5.4.7 Infiltration Areas

Description: Infiltration areas are properly sized engineered vegetated areas designated to receive runoff from disconnected roof downspouts, driveways, parking lots, and other impervious areas. Infiltration areas are low cost and have been proven to reduce the volume and flows associated with stormwater runoff.

Figure 1: Roof downspout is directed to an infiltration area (Source: The SMART Center).

Key Design Criteria: (NC, 2014)

- Must provide adequate sheet flow.
- **Vegetated cover:** dense lawn with no clumping species.

Site Constraints:

- **Setback from building foundations:** 5 feet
- **Setback from water supply wells:** none
- **Soil type:** any
- **Maximum slope:** 7 percent with land graded to promote sheet flow for B, C, and D soils, 15% for A soil
- **Seasonal high table requirement:** none
- **Hotspots:** shall not be used to treat stormwater hotspot

Advantages:

- Cost effective
- Promotes infiltration, reducing runoff volume & peak discharge
- Vegetated areas for infiltration provide aesthetics

Disadvantages:

- For appreciable volume and peak discharge reduction, must be applied broadly
- Requires owner buy-in and maintenance to ensure proper drainage
- May require large on-lot pervious areas
- Must avoid causing foundation flooding or ice hazards
- Difficult to regulate and oversee, especially for subdivision grading permit projects

Maintenance:

- Should be accessible by mowing equipment
- Remove sediment and debris from contributing impervious surfaces.
- Repair any areas that are eroding or where vegetation has died.
- Re-grade the soil if necessary to remove the gully and re-seed and water until it is established.

Design Checklist:

- ❑ Ensure acceptable conditions for construction
- ❑ Design the Drainage and Outlet System
- ❑ Design infiltration area in accordance with design criteria and typical details
- ❑ Submit plans for review

1. Design

1.1 Description

An infiltration area is a vegetated area that is sized and graded to receive discharges runoff from built-upon area (usually a roof or a paved surface) to reduce runoff and pollutants. Much of the development across the state has been designed as **connected impervious surface**; that is, draining to pipes and ditches that rapidly convey stormwater without runoff reduction or treatment. Infiltration areas can only work if **impervious surfaces are disconnected** and runoff is routed to it. Using infiltration area and **Disconnected Impervious Surface (DIS)** technique can help restore the hydrology of streams and reduce pollutant loadings.

There are two types of DIS discussed in this chapter: rooftop downspout disconnection and pavement disconnection.

Rooftop Downspout Disconnection

Table 1: Simple Rooftop Disconnection Design Criteria (NCDENR, 2014).

Design Factor	Simple Disconnection
Maximum impervious (Rooftop) area treated	300 sq. ft. per disconnection
Longest flow path (roof/gutter)	75 feet
Infiltration area length	Equal to longest flow path, but no less than 40 feet[1]
Infiltration area slope	< 2%, or < 5% with turf reinforcement[2]
Distance from buildings or foundations	Extend downspouts 5 ft.[3] (15 ft. in karst areas) away from building *if grade is less than 1%*
Type of pretreatment	External (leaf screens, etc)

1 *An alternative runoff reduction practice must be used when the disconnection length is less than 40 feet.*

2 *Turf reinforcement may include appropriate reinforcing materials that are confirmed by the designer to be non-erosive for the specific characteristics and flow rates anticipated at each individual application, and acceptable to TDEC.*

3 *Note that the downspout extension of 5 feet is intended for simple foundations. The use of a dry well or French drain adjacent to an in-ground basement or finished floor area should be carefully designed and coordinated with the design of the structure's water-proofing system (foundation drains, etc.), or avoided altogether.*

Pavement Disconnection

Table 2: Pavement Disconnection Design Criteria (NCDENR, 2014).

Design Factor	Simple Disconnection
Maximum run of the flow on the pavement	100 feet
Maximum slope of the pavement	7%
Infiltration area length	Min. 10 feet
Infiltration area slope	Max. 7%
A gravel verge or other transition shall be provided between the edge of the paved surface and the infiltration area.	

