

EXFILTRATION DESIGN REQUIREMENTS:

Purpose

The Exfiltration Design Requirements is intended to be a reference for designers to follow in the design of exfiltration systems for projects located in Georgetown County.

Exfiltration vs. Infiltration

In the practice of stormwater management, exfiltration and infiltration terminology is used interchangeably. Infiltration is most commonly used when a structure collects water. Exfiltration is when a structure releases water. Infiltration systems include: underdrains, trench or French drains, swales, porous pavement, and infiltration basins. Exfiltration systems are completely underground and receive stormwater from common drainage structures such as street gutters and pipes. The water is allowed to exfiltrate or leave the system through natural drainage into the surrounding soil.

Darcy's Law $Q = k i A$

Darcy's Law characterizes the flow through porous media, assuming that the viscosity, temperature and density of the fluids are constants. The flow rate is a function of the flow area, the hydraulic gradient and proportionality constant.

$$Q = k i A$$

Where:

Q = Flow Rate (cfs)

k = Permeability Constant (ft / sec)

i = Hydraulic Gradient ($i = \Delta H / L$)

A = Cross-sectional area of soil conveying flow (ft²).

ΔH = Change in the hydraulic grade line (ft)

L = Distance between points of interest (ft)

Hydraulic Conductivity of Soils $K = Q/A \times \Delta H$

The hydraulic conductivity of a soil, is a field measurement, and is the ratio between the discharge through the unit area of soil perpendicular to the flow per unit of head (i.e. cfs/ft² – ft of head). This is the primary factor used to determine the exfiltration rate of a system.

$$K = Q/A \times \Delta H$$

Where:

Q = Flow Rate (cfs)

A = Flow Area (ft²)

ΔH = Hydraulic Head (ft)

Hydro-Geotechnical Testing

The hydrologic and geotechnical properties of a soil can be measured in the laboratory or in the field and the following tests are suggested:

- The double-ring infiltrometer test (ASTM D3385) is a field method to determine the hydraulic conductivity of soils measured at the depth where the exfiltration system to be installed. It is relatively simple and inexpensive and provides a direct hydraulic conductivity rate, as opposed to the percolation test or the laboratory permeability test.
- Determination of the Seasonal High Ground Water Table (SHGWT).

Construction and Maintenance Considerations:

Stormwater exfiltration systems shall be installed no less than 2 feet from parallel underground utilities and 20 feet from existing large trees to remain in place. Careful evaluation of the existing soils and the excavation method is necessary if the exfiltration system is located in close proximity to the right of way line to avoid damages to the adjacent properties. Erosion control measures should be implemented to impede the access of sediments and debris into the exfiltration system during construction, which can clog the filter fabric diminishing the capacity of the exfiltration trench.

Exfiltration systems should not typically be used within any type of manmade, compacted embankment since there is little to no percolation in compacted fill as compared to natural soils. Do not install exfiltration systems in close proximity to and behind retaining walls.

Seepage forces would need to be included in the design of the exfiltration system and daylighting filtrate could result in soil washouts, unsightly mildew, vegetation, staining and other maintenance problems.

The bottom of the exfiltration trench shall be a minimum of 1.0 FT above the SHGWT unless a means for a passive positive drawdown is provided such as using sock wrap underdrains. Underdrains shall be installed outside and one foot below the bottom of the exfiltration trench with positive slope to provide a minimum of 2.5 FPS to the point of outfall piping and clean outs shall be installed no further than 100' apart.

Exfiltration Systems shall be assessable from catch basins or manholes spaced no further than 100 FT apart to allow for maintenance and shall not be smaller than 3' X 3' and the system shall terminate at a catch basin. The slope of exfiltration systems shall be designed with zero slope between catch basins and the system shall be provided with an Emergency Overflow.

Water Quality:

The Treatment Volume shall be calculated using the void volume of the rock in the exfiltration trench, volume of the pipe and the volume of the voids of the in situ soils not exceeding the volumes as based on the permeability rates as follows:

10 In/Hr = 10% of the total treatment volume

20 In/Hr = 20% of the total treatment volume

40 In/Hr = 40% of the total treatment volume

Where the volume of the voids of the in situ soils is not unlimited and is bounded by the SHGWT and where the volume of the voids has been replaced by the infiltrate from the exfiltration system.

The Voids Ratio of No.5 rock and washed No. 57 stone shall not exceed 40% and 33% respectively.

The Permeability of soil cannot be greater than 40 In per Hour

The Permeability of soil cannot be less than 10 In per Hour

Recovery Time:

The Recovery Time Calculation shall be based on Darcy's Law, $Q=KiA$

$Q = CFS$

$K = CFS / SF - LF$; Permeability Rate X 0.00002315

$A = SF$ (1/3 the Area of the side of the trench)

$i =$ Hydraulic Gradient based on field measurement or 0.5 Height of the Trench x Permeability of the soil x Slope of the Land; FT/FT.

The Recovery Calculation can only consider Horizontal Flow through the one half of the side area of the exfiltration trench and must have a factor of safety of 2.

Site Observation:

Installation of the Exfiltration System shall require continuous on site observation by the Engineer or his representative and Site Inspection Reports shall be provided to the County for the entire installation of the exfiltration system.

Filter Fabric must be laid perpendicular to the direction of the trench.

Weight tickets shall be required for the rock to be installed and only wash stone or rock without fines shall be approved for the exfiltration trench. Weight tickets must be provided prior to installation otherwise material placed shall be removed.