WQ-07 INFILTRATION TRENCH

1.0 Infiltration Trench

1.1 Description

Infiltration Trenches are excavations filled with stone to create an underground reservoir to manage stormwater runoff. Use individual Infiltration Trenches for drainage areas up to 2 acres in size.

The stormwater runoff volume enters the Infiltration Trench, is temporarily stored, and gradually exfiltrates through the bottom and sides of the trench into the subsoil. Infiltration Trenches fully de-water within a 24- to 72-hour period depending on trench dimensions, soil type, and underdrain system.

By diverting stormwater runoff into the soil, the Infiltration Trench not only treats the water quality volume, but it also preserves the natural water balance. Using natural filtering properties, Infiltration Trenches can remove a wide variety of pollutants from the runoff through adsorption, precipitation, filtering, and bacterial and chemical degradation.

Use Infiltration Trenches to capture sheet flow from a drainage area or function as an off-line device. Due to the relatively narrow shape, Infiltration Trenches can be adapted to many different types of sites and can be utilized in retrofit situations. Because Infiltration Trenches are sensitive to fine sediments, do not install them on sites where the contributing area is not completely stabilized or is periodically being disturbed.

1.2 Design

Infiltration Trenches are limited to areas with highly porous soils where the water table and or bedrock are located below the trench bottom. Design Infiltration Trenches to ensure the following:

- The maximum drainage area for any single Infiltration Trenches is 2 acres.
- Applicable for underlying soils that have a minimum infiltration rate of 0.5 inches per hour determined from site specific soil boring samples.
- Testing of infiltration rate will be performed at the depth of the interface between the Infiltration Trench and the underlying subgrade, where infiltration into the soil will occur.
- Place an underdrain system above the bottom of the Infiltration Trench for all Infiltration Trench applications as many of the native soils found in Greenville County do not allow for adequate infiltration.
- Vertical distance of 4 feet between the Infiltration Trench bottom and the elevation of the seasonally high water table.
- Minimum depth of 3 feet, and a maximum depth of 8 feet.
- Not placed in fill material because piping along the fill-natural ground interface may cause slope failure.
- Designed and located to avoid ground water contamination.
- Not intended to trap sediment during construction activities.
- Have a sediment forebay or other pre-treatment measure such as a stabilized vegetated filter a minimum of 20 feet in length to prevent clogging in the gravel.
- Have an overflow system to provide non-erosive flow velocity along the length and at the outfall.
- Are applicable for impervious areas where there are low levels of fine particulates in the runoff and the site is completely stabilized and the potential for possible sediment loads are very low.

1.2.1 Infiltration Trench Area

The preferred method is to size Infiltration Trenches to trap 85% of TSS based on annual loadings (the Greenville County IDEAL Model or another model such as the USEPA overflow model may be used to design Infiltration Trenches to meet this criteria). Infiltration Trenches may also be part of a BMP treatment train which traps 85% of TSS based on annual loadings.

As an alternative design criteria, Infiltration Trenches may be designed to capture and accommodate at a minimum the first 1-inch of runoff from impervious areas located on the site and discharge it over a 24- to 72-hour period. Calculate the required Infiltration Trench area using the following equation:

$$A = \frac{V}{\left(nd + \frac{kT}{12}\right)}$$

Where:

A = Surface area of Infiltration Trench (feet^2)

V = Water Quality volume **(1-inch** of runoff from impervious areas located on the site)

n = Porosity of stone in infiltration trench (0.3 to 0.5 depending on stone)

*Use conservative porosity value (**n**) of 0.32 unless an aggregate specific value is known.*

d = Depth of trench (ft)

k = Percolation rate of soil (in/hour)

T = Fill time (hours). A fill time of 2 hours is recommended for most design calculations.

1.3 Materials

A summary of the Materials used in Infiltration Trenches areas are shown in Table 1.

Table 1: Material Specifications

Material	Specification
1.0- to 2.5-inch D_{50} Crushed Stone	Clean Coarse Aggregate Size No. 2, 24 or 3
Pea Gravel	ASTM D 448; Stone Size No. 6 or 1/8” to 3/8” washed aggregate
Pipe Underdrains	Use perforated pipe underdrains with a minimum diameter of 4 inches
Observation Well and Outlet Pipe	Use non-perforated with a minimum diameter of 4 inches
Permeable Non-woven Geotextile Fabric	Use Class 2 Type C non-woven geotextile fabric

1.3.1 Infiltration Trench Bottom Filter Fabric

Place a permeable non-woven filter fabric on the bottom of the Infiltration Trench.

1.3.2 Underdrain System

Place an underdrain system above the bottom of the Infiltration Trench for **all** Infiltration Trench applications as many of the native soils found in Greenville County do not allow for adequate infiltration. The perforated underdrain drain pipe is connected to a stormwater conveyance system or discharges to a stabilized outlet.

Provide an underdrain system that consists of continuous closed joint perforated plastic pipe underdrains with a minimum 4-inch diameter.

1.3.3 Observation Well

Install observation wells spaced a maximum of 100 feet in every Infiltration Trench. The well is made of 4- to 6-inch PVC pipe. Extend the observation well to the bottom of the trench. The observation well shows the rate of de-watering after a storm event, and predicts when maintenance is required for the Infiltration Trench. Install the observation well along the centerline of the trench, flush with the ground elevation of the trench. Cap the top of the well to discourage vandalism and tampering.