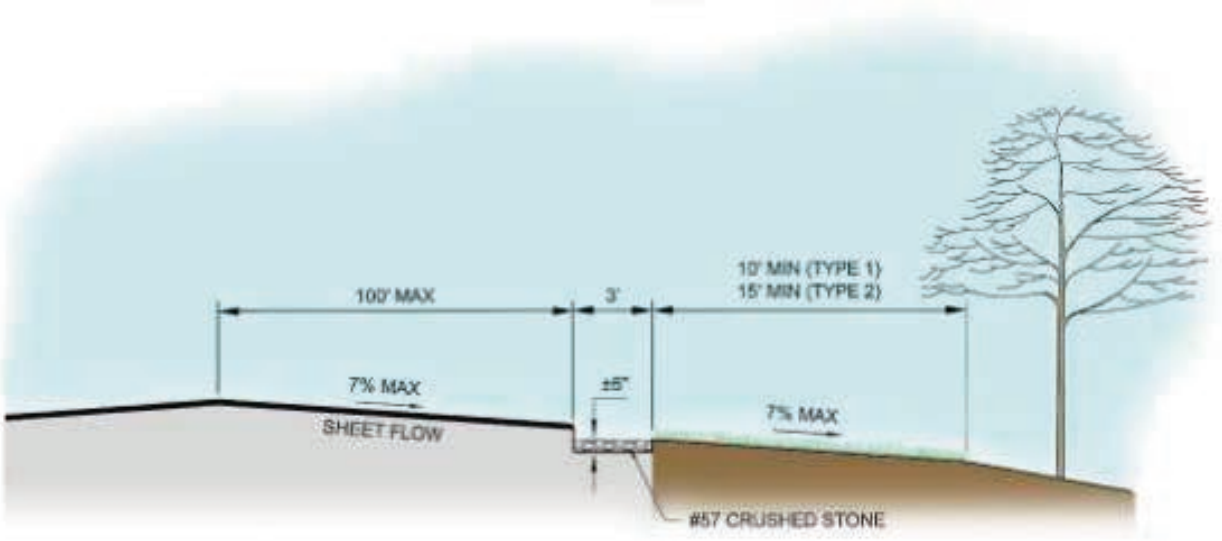

Figure 2: Schematic Cross Section of a Disconnected Paved Area (Source: NCDENR, 2014).

1.2 Major Design Elements

Table 3: Major Design Elements for Infiltration Area (NCDENR, 2014).

1. The infiltration area shall not include any impervious surface.
2. The infiltration area shall have a maximum slope of 7% for B, C and D soils and 15% for A soils with land graded to promote diffuse flow in all directions. Vegetative cover shall establish a dense lawn with no clumping species.
3. If the infiltration area is established on fill soils that are less permeable than the in-situ soils, then the soil type for crediting purposes shall be based on the fill soils. However, if the fill soils are more permeable than the in-situ soils, then the soil type for crediting shall reflect the in-situ soil type.
4. The vegetated cover shall be established dense lawn with no clumping species.
5. All sites built within the past fifty years shall be tilled to eight inches prior to vegetation establishment.
6. Recommended: There should be a minimum 5-foot distance between building foundation and infiltration area.

1.3 Siting and Feasibility

Table 4: Siting and Feasibility Considerations for Infiltration Areas (NCDENR, 2014).

Installation Size	The size of disconnected roof areas is limited to a maximum of 300 square feet per downspout. Paved areas are limited to a 100-foot run of pavement; however, there is no limit to the length of pavement that may be disconnected. This will allow most standard roadway cross-sections to be disconnected provided that there is an adequate width of infiltration area in the right-of-way.
Proximity to building foundations & utilities	As a precaution, at least five feet of setback from building foundations should be allowed for downspout disconnection. The limit of 300 square feet for each downspout makes it unlikely that foundations or underground utilities will be adversely affected by infiltration area.

