4.3 SUSTAINABLE DRAINAGE DESIGN

Sustainable drainage design is necessary for the protection of creek, river, and tidal waters in order to manage stormwater runoff rates and reduce channel erosion and flooding. This section presents the methodology to calculate the drainage design volume and low impact development options to satisfy performance standards. If a planned development cannot achieve compliance with the given low impact development standards, then the project shall provide the design volume in approved structural measures found in Chapter 5.

4.3.1 LOW IMPACT DEVELOPMENT

SINGLE-FAMILY DEVELOPMENT

Low impact development (LID) standards employing low impervious cover levels with vegetative conveyance of stormwater runoff allow developments to protect water quality while minimizing cost and long-term maintenance needs. Compliance with the following specifications is assumed to meet the 80% total suspended solids and peak flow rate management standards using a design storm rainfall depth of 1.5 inches. Development eligible for these low impact development standards must meet the following design requirements:

- The gross development site impervious cover is 20% or less and the cluster development sections (individual drainage areas) have 25% or less gross impervious cover;
- Street and drainage networks are designed to include the use of open-roadway sections, ribbon curb, and maintenance of sheet flow;
- Stormwater credits as defined in this guidance manual can be used to gain compliance with the impervious cover limits stated above; and
- Commercial tracts with gross impervious cover less than 20% can obtain compliance by providing vegetated filter strips per below and satisfying the above conditions.

A cluster development section can be considered as an individual drainage area or discharge point containing development. The impervious cover is computed within this area and divided by the drainage area to determine the cluster development impervious cover percentage.

COMMERCIAL DEVELOPMENT

For commercial projects less than three (3) acres in area, low impact development measures employing vegetated filter strips and grassy swales can be used to comply with performance standards. Commercial development eligible for these low impact development option must meet the following design requirements:

- Projects less than three (3) acres in area can achieve compliance with this section through the use of vegetated filter strips, vegetated swales, and flow spreading methodologies.
- The vegetated filter strip area is computed per the criteria found in this Chapter and designed and constructed per the guidance in Chapter 5.
- Vegetative filter strips must be located down-gradient of the developed areas.
- Runoff must discharge in a sheet flow manner from the impervious areas to the vegetated filter strips.

Projects gaining compliance with low impact development standards still must perform pre-development planning (if required), delineate buffers, prepare an erosion and sediment control plan, and incorporate water quality education materials.

4.3.2. STORMWATER CREDITS FOR LOW IMPACT DEVELOPMENT COMPLIANCE

The stormwater basin sizing criteria provides a strong incentive to reduce impervious cover at development sites, since significant reductions in impervious cover will result in smaller and less costly sustainable drainage measures.

The techniques presented below are considered options for use by designers to gain compliance with the low impact development approach or reduce the size of structural control measures. Due to local codes, soil conditions, and topography, some of these site design features may be restricted. In single-family subdivisions, stormwater credits will most likely be accrued on single-family lots. Since these activities will be constructed by homebuilders and not the developer, the stormwater credit will require easements, deed restrictions, or other articles approved by a regulating entity in the permitting process to ensure the proper installation, maintenance, and survivability. Additional details for each credit can be found in Chapter 5.

Table 4-3: Stormwater Credits for Low Impact Development

Stormwater Credits	Alternate Standard Application	Stormwater Volume Application	Comments
Porous Pavement or Pavers	Reduce paved area IC by 90%	Reduce paved area IC by %90	Product information shall support infiltration in excess of 10 inches per hour
Rainwater Harvesting (cisterns)	Reduce roof top IC up to 75%	Reduce roof top IC based on tank volume ratio to catchment area	Tank volume requirements related to catchment area
Soil Amendment	Reduce IC by 2%	Reduce drainage area IC by 2%	6-8" blended soil depth and appropriate turf
Conservation Landscaping	Reduce IC by 5%	Reduce drainage area IC by 5%	Limitations on turf area, use native plants/shrubs
Disconnection of Roof-Top Runoff	Deduction of rooftop IC based on flow length and rainwater storage	Deduction of rooftop IC based on flow length and rainwater storage	75' flow length for full deduction with 90% grass
Natural Area Preservation	Include natural area in development cluster IC calculation	Natural area is subtracted from drainage basin area	Supports conservation development initiatives, yet connects to hydrology
Vegetated Filter Strips	Reduce IC by 50%	Reduce contributing drainage area IC by 50%	Natural filter strip minimum width of 25 feet or engineered filter strip minimum width of 15 feet and other criteria (slope, vegetation) are met
Vegetated Swale	Reduce IC by 20%	Reduce contributing drainage area IC by 20%	Vegetated channel with a slope of less than 0.5%, a minimum length of 50 feet and a maximum drainage area of 2 acres

IC = Impervious Cover
VFS = Vegetated Filter Strip

See next page for calculation procedures for each stormwater credit.

