

16. Infiltration Devices

<p>Description Infiltration devices are trenches or basins that fill with stormwater runoff and allow the water to exfiltrate, i.e., exit the device by infiltrating into the soil.</p>

<p>Regulatory Credits</p> <p><i>Pollutant Removal</i></p> <p>85% Total Suspended Solids 30% Total Nitrogen 35% Total Phosphorus</p> <p><i>Water Quantity</i></p> <p>possible Peak Runoff Attenuation yes Runoff Volume Reduction</p>	<p>Feasibility Considerations</p> <p>High Land Requirement Med-High Cost of Construction Med Maintenance Burden Small-Med Treatable Basin Size High Possible Site Constraints Med-High Community Acceptance</p>
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Major Design Elements

<p>Required by the NC Administrative Rules of the Environmental Management Commission. Other specifications may be necessary to meet the stated pollutant removal requirements.</p>	
1	Sizing shall take into account all runoff at ultimate build-out including off-site drainage.
2	Side slopes stabilized with vegetation shall be no steeper than 3:1.
3	BMP shall be located in a recorded drainage easement with a recorded access easement to a public ROW.
4	If the BMP is used for sedimentation and erosion control during construction, it must be cleaned out and returned to the design state.
5	The design shall be located a minimum of 30 feet from surface waters, and 50 feet from Class SA waters.
6	The design shall be located a minimum of 100 feet from water supply wells.
7	The bottom shall be a minimum of 2 feet above the seasonal high water table.
8	Volume in excess of the treatment volume, as determined from the design storm, shall bypass the device. (also see 16.3.9)
9	Volume in excess of the treatment volume, as determined from the design storm, shall be evenly distributed across a minimum 30 feet long vegetated filter strip. (A 50-ft filter is required in some locations.) (also see 16.3.9)
10	The storage volume must completely draw down to the seasonally high water table under seasonally high water conditions within 5 days.
11	Soils must have a minimum infiltration rate of 0.52 inches per hour to be suitable for infiltration.
12	Device must not be sited on fill material. (also see 16.3.2)
13	Trenches must be shallower than their largest surface dimension to prevent categorization as an "injection well."

Major Design Elements (Continued)

Required by DWQ policy. These are based on available research, and represent what DWQ considers necessary to achieve the stated removal efficiencies.	
14	The bottom shall be installed at a 0-0.05% grade (level).
15	BMP shall be located a minimum of 15 feet downgradient of any structure.
16	There shall be a maximum of 2 acre-inches of runoff per inlet into the device. See Section 16.3.3.
17	The bottom shall be a minimum of 2 feet above any underlying impervious soil horizon or bedrock.
18	BMP shall be used only after entire upstream area has been stabilized.
19	BMP shall not be used on industrial sites or designated contaminated land uses or activities such as areas subject to frequent oil or other petroleum contamination.
20	Pretreatment devices must be provided to prevent clogging.
21	Trench depth shall be no more than 8 feet.
22	Minimum of 1 observation well shall be provided.

<p><u>Advantages</u></p> <ul style="list-style-type: none"> - Reduce frequency of flooding by reducing the amount of water flowing to surface waters. - Help recharge groundwater, which supports dry-weather flows in streams. - Particulate pollutant removal efficiencies generally as good as other BMPs. 	<p><u>Disadvantages</u></p> <ul style="list-style-type: none"> - Often fail relatively quickly compared to other types of BMPs if not maintained. - Restricted to areas with permeable soils. - May cause undesirable groundwater seepage into basements and foundations if not properly sited. - Infiltration of contaminated stormwater may contaminate groundwater.
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16.1. General Characteristics and Purpose

“Infiltration,” in the context of BMPs, refers to the process of stormwater soaking into the soil. Infiltration devices enhance percolation to groundwater by directing surface runoff to locations where it can come into contact with pervious underlying soils and then detaining that runoff until it can soak into the underlying soil. Infiltration devices reduce runoff volume, recharge groundwater, and have high removal efficiencies for sediment and for pollutants adsorbed onto sediment particles. A number of infiltration devices with differing designs have been used in various locations throughout the country, and are appropriate in the majority of the coastal counties of North Carolina and as an alternative practice in other areas with suitable soils.