Proximity to water supply wells	No setback from water supply wells is required for infiltration areas.
Status of the site as high or low density	Infiltration areas can be used on either high or low density sites. On high density sites, infiltration areas can reduce required SCM volumes. However, they may be impractical on highly built-out sites that do not have vegetated areas available to receive stormwater runoff. On low density sites, as much impervious surface as possible can be treated as infiltration area if flow rate is low.
Soil type	Infiltration areas may be used on any soil type, although the credit will vary.
Site slopes	In B, C and D soils, the vegetated areas associated with infiltration areas shall have a slope of seven percent or less. In A soils, the slope may not exceed 15 percent. It may not be cost-effective to meet the requirement for gently sloping vegetated surface on a steep site.
Seasonal high water table	There are no seasonal high water table requirements associated with infiltration area.
Stormwater hotspots	Infiltration areas shall not be used to treat stormwater hotspots – areas where concentrations of pollutants such as oils and grease, heavy metals and toxic chemicals are likely to be significantly higher than in typical stormwater runoff.
Redevelopment sites	Care should be taken when implementing infiltration areas at redevelopment sites. Stormwater shall not be infiltrated into contaminated soils because this can cause dispersion of toxic substances. If contaminated soils are present or suspected, the state recommends that the designer consult with an appropriately licensed TN professional.
Maintenance access	Because its performance depends on maintenance, infiltration areas should be accessible by mowing equipment

1.4 Design

The design standards for Infiltration Area are based on providing a minimum loading ratio of 7:1 for (rooftop area: vegetated area) or 10:1 for (pavement area: vegetated area). These loading ratios ensure a significant level of infiltration for stormwater and significant pollutant reductions.

1.4.1 Design Step 1: Ensure Acceptable Conditions for Construction

Before pursuing an infiltration area beyond the conceptual stage, the designer shall verify site feasibility and meet with the owner to explain the installation, construction and maintenance requirements of the proposed infiltration area. These costs are likely lower than other SCMs, but it is important to integrate maintenance requirements into the owner's planning for site operations.

1.4.2 Design Step 2: Design the Drainage and Outlet System

For disconnected roofs, the gutter system shall be designed so that no more than 300 square feet of roof flows to each downspout if the downspout releases at a single point as shown in Figure 3. If the flow is distributed evenly across the infiltration area via a spreading device such as a level spreader, then up to 500 square feet of rooftop may flow to the downspout. Most designs require the use of a converter joint as shown in Figure 3.

Figure 3: Disconnected downspouts on the left and a converter joint on the right (Source: Carmen, NCSU).

Figure 4 shows two potential problems with downspout disconnection. In Figure 4 (left), the converter joint was omitted and instead the four-inch corrugated plastic pipe was split. This weakens the structure and the pipe will most likely continue to split over time. In Figure 4 (right), the downspout releases onto a sidewalk instead of vegetated area. Additionally the sidewalk is graded to collect water.

Figure 4: Poorly designed and installed downspout disconnections (Source: Carmen, NCSU).

There are many possible outlet configurations for a disconnected downspout. Figure 5a-c shows a variety of possibilities. All outlet configurations should be designed with maintenance in mind. As mentioned above, outlet configurations that are equipped with a durable means of spreading the flow evenly across the vegetated filter strip shall be able to serve a larger rooftop area.

