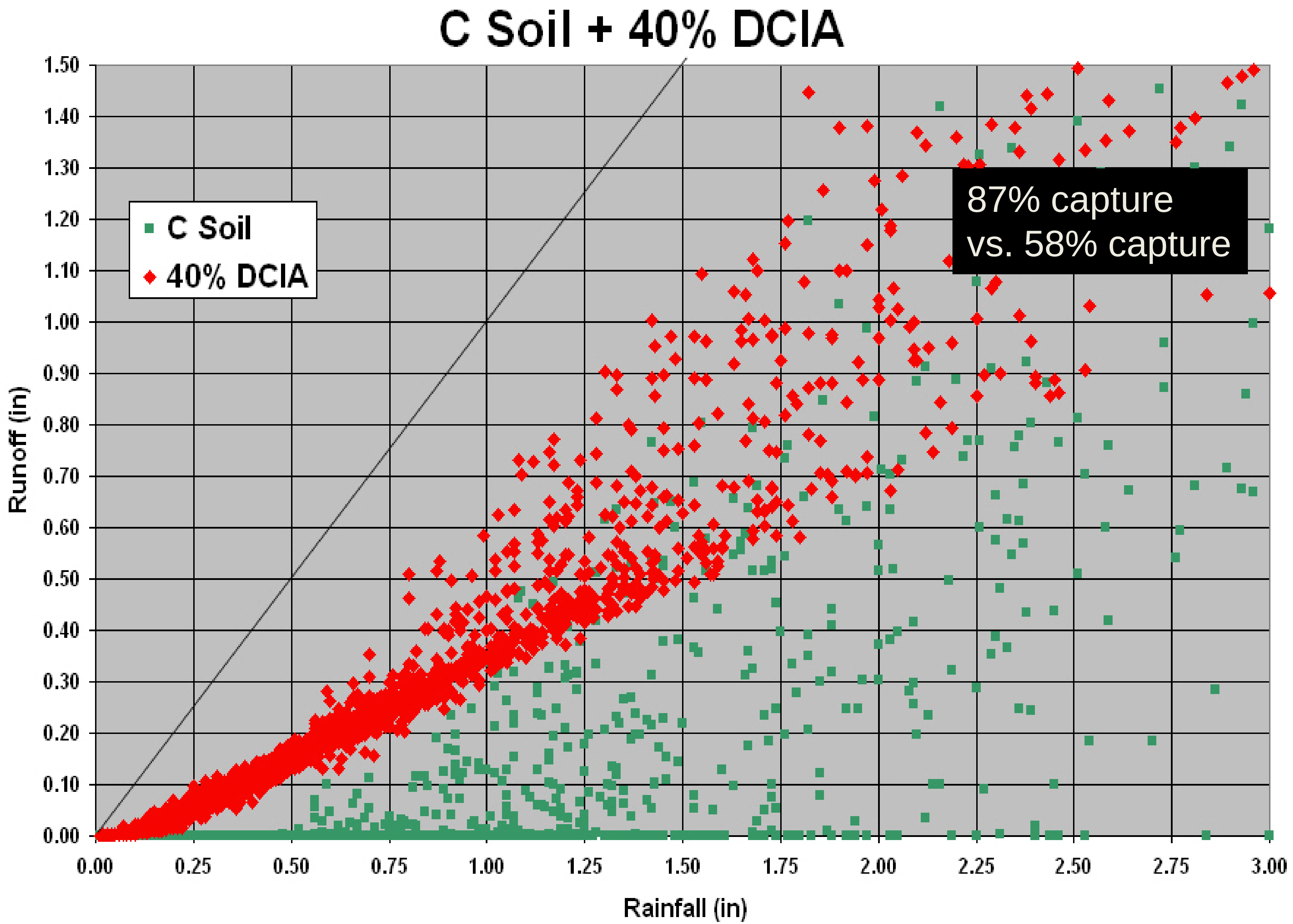
What does “retain” mean?