Infiltration devices transfer more stormwater to the soil than any other type of BMP, and they more closely mimic the natural hydrology of the area by taking a portion of concentrated flow and allowing it to infiltrate into the soil. They work best in relatively

small drainage areas and drainage areas that are completely impervious or stable (to minimize the amount of sediment going to the BMP).

Infiltration devices are frequently used to infiltrate runoff from adjacent impervious surfaces, such as parking lots. In these cases, a filter strip should be installed between the pavement and the device to trap sediment and litter before it is washed into the device. Another approach is to construct infiltration devices at the downgradient edges of areas with permeable pavement. In this case, the permeable pavement is the inlet to the device. Because water also will infiltrate through the base of the pavement, the size of the infiltration devices can be reduced significantly.

This section discusses two types of infiltration devices: infiltration trenches (see Figure 16-1) and infiltration basins (see Figure 16-2).

Infiltration Trenches

Infiltration trenches are filled with large crushed stone or other media to create storage for the stormwater in the voids between the media. Other versions use precast concrete vaults with open bottoms to provide a large storage volume to hold stormwater for infiltration into the soil. Infiltration trenches are usually used to manage the runoff from parking lots and buildings.

Figure 16-1a
 Typical Infiltration Trench
 (Adapted from Schueler et al., 1992)