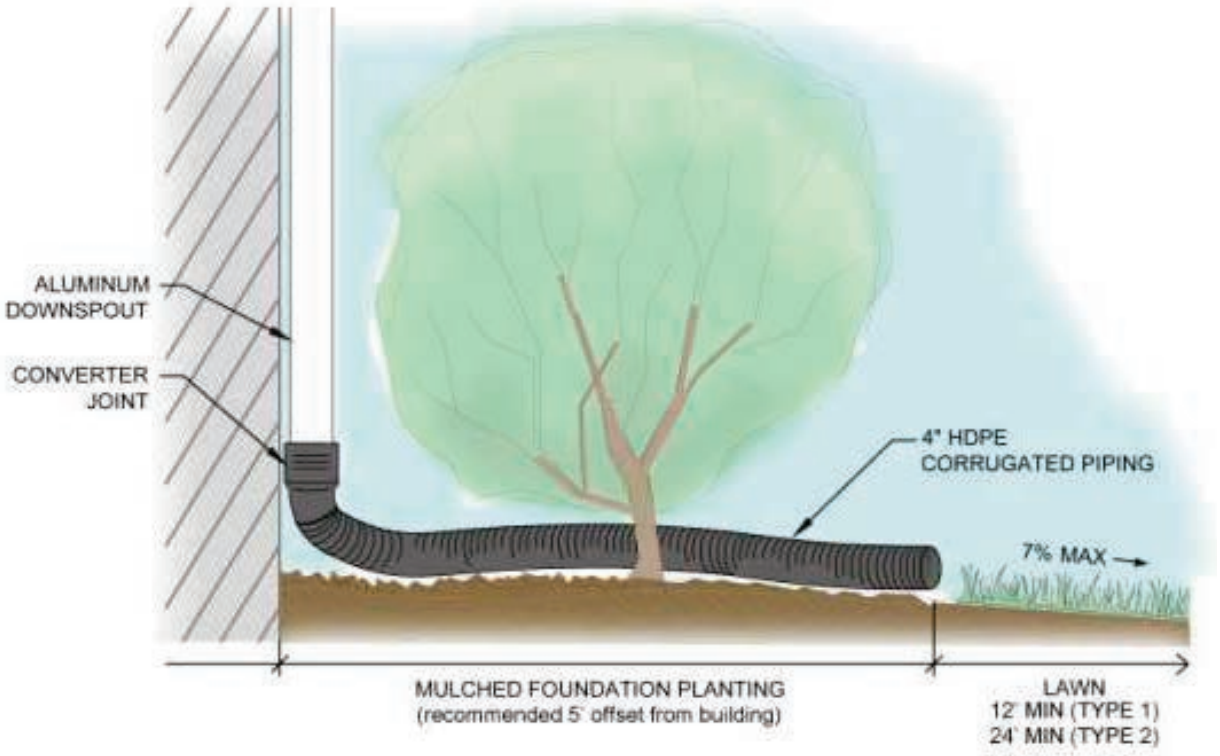

Figure 5a: Outlet configuration with a foundation planting (Source: Carmen, NCSU).