“…must be retained on site”

"retain" means...

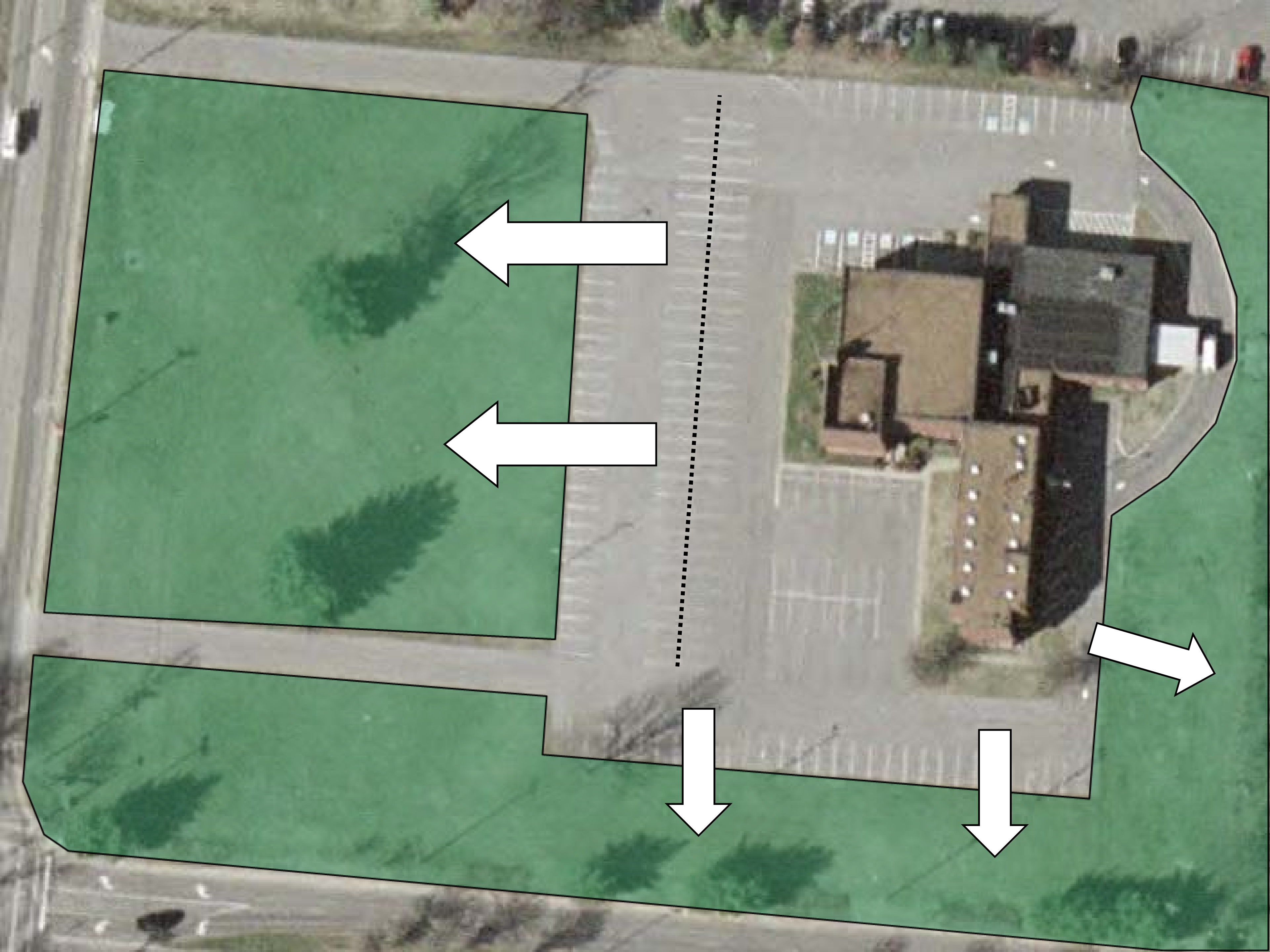


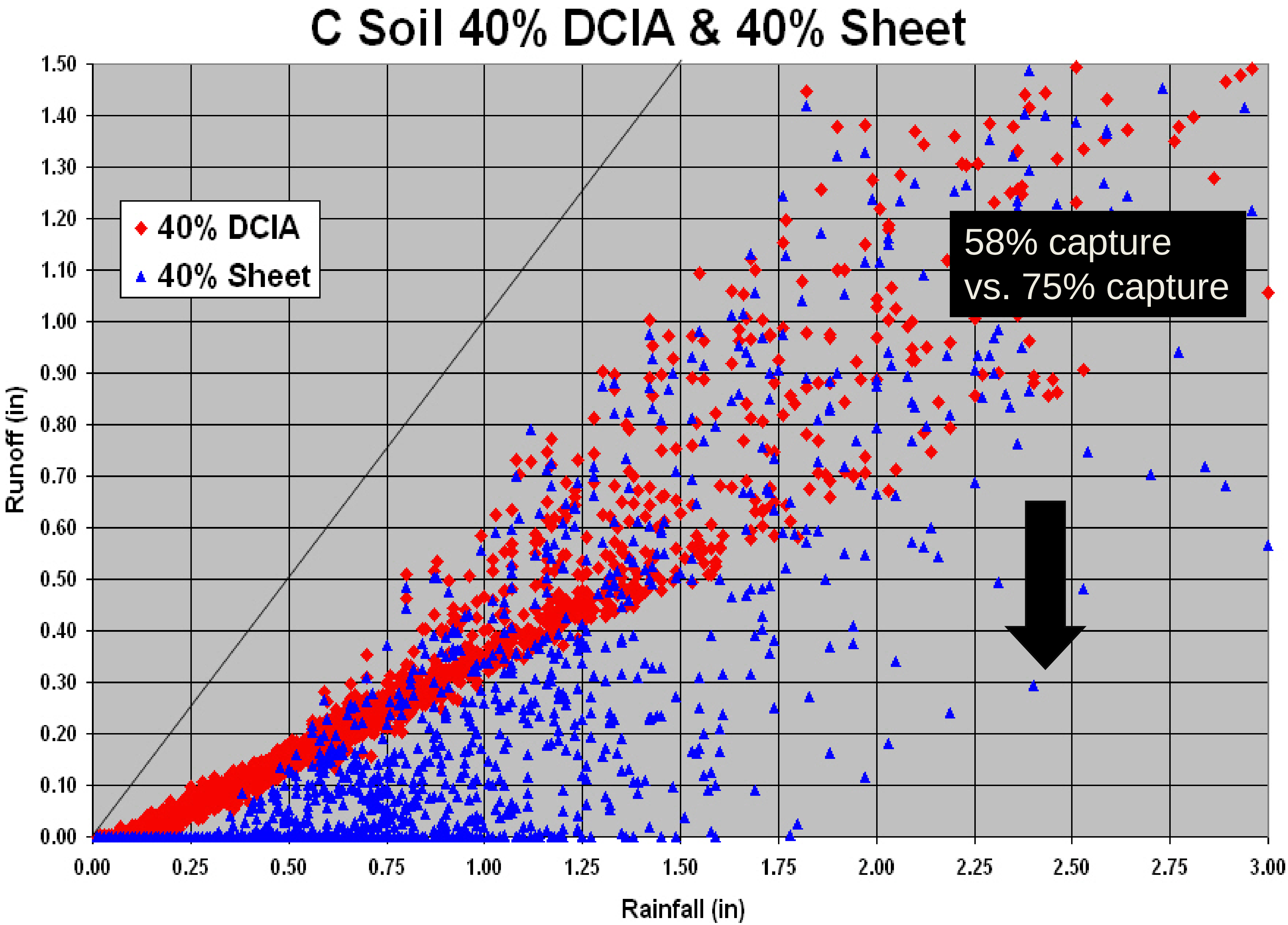

40% Impervious DCIA


C Soil + 40% DCIA
C Soil
40% DCIA
87% capture
vs. 58% capture
Runoff (in)
Rainfall (in)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00

Steps to "retain" water?