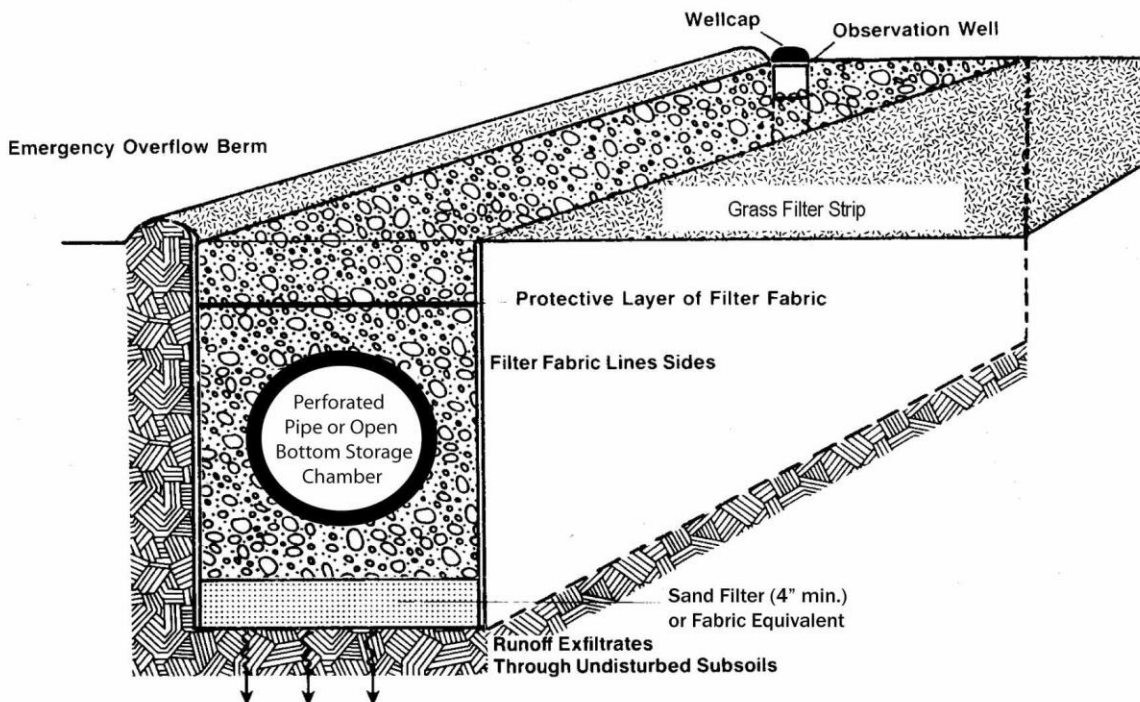
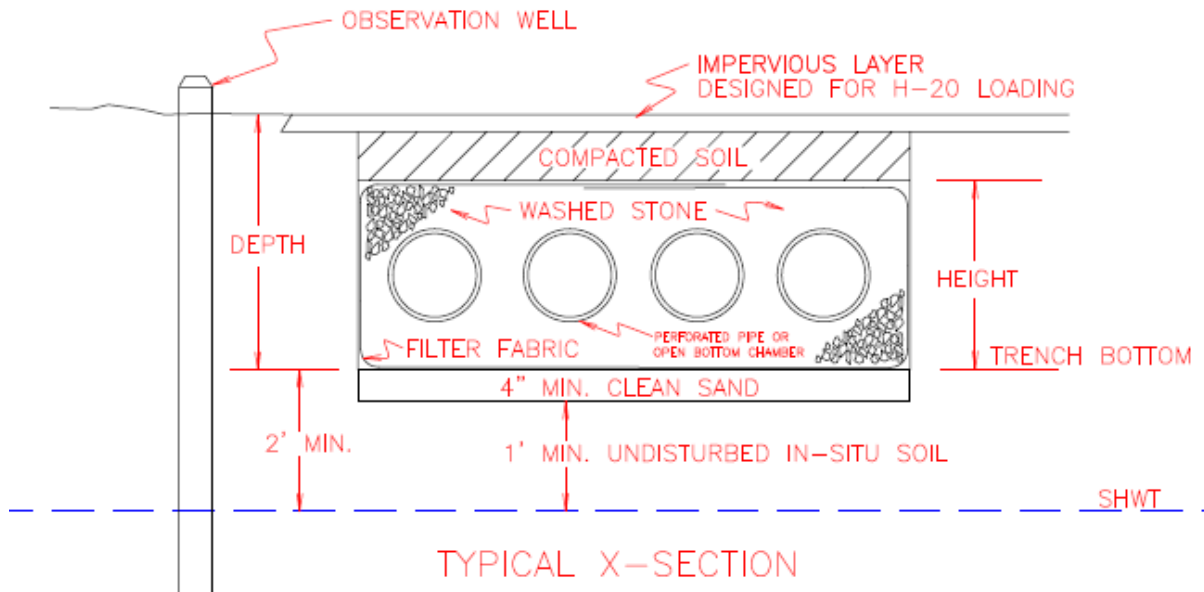


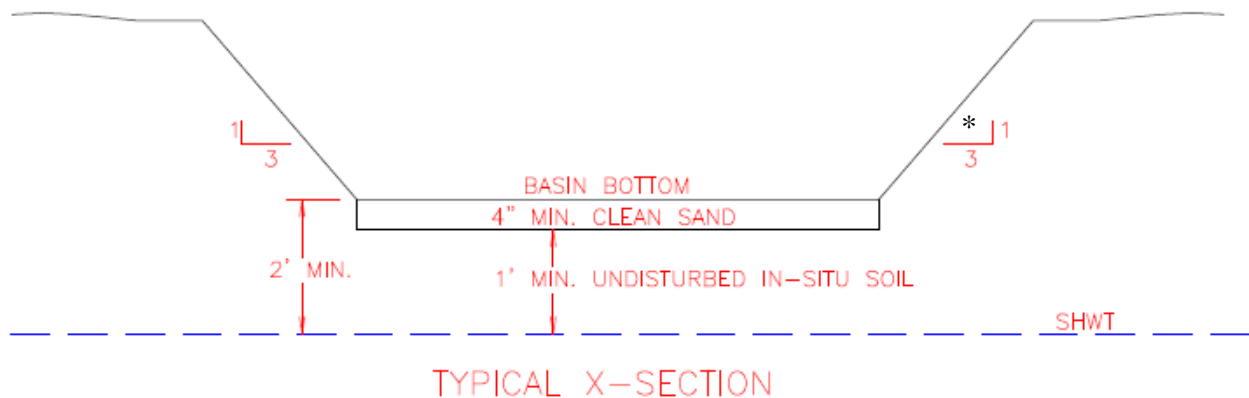
Figure 16-1b
Typical Infiltration Trench: Cross-Section