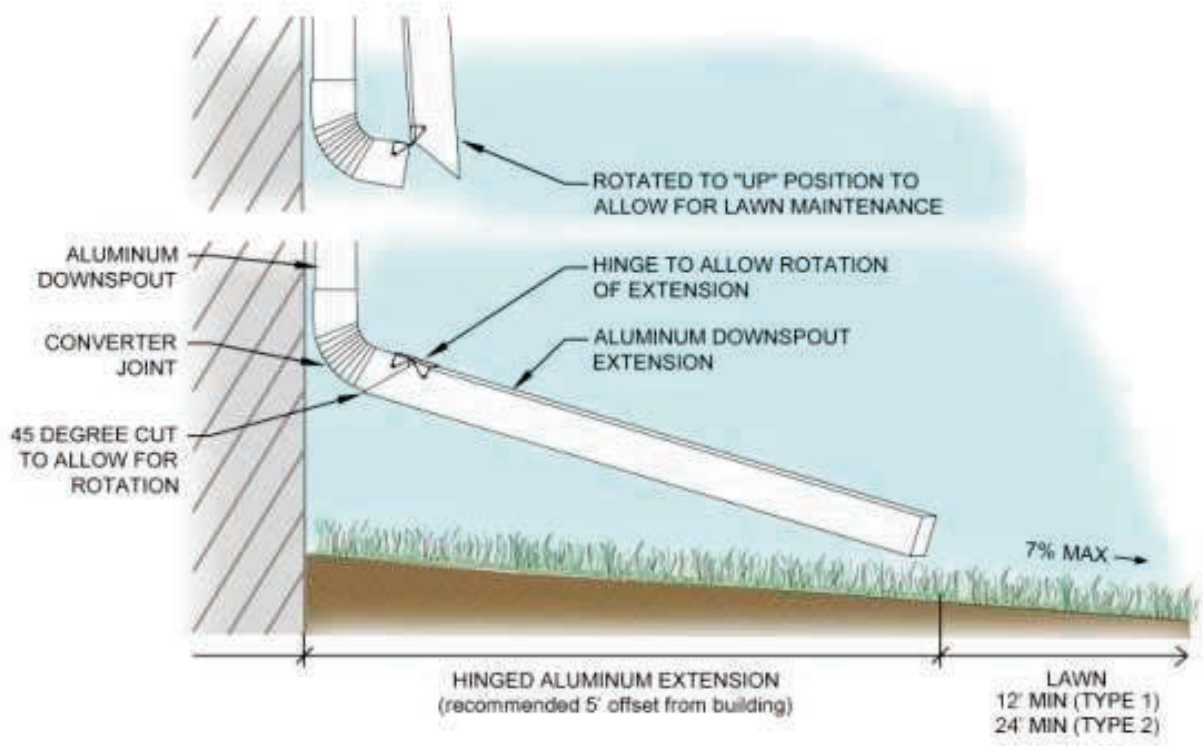

Figure 5b: Hinged outlet configuration (Source: Carmen, NCSU).