Porous pavement/pavers. Refers to porous asphalt, concrete, and paver surfaces through which stormwater runoff can infiltrate to the soil profile. Reduced impervious cover credit is computed per Equation 4.1.

Equation 4.1 **Ar = Ap * 0.90**

Where:
Ar = Allowable reduction in impervious cover
Ap = Area of porous pavement or pavers

See Chapter 5 for details and specifications.

Rainwater Harvesting. Refers to the collection of stormwater runoff from roof-tops and its use for domestic or landscape purposes. Reduced impervious cover credit is computed per Equation 4.2. See Figure 4-1 below.

Equation 4.2 **Ar = ART * %IC REDUCTION FACTOR (Per Figure 4-1 below)**

Where:
Ar = Allowable reduction in impervious cover
ART = Area of roof-top directed to rain barrel(s) (catchment area) (sq ft)
% IC REDUCTION FACTOR = % Impervious area reduction
RBV = Rain barrel volume (cubic feet)

See Chapter 5 for details and specifications.

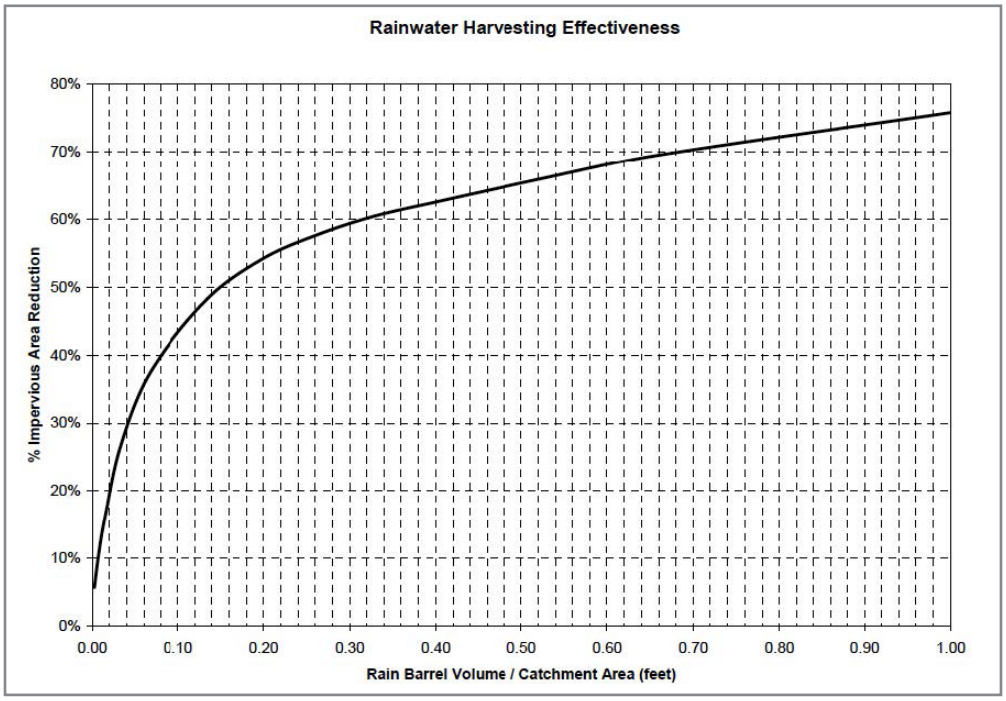

Figure 4-1: Rainwater Collection Credit (Photo courtesy of LCRA Highland Lakes Water Quality Technical Manual, 2007)

Soil Amendment. Refers to the placement of native or blended soils to a depth of six (6) to eight (8) inches to support appropriate turf grasses and landscaping. The soil amendment is applied to all lots within the development. Reduced impervious cover credit is computed by Equation 4.3.

Equation 4.3 **Ar = A * 0.02**

Where:
Ar = Allowable reduction in impervious cover
AA = Amended area

Conservation Landscaping. Refers to the use of limited turf area, preservation of natural vegetation, and the planting of native trees, shrubs, and perennials to infiltrate stormwater runoff and minimize chemical use. Conservation landscaping should be applied to all lots within the development. Reduced impervious cover credit is computed by Equation 4.4.

Equation 4.4 **Ar = AA * 0.05**
Where: Ar = Allowable reduction in impervious cover
AA = Amended area

See Chapter 5 for details and specifications.

Roof-top Disconnection Credit. Using Table 4-4, the designer can deduct the disconnected impervious cover from the total impervious cover. The credit is based on distance of disconnection of roof top from conveyance system and/or use of localized water storage areas (rain gardens, bioretention, dry well, or cistern) in combination with the roof-top disconnection length. This credit applies only to single-family development with an average lawn slope of 5% or less.