Infiltration Basins

Infiltration basins are normally dry basins, much like extended dry detention basins, with the exception that the stormwater does not flow out into a receiving stream. Rather, the stormwater is only allowed to infiltrate into the soils and eventually to the groundwater.

Figure 16-2
Typical Infiltration Basin: Cross-Section



*Retaining walls may be used in place of the 3:1 vegetated side slopes.

16.2. Meeting Regulatory Requirements

To obtain a permit to construct an infiltration device in North Carolina, the infiltration device must meet all of the Regulatory Design Elements listed in the beginning of this Section.

To receive the pollutant removal rates listed in the front of this Section, the infiltration device must meet all of the Major Design Elements listed in the beginning of this Section.

Pollutant Removal Calculations

The pollutant removal calculations for infiltration devices are as described in Section 3.8, and use the pollutant removal rates provided in Table 4-2 in Section 4.0. Construction of an infiltration device also passively lowers nutrient loading since it is counted as pervious surface when calculating nutrient loading.

Volume Control Calculations

An infiltration basin typically can be designed with enough storage to provide active storage control, calculations for which are provided in Section 3.4. Infiltration trenches may not have enough water storage to meet the volume control requirements of the particular stormwater program so they may need to be used in series with another BMP with volume control capabilities. All infiltration devices provide some passive volume control capabilities by providing pervious surface and therefore reducing the total runoff volume to be controlled.

16.3. Design

16.3.1. Converting Sediment and Erosion Control Devices

Often, the same basin can be used during construction as a sediment and erosion control device and later converted to an infiltration basin. Before conversion, all accumulated sediment must be removed and properly disposed of, then the appropriate modifications to the basin depth, geometry, and hydrology, as well as inlet and outlet structures, etc., must be made. A minimum of 6 inches of bottom material (below the design bottom of the original sediment and erosion control device) must be removed prior to conversion to a stormwater BMP, so appropriate design bottom depth changes must be considered. Infiltration trenches shall not be used as sediment and erosion control devices. It is essential that the site be completely stabilized before the erosion and control devices are removed or converted.

16.3.2. Siting Issues

Infiltration devices must be constructed level (at a 0-0.05% grade). It is recommended that they not be located on slopes greater than 15 percent. They shall not be located within fill soils. Infiltration devices shall not be placed in locations with less than 2 feet between the bottom of the infiltration device and the seasonal high groundwater table, underlying impervious soil horizon, or bedrock (a 4 foot separation distance is recommended). On a case by case basis exceptions may be made if the detailed hydrogeologic analysis and opinion from a qualified design professional shows that the

proposed system will operate as intended and will not have a negative impact on the environment or human health. Relief regarding fill soils and/or separation may be granted per Section 2.(b)(4)e. of SL 2008-211.

Potential mounding of the water table caused by the infiltration of the BMP is also a potential problem. If the mounded water table encroaches above the bottom of the infiltration device the hydraulic gradient is greatly reduced. Designing infiltration devices according to the requirements and guidelines presented in this manual should avoid this condition.

A common cause of failure among infiltration devices is clogging due to excessive sediment loads. Infiltration devices shall be used only once upstream areas have been properly stabilized.