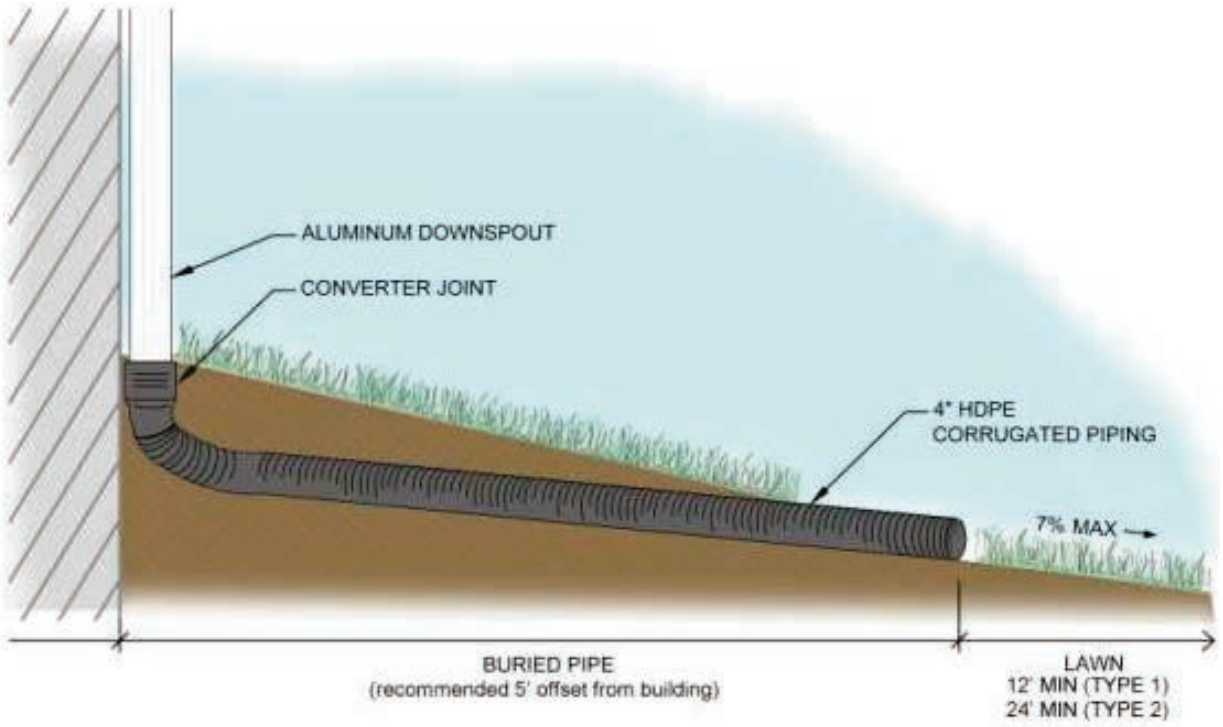

Figure 5c: Buried pipe outlet configuration (Source: Carmen, NCSU).

For disconnected pavement, a stone verge or concrete edge restraint should be used between contributing pavement and receiving vegetated area.

1.4.3 Design Step 3: Design the Infiltration Area

Disconnected downspouts and pavement shall be directed to appropriately sized infiltration areas based on Tables 1 and 2. In B, C and D soils, the vegetated receiving area shall have a uniform slope that does not exceed 7 percent. In A soils, the slope of the infiltration area may be increased up to 15 percent. The infiltration area may be graded to achieve this slope, but shall have additional positive grade at the end of the infiltration area for possible runoff to be directed offsite and not cause ponding.

If appropriate vegetation is not already established on site, then seed blend application is recommended. Seed blends should be selected based on shade/sun exposure of the infiltration area and regional climate within Tennessee. A non-clumping species should be selected. Sod should not be grown in a clay base or otherwise should be washed. Forested areas are not recommended as infiltration areas because uneven micro-topography often causes channelization, which reduces surface area exposed to stormwater.

1.4.3.1 Practice Dimensions using TNRRAT

Sizing the practice dimension can be done using the Tennessee Runoff Reduction Assessment Tool (TNRRAT). The tool allows users to iteratively size their SCM(s) to meet the goal of 1-inch runoff reduction and 80% pollutant removal. The inputs needed for the tool are:

- Location
- Management types (such as good, fair, poor forest, turf, and natural grasses)
- Soil texture
- Depth surface to restrictive layer
- Type of materials

1.4.3.2 Practice Dimensions using other method

Although using TNRRAT is recommended, designer and engineers are welcomed to use other methods to size the infiltration area. Refer to tables 2-3, and section 1.4 for more guidance.

1.5 Typical Details

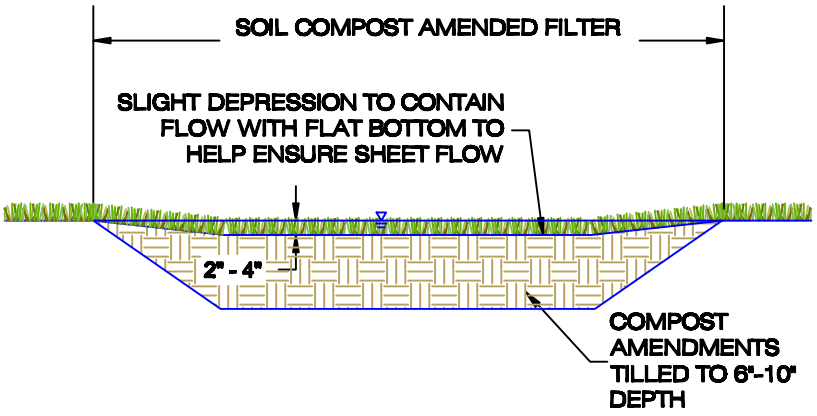

Figure 6: Disconnection: Soil Compost Amended Filter Path (Source: VADCR, 2011).