Table 4-4: Rooftop Disconnection Impervious Cover Credit

Disconnection Length Provided	0 to 14 ft.	15 to 29 ft.	30 to 44 ft.	45 to 59 ft.	61 to 74 ft.	> 75 ft.
% Impervious Cover Credit	10%	20%	40%	60%	80%	100%
Dry Well, Rainwater Harvesting, Rain Garden, Storage Volume Required to achieve 100% Credit (in combination with flow length)	104 cu-ft.	83 cu-ft.	62 cu-ft.	42 cu-ft.	21 cu-ft.	0 cu-ft.

Source: LCRA Highland Lakes Water Quality Technical Manual, 2007.

Equation 4.5 **Ar = ART * %ICD**
Where: Ar = Allowable reduction in impervious cover
ART = Area of roof-top
%ICD = Impervious cover credit factor per Table 4-3

The reduction in impervious cover per the above techniques is summed and then subtracted from the total impervious cover to determine the effective impervious cover.

Equation 4.6 **ICeff = ICTOT - (Sum of individual Ar)**
Where: ICeff = Effective impervious cover
ICTOT = Total impervious cover

The effective impervious cover is used to determine Low impact development compliance or compute the structural measure volume.

Natural Area Preservation Credit. The credit for stormwater basin volume is computed by subtracting the preserved area from the area draining to individual stormwater control measures. This credit is granted for all preservation areas permanently protected under conservation easements or other locally acceptable means. The credit is computed by Equation 4.7.

Equation 4.7 **DAeff = DATOT - ANA**
Where: DAeff = Effective drainage area
ANA = Natural area preserved
DATOT = Total drainage area

When computing stormwater volume for a measure using the natural area preservation credit, the designer will not need to adjust the effective impervious cover based on the reduced drainage area.

Vegetated Filter Strip Credit. The credit is applied when parking lots and roads drain via sheet flow to a natural or engineered filter strip per the criteria and specifications in Chapter 5.

Equation 4.8 **Ar = Ap * 0.50**
Where: Ar = Allowable reduction in impervious cover
Ap = Area of parking lot or street with a maximum flow length of 72 ft

Vegetated Swale. The credit is applied when parking lots, roads, and rooftops drain to a vegetated swale designed per the criteria and specifications in Chapter 5.

Equation 4.9 **Ar = Ap * 0.20**
Where: Ar = Allowable reduction in impervious cover
Ap = Area of parking lot or street within a 2-acre drainage area

Percent impervious cover. Use Equation 4.10 to find the percentage of impervious cover.

Equation 4.10 **IC = ICeff / DATOT**
Where: IC = Percent impervious cover

4.3.3. STRUCTURAL PRACTICES SIZING CRITERIA

Structural practices are sized to accomplish water quality protection, creek erosion management, and runoff rate management.

Designers are encouraged to use the design spreadsheet model to compute stormwater volume requirements and determine the benefits of developing under the Low Impact Development approach. The model can be obtained from the GLO website at https://cleancoast.texas.gov/.

STRUCTURAL CONTROLS

Stormwater runoff generated on the site must be managed through the use of one or more of these structural practices if low impact development compliance is not achieved:

- Vegetated Swale
- Vegetated Filter Strip
- Porous Pavement/pavers
- Enhanced Detention
- Bioretention/Rain gardens
- Infiltration Basins

For the structural practices that are sized based on runoff volume (bioretention, enhanced detention, infiltration basins, porous pavement/pavers), the capture volume must be sized to accommodate the runoff from a 1.5" rainfall event at a minimum. The runoff coefficient is a function of the impervious cover and is calculated as:

Equation 4.9 $\boldsymbol{Rv = 0.05 + 0.90IC}$

Where:

Rv = Runoff Coefficient

IC = Fraction of impervious cover in the catchment of the structural practice

The minimum capture volume is then calculated as:

Equation 4.10 $\boldsymbol{V = P \times A \times Rv/12}$

Where:

V = Minimum required capture volume

P = Rainfall depth (1.5 inches)

A = Watershed area of the practice (ft^2)

Rv = Runoff Coefficient

Table 4-5: Runoff Volume 1.5 Inch Storm

Impervious Cover Percentage	Runoff Volume (in)
15%	0.28
20%	0.35
30%	0.48
40%	0.62
50%	0.75
60%	0.89
70%	1.02
80%	1.16
90%	1.29
100%	1.43

The 1.5-inch rainfall event runoff volume will be detained a minimum of 24-hours but not longer than 72 hours.

To provide sediment storage between structural practice maintenance, the structural practice capture volume is increased by 5%.