Infiltration devices should not be placed in locations that cause water problems to downgradient properties. They must be a minimum of 15 feet downgradient from structures. On a case-by-case basis, infiltration devices may be allowed to be located closer than the 15 feet minimum from structures. The structure and BMP must be sufficiently designed such that the structure is safeguarded and is not damaged or undermined. The facilities must also be located a minimum of 100 feet horizontally from any water supply well, 50 feet from Class SA waters, and 30 feet from surface water, as required by applicable North Carolina regulations (15A NCAC 2H .1008 (d) Infiltration System Requirements).

Infiltration of contaminated stormwater may contaminate groundwater (Schueler et al., 1992). To protect groundwater from possible contamination, runoff industrial sites and from designated contaminated land uses or activities (such as areas subject to frequent oil or other petroleum product contamination) cannot be infiltrated without proper pretreatment to remove hydrocarbons, trace metals, and other hazardous substances.

16.3.3. Contributing Drainage Basin

The potential erosion or device overflow created by a large inflow is a concern in the design of infiltration devices. An individual infiltration device shall not receive more than 2.0 acre-inches of runoff, and less than 1.0 acre-inches of runoff is recommended. A general guidance is that the contributing area to an individual infiltration device will often be in the range of 5 acres or less. Also, infiltration devices must be off-line, that is, runoff in excess of the water quality volume should bypass the system.

There are two exceptions to the 2.0 acre-inches of runoff requirement:

1. If the design engineer, A.) Provides borings to ensure that the water table does not fluctuate widely over the surface area of the BMP, and B.) Minimizes the width of the basin (no more than twice the reach of a backhoe) so that it can be maintained, then the BMP can be designed to be larger.
2. Two devices can share a single feeding header. Or, 2 acre-inches of volume is allowed per inlet.

16.3.4. Pretreatment and Inflow

Pretreatment devices for removing sediment and solids must be used to protect infiltration devices from clogging. A few options for pretreatment include filter strips, grassed swales with check dams, concrete sumps, and forebays (sediment traps).

Consideration should be given to the inlet when infiltration facilities are designed. The type of inlet will depend on whether the upgradient source of runoff is overland flow or a concentrated source of discharge. Infiltration trenches require relatively even distribution over their length. An infiltration basin can be designed to accommodate a concentrated influent flow; however, an energy dissipater and/or level spreader may be needed.

Infiltration devices that are interconnected with roof downspouts or patio drains must include measures to strain out entrained leaves and other litter.

16.3.5. In-Situ Soil Requirements

A *site-specific* hydrogeologic investigation shall be performed to establish the suitability of site soils for the BMP. To be suitable for infiltration, underlying soils must have an infiltration rate of 0.52 inches per hour or greater, as initially determined from NRCS soil textural classification (typically hydrologic soil groups A and B) and subsequently confirmed by field geotechnical tests. The minimum geotechnical testing is one test hole per 5,000 ft² of infiltrating area, with a minimum of one boring and infiltration test per facility (taken within the proposed limits of the BMP). Double-ring infiltrometers or basin flooding tests should be used (EPA, 1981). Other widely accepted methods may also be used. The highest measurement should be discarded when computing the average hydraulic conductivity for the site.

16.3.6. Length, Width, Depth and Geometry

The sizing of an infiltration device is determined by the dewatering requirements. Infiltration devices must be able to completely dewater within 5 days. The time to dewater can be estimated roughly as the runoff capture volume for the device divided by the product of the hydraulic conductivity and the effective infiltrating area. This can be rearranged to produce the following equation for determining the effective infiltrating area needed:

$$A = \frac{V}{2 * (K * T)}$$

where:

- A = effective infiltrating area (ft²)
- V = volume of water requiring infiltration (ft³)
- K = hydraulic conductivity of soil (in/hr)
- T = dewatering time (days)

The volume of water requiring infiltration (V) is prescribed by the specific stormwater program that applies to the site, and the runoff characteristics of the site (see Section 2.0 and 3.0 for further information). If the infiltration device is not going to meet the volume control requirements, it is simply the volume of water that is diverted and stored for infiltration. The runoff capture storage volume of an infiltration device that is filled with a drainage medium is equal to the volume of the facility, multiplied by the porosity of the medium, plus any temporary ponding that may be allowed before the facility overflows.