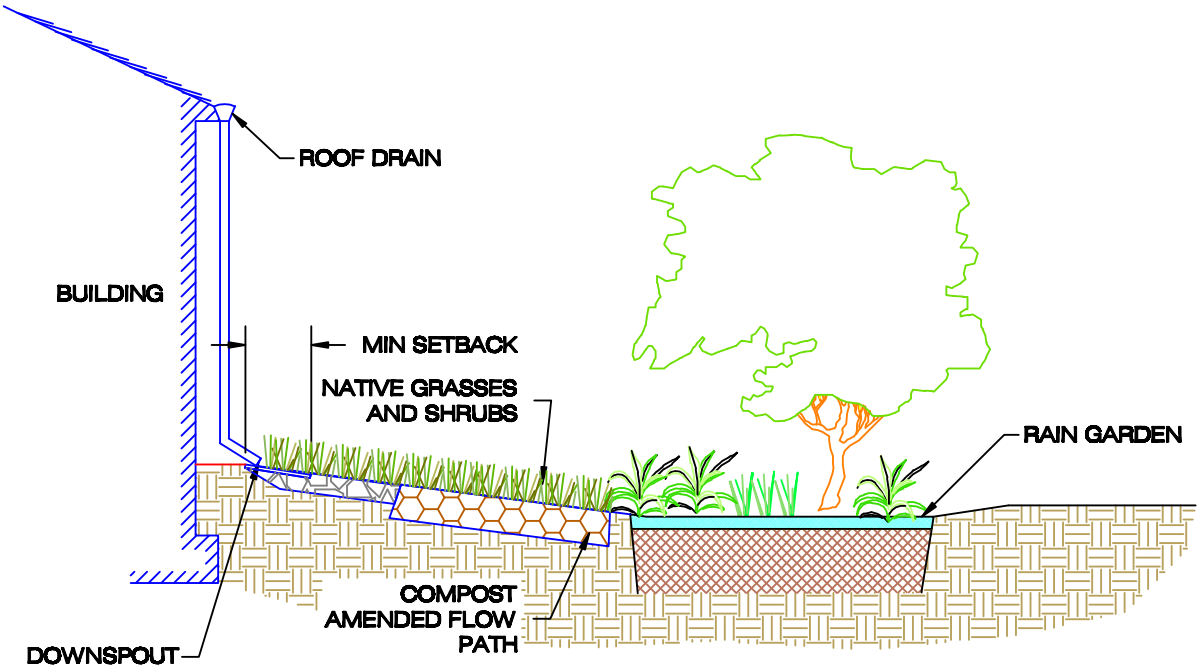

Figure 7: Rooftop Disconnection – Section View: Simple disconnection to downstream bioretention (Source: VADCR, 2011).

2. Construction

For an existing home, downspouts can be disconnected easily with minimum effort and expense if there is already an appropriately sized, sloped and vegetated area on the lot. For a new construction project, a preconstruction meeting is highly recommended to ensure contractors understand the locations and function of the infiltration area. Contractors will need to understand the need to construct the site drainage system according to the plans. Also, contractors shall grade and till the vegetated receiving areas as one of the last steps in the site construction process. A preconstruction meeting is also an opportunity to discuss other unique construction considerations for infiltration areas.

2.1 Construction Step 1: Ensure Acceptable Conditions for Construction

Do not construct infiltration areas until:

- Impervious areas that will drain to the infiltration areas are completed.
- Areas of the site adjacent to the infiltration area are stabilized with vegetation, mulch, straw, seed, sod, fiber blankets or other appropriate cover.
- The forecast calls for a window of dry weather to prevent smearing and compaction if grading the vegetated receiving area is necessary subgrade.
- The forecast calls for extremely hot or cold temperatures, which can hinder establishment of vegetation.

2.2 Construction Step 2: Install the Downspout System (If Applicable)

The downspout system shall be installed per the plans. In the field, verify that the downspout system has been installed correctly and that the drainage areas do not exceed the allowable design standards.

2.3 Construction Step 3: Grade, Prepare and Plant the Vegetated Receiving Area

It is important to ensure that the vegetated receiving areas are uniformly graded with no gullies, low spots or lateral slopes. Soils should be tilled to a depth of 8 inches unless this is an existing site that was built more than 50 years ago. When the sod is brought to the site, inspect it to be certain that it does not have a clay base or has been washed. A one-time fertilizer application and regular watering should be conducted to establish the vegetation in an infiltration area.