1. The very best way is to develop in such a way that little water runs off – "Better Site Design"



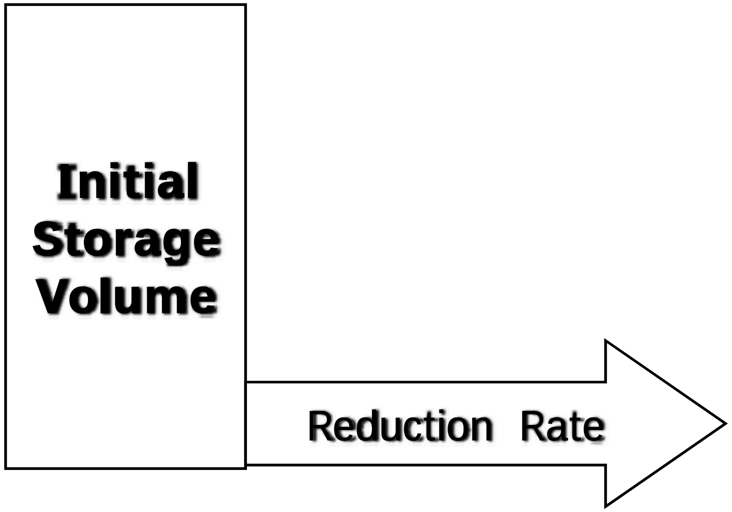

C Soil 40% DCIA & 40% Sheet
40% DCIA
40% Sheet
58% capture
vs. 75% capture
Runoff (in)
Rainfall (in)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00

Steps to "retain" water?

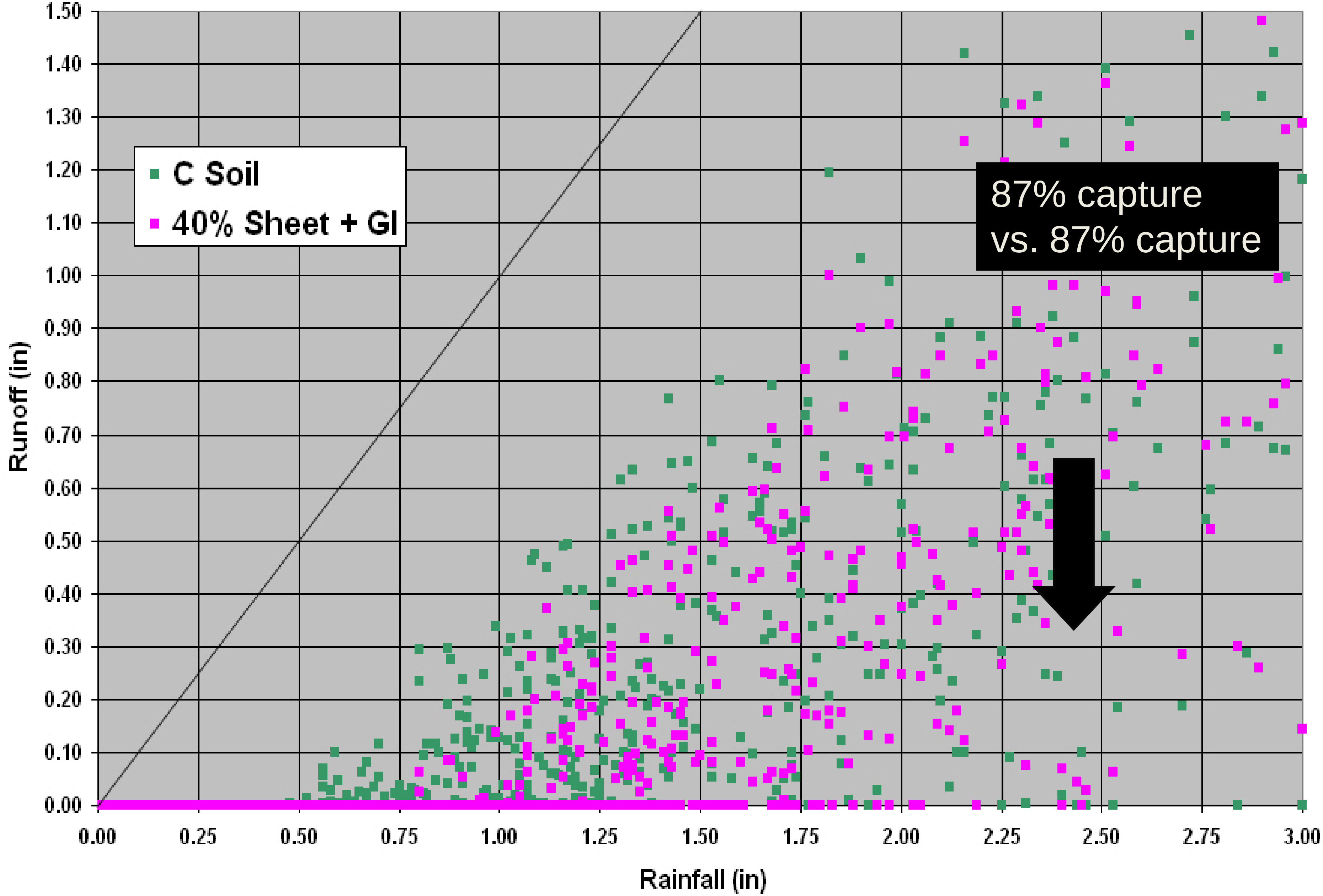
1. The very best way is to develop in such a way that little water runs off – "Better Site Design"
2. After that has been done (or if it is too late) then look to other kinds of Green Infrastructure controls…