The hydraulic conductivity of the soil (K) is the resultant value from the field testing performed on the site. The dewatering time (T) for infiltration devices must be 5 days or less. A value of less than 3 days is recommended for use in the formula.

Once the effective infiltrating area (A) is obtained from the formula, it can still be somewhat difficult to translate that into actual infiltration device dimensions. The value for A used in the formula is actually the larger of either the bottom surface area or one-half of the total (wetted) wall area. The determination of the length, width, and depth dimensions is therefore often an iterative process using the effective infiltrating area (A), the correction factor for true surface areas of the in-situ soil interface, and typical length, width, and depth recommendations. Injection well regulations in 15A NCAC 2C prohibit stormwater drainage wells. In order to avoid falling within the regulatory definition of "injection Well," infiltration trenches must be constructed such that their depth is less than their greatest surface dimension (length or width).

Trench depths shall be no more than 8 feet. It is recommended that the width of a trench (perpendicular to influent flow direction) be less than 25 feet. Broad, shallow trenches reduce the risk of clogging by spreading the runoff over a larger area for infiltration.

Infiltration basins, on the other hand, may appear in many different geometries. Runoff frequently is piped to these devices from stormwater inlets on patios, parking areas, roofs, and other impervious areas. These devices may also receive runoff via sheet flow.

16.3.7. Media Requirements

Uniform sand, gravel, or crushed stone (i.e., uniformity coefficient of 2 or smaller) is preferable as a drainage medium. Uniform materials have high porosity and large storage capacities so less material is required. Rounded stone has a larger void ratio than angular crushed stone. The porosity of the material should be determined by laboratory tests and be certified by the supplier. Drainage media materials should be hard, durable, inert particles, free from slate, shale, clay, silt, and organic matter. The material shall be washed, and it is recommended that it be double-washed.

To increase the runoff capture storage volume of trenches, plastic, aluminum or concrete gallery frames can be inserted. The gallery frames introduce open space inside the trench and help distribute flow. Adequate maintenance access must be provided to the gallery frames.

The bottom of infiltration basins and trenches must be lined with a layer of clean sand with a depth of 4 inches or greater, unless the native soil is equivalent (1-2% fines or less).

Drainage media should be enclosed on all sides by a geotextile filter. Proper specification of the geotextile is critical to prevent two problems: accumulation of soil into the device and clogging at the soil interface. The top surface of the geotextile should be 6-12 inches below to upper surface of the drainage media. The other surfaces of the geotextile should be in contact with the in-situ soil. The fabric, together with the overlying material, can be removed and disposed of when excessive sediments accumulate on the filter and begin to retard flow into the device.

16.3.8. Outlet Design

Infiltration devices, by their very nature, do not have regular outlet devices (the stormwater entering the BMP leaves through the soils). They should, however, be designed with dewatering provisions in the event of failure. It can be dewatered by pumping out or allowed to gravity drain through a pipe. If a dewatering outlet pipe is installed to facilitate emergency draining, a lockable watertight valve must be installed and kept closed at all times.

16.3.9. Offline Bypass & Vegetated Filter Strip

Properly designed vegetated filters are required from the overflow of all infiltration systems. However, this requirement may be difficult to meet on some sites due to topographic or space constraints. For sites that have difficulty meeting this requirement, the following options are available for waiving of the offline bypass and vegetated filter strip by permitting the system under the alternative design criteria in NCAC 2H .1008(h). The system must demonstrate equal or better stormwater control and equal or better protection of waters of the State and not result in an increased potential for nuisance conditions.