1.3.4 Stone Fill

The stone fill media consists of 1.0- to 2.5-inch D_{50} crushed stone with 6 inches of pea gravel placed on top of the crushed stone. Separate the stone fill and the pea gravel with a non-woven geotextile filter fabric.

1.3.5 Permeable Non-woven Geotextile Fabric

Place a permeable non-woven geotextile filter fabric between the stone fill and adjacent soil of the excavated trench. Place a separate permeable non-woven geotextile filter fabric between the pea gravel and stone fill preventing sediment from passing into the stone media. Ensure the filter fabric between the pea gravel and stone fill is easily separated from the fabric that protects the sides of the excavated trench.

1.4 Construction Requirements

Ensure stormwater runoff from areas draining to Infiltration Trenches passes through stabilized vegetated filter at least 20 feet in length, a sediment forebay or other pre-treatment measure before discharging to the Infiltration Trench.

Do not install Infiltration Trenches in fill material as piping along the fill/natural ground interface may cause slope failure.

Do not install an Infiltration Trench on a slope with a natural angle of incline exceeding 20%.

1.4.1 Site Preparation

Ensure a vertical distance of 4 feet between the Infiltration Trench bottom and the elevation of the seasonally high water table, whether perched or regional. The water table is determined by direct piezometer measurements and on-site soil borings.

Locate Infiltration Trenches greater than 3 feet deep a minimum of 10 feet from basement walls.

Locate Infiltration Trenches a minimum of 150 feet from any public or private water supply well.

Construct Infiltration Trenches with a maximum width of 25 feet.

1.4.2 Installation

Construct an excavated trench with a minimum depth of 3 feet, and a maximum depth of 8 feet. The maximum slope bottom of the Infiltration Trench is 5%.

Prior to placing the underdrain system, alleviate compaction on the bottom of the Infiltration Trench by using a primary tilling operation such as a chisel plow, ripper, or subsoiler to a depth of 12 inches. Substitute methods must be approved by the Engineer. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment.

Remove any ponded water from the bottom of the excavated area. Line the excavated area with a Class 2, Type C non-woven geotextile fabric.

Place the pipe underdrains on top of the underlying filter fabric. Lay the underdrain pipe at a minimum 0.5% longitudinal slope. The perforated underdrain drain pipe is connected to a stormwater conveyance system or discharges to a stabilized outlet.

Install the observation well along the centerline of the Infiltration Trench a maximum of 100 feet and flush with the ground elevation of the trench. Cap the top of the well to discourage vandalism and tampering.

Place the crushed stone fill media to a depth of 6 inches below the top ground surface and place a permeable geotextile filter fabric over the crushed stone. Install this permeable filter fabric so it is easily separated from the geotextile filter fabric that protects the sides of the excavated trench.

Place 6 inches of pea gravel on top of filter fabric that was placed over the crushed stone.

1.5 Inspection and Maintenance of Infiltration Trenches

Regular inspection and maintenance is critical to the effective operation of Infiltration Trenches. Maintenance responsibility for the Infiltration Trench is vested with a responsible authority by means of a legally binding and enforceable maintenance agreement that is executed as a condition of plan approval. Typical maintenance responsibilities include:

- Keeping a record of the average de-watering time of the Infiltration Trench to determine if maintenance is required.
- Replacing the top 6-inch layer of pea gravel and the permeable non-woven geotextile filter fabric separating the pea gravel from the stone media when they become full of sediment.
- Clearing debris and trash from all inlet and outlet structures monthly.
- Checking the observation wells after three consecutive days of dry weather after a rainfall event. If complete de-watering is not observed within this period, there may be clogging within the trench and proper maintenance is required.
- Removing trees, shrubs, or invasive vegetation semi-annually.
- If complete failure is observed, performing total rehabilitation of the Infiltration Trench by excavating the trench walls to expose clean soil, and replacing the gravel, geotextile filter fabric, and topsoil.

Required maintenance activities and their frequencies are listed in Table 2.

Table 2: Summary of Maintenance Requirements

Required Maintenance	Frequency
Ensure that the contributing area is stabilized with no active erosion	Monthly
Mow grass filter strips and remove grass clippings.	Monthly
Check observation wells after 72 hours of rainfall. Ensure Wells are empty after this time period. If wells have standing water, the underdrain system or outlet may be clogged.	Semi-annual (every 6 months)
Remove evasive vegetation.	Semi-annual (every 6 months)
Inspect pretreatment structures for deposited sediment.	Semi-annual (every 6 months)
Replace pea gravel, topsoil and top surface geotextile filter fabric.	When clogging or surface standing water is observed
Perform total rehabilitation of Infiltration Trench.	Upon observed failure

1.6 IDEAL Modeling

The County's preferred method of demonstrating compliance with its water quality standard is to use the IDEAL model. To facilitate use of this model, Table 3 shows how to represent this BMP and BMPs similar to this one in the IDEAL model. It lists the parameters needed to successfully run the model and the parameters that affect the trapping efficiency of the BMP.

Table 3: IDEAL Modeling Guide

Infiltration Trench Modeling in IDEAL		
What to Model as in IDEAL	Infiltration Trench	
Similar BMPs	Gravel Wetland Filters	
Specifications Needed for IDEAL	Size of the trench	
	Porosity of rockfill (fraction)	
	Soil texture and degree of saturation of the soil within the trench	
Parameters that Drive Performance	Feature	How Value Affects Sediment Trapping Efficiency (TE)
	Underlying Soil Texture	Soils with higher infiltration capabilities increase TE
	Porosity	Increasing porosity increases TE