Green Infrastructure Signatures

1. Infiltration-based BMPs
   - Bioretention
   - Porous Surfaces
   - Amended soils
2. Rainwater Harvesting and Use
   - Cisterns
   - Rain Barrels
3. Evapotranspiration
   - Trees
   - Green roofs



C Soil + Sheet Flow and Green Infrastructure



In closing:

1. There is a rapid change in thinking toward capture of stormwater & Green Infrastructure – its almost everywhere but…
2. …it may be years away in Texas. But…
3. …it may be a way to attain hydrologic mimicry at less cost than now.

4. But what IS on your horizon?

How Does LEED Fit In?

LEED SS Credit 6.1: Stormwater Management Design Requirements that Reduces Storm Water Runoff (Quantity Control) – **1 point**

- <u>CASE 1. Sites with Existing Imperviousness 50% or Less</u>
  - *OPTION 1:* Post development peak discharge rate and quantity does not exceed the predevelopment peak discharge rate and quantity for the 1- and 2-year 24-hour design storms.
  - *OPTION 2:* Protect receiving stream channels from excessive erosion.
- <u>CASE 2. Sites with Existing Imperviousness Greater Than 50%</u>
  - Implement a stormwater management plan that results in a 25% decrease in the volume of stormwater runoff from the 2-year 24-hour design storm.

How Does LEED Fit In?

LEED SS Credit 6.2: Stormwater Management Design Requirements that Improve Quality of Stormwater Runoff (Quality Control) – **1 point**

- Treat the stormwater runoff from the 90% storm using BMPs.
  - Semiarid Watersheds (20 to 40 inches annually)- 0.75 in. of rainfall
- BMPs must remove 80% of the average TSS load.
- BMPs are considered to meet these criteria if:
  - They are designed in accordance with standards and specifications from a state or local program that has adopted these performance standards, OR
  - There exists infield performance monitoring data demonstrating compliance with the criteria.

QUESTIONS?

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