For a downspout disconnection system, the vegetated receiving area shall be kept offline until vegetation has been established. For disconnected pavement, soils should be stabilized with temporary means such as straw or matting until the permanent vegetative cover has taken root.

2.4 Construction Step 4: As-Built Inspection

After installation, an appropriately licensed Tennessee design professional shall perform a final as-built inspection and certification that includes:

- Ensuring that the infiltration area is installed per the plans and specifications.
- Checking that the vegetated receiving areas are sized correctly and that the vegetated receiving areas are stabilized with vegetation.
- Checking that the impervious surfaces are free from sediment and debris.

Any deficiencies found during the as-built inspection shall be promptly addressed and corrected.

3. Maintenance

Infiltration areas require maintenance to provide long-term stormwater benefits. Regular inspections will determine whether the impervious surface and the vegetated receiving area are draining and functioning as intended.

3.1 Directions for Maintenance Staff

Communication with maintenance staff is important in maintaining DIS. Maintenance staff shall:

- Not regrade infiltration areas or cover them with impervious surfaces such as a shed or patio.
- Not stockpile soil, sand, mulch or other materials on the infiltration area.
- Immediately repair any areas that are eroding or where vegetation has died.
- Immediately remove sediment and debris from contributing impervious surfaces.

3.2 Required Operation and Maintenance Provisions

After the infiltration area is constructed, it shall be inspected once a quarter. The inspector shall check each component and address any deficiencies in accordance with Table 5. The person responsible for maintaining the infiltration area shall keep a signed and notarized Operation and Maintenance Agreement and inspection records. These records shall be available upon request.

At all times, the roof area shall be maintained to reduce the debris and sediment load to the system. Excess debris can clog the system and lead to bypass of the design storm and reduced infiltration and pollutant removal.

To ensure proper operation as designed, a licensed Professional Engineer, Landscape Architect or other qualified professional shall inspect the system annually. The system components will be repaired or replaced whenever they fail to function properly.

Table 5: Inspection Process and Required Remedies for Infiltration Area (Source: NCDENR, 2014).

SCM Elements	Potential problem	How to remediate the problem
The contributing impervious area	Excess debris or sediment is present on the rooftop or impervious surface	Remove the debris or sediment as soon as possible.
The gutter system (if applicable)	Gutters are clogged or water is backing up out of the gutter system.	Unclog and remove the debris. May need to install gutter screens to prevent future clogging.
	Rooftop runoff is not flowing into the gutter system	Correct the positioning or installation of the gutters. Replace if necessary to capture the roof runoff.
Roadways & parking lots (if applicable)	Runoff flows to the pervious area as concentrated flow	Remove any sediment or obstructions at the pavement-vegetate area interface.
	The aggregate transition area or concrete edge restraint is cracked, settled, undercut, eroded or otherwise damaged.	Repair or replace the transition area or concrete edge restraint.
The pervious area	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully and re-seed and water until it is established. Provide lime and a one-time fertilizer application.
	Trees or shrubs have begun to grow	Remove them.
	Vegetation is too short or too long.	Maintain vegetation at a height of approximately three to four inches.

REFERENCES

Carmen, N.B., W.F. Hunt, and A.R. Anderson. "Evaluating Residential Disconnected Downspouts as Stormwater Control Measures." 6th International Low Impact Development Conference. St. Paul, MN. (2013)

Metro Water Service, Metropolitan Government of Nashville and Davidson County. "Downspout Disconnection" Volume 5 Low Impact Development Stormwater Management Manual. 2012.

NCDENR. "24. Disconnected Impervious Surface (DIS)." NCDENR Stormwater BMP Manual. 2014.

VADCR. "Virginia DEQ Stormwater Specification No. 1: Rooftop (Impervious Surface) Disconnection." Virginia Stormwater Management Handbook. 1.9 ed. 2011.