1. To waive the offline bypass requirement alone, the applicant must provide active storage volume in the system for 2 times the regulated design storm and infiltrate that volume within 5 days using an infiltration rate of one-half the infiltration rate reported in the soils report.
2. To waive the vegetated filter strip requirement alone, the applicant must provide active storage volume in the system for 2 times the regulated design storm and infiltrate that volume within 5 days using an infiltration rate of one-half the infiltration rate reported in the soils report.
3. To waive both the offline bypass and vegetated filter strip requirements in a single infiltration system, the applicant must provide active storage volume in the system for 2.5 times the regulated design storm and infiltrate that volume within 5 days using a soils infiltration rate of one-half the infiltration rate reported in the soils report.
4. If the applicant can demonstrate that the 10 year, 24 hour storm event can be infiltrated without discharging the system using an infiltration rate of one-half of the infiltration rate reported in the soils report, no bypass, no vegetated filter strip and no additional storage volume is required.

In addition, the following requirements apply:

1. Infiltration of the 10 year storm will require more frequent inspection of the filter media for clogging. Cleanout intervals must be shortened in order to prevent the premature failure of the system.
2. A bypass/overflow (not offline) for storm events larger than the 10 year storm must be provided in order to protect the system from damage.
3. Projects located within ½ mile of and draining to class SA waters (SR waters for Phase II) may not have a new point of stormwater discharge.
4. If the applicant can provide the minimum required storage volume per the stormwater rules with an offline bypass and vegetated filter strip, the full infiltration rate as verified by the soils consultant is used to determine the drawdown time of the system.

16.3.10.Pumped Infiltration

Where sites have small areas of good soils for infiltration, the system proposed usually involves the design of a separate storage basin in the low area with the runoff being pumped up to the infiltration area. This is referred to as “pumped infiltration”.

The Division intends to give some credit for a reasonable amount of runoff volume that can infiltrate during the design storm event, so that the storage requirement in the basin can be reduced. Credit for the volume of runoff that is pumped to the infiltration area and is infiltrated during the storm event will ONLY apply to infiltration systems where a pump is being utilized to pump the runoff to a separate infiltration area, and will not apply to normal infiltration trenches and basins where storage and infiltration are occurring in the same facility. The pumped infiltration system will be considered on a case-by-case basis, and will take into consideration the basin location, soils, water table and other site-specific factors and requires prior approval of the Division.

1. Provide/ demonstrate the following in regard to pumped infiltration systems:
 - a. Set the pump inlet piping at or above sediment cleanout level of the storage pond to avoid plugging the system between storage pond and infiltration basin.
 - b. Provide calculations of the amount of volume pumped to the infiltration basin during the storm event. In no case shall this volume exceed 25% of the design storm runoff volume.
 - c. Provide calculations of the available storage volume in the storage pond between the sediment cleanout level and the overflow elevation. In no case shall this volume be less than 75% of the total design storm runoff volume.
 - d. The sum of the two (2) volumes from (b) and (c) above must equal or exceed the total volume associated with the design storm.
 - e. The bottom of the storage pond(s) must be located at least two (2) feet above the SHWT or a liner must be provided. The liner must either be of natural material at least one foot in thickness and having a hydraulic conductivity of no greater than 0.01 in/hr when compacted, or a synthetic liner of sufficient thickness to exhibit structural integrity and an effective hydraulic conductivity no greater than that of the natural material liner.

- f. The tradeoff for allowing the minimum basin volume to be reduced by that amount being infiltrated during the storm will be the creation of STANDING WATER IN THE STORAGE BASIN. Please consider specifying a means to reduce the nuisance potential for mosquitoes and algae, such as floating fountains.
2. Provide pump system details on the plans, calculations, and specifications to include:
 - a. Sealed TDH calculations with piping and fitting count, entry and exit losses.
 - b. The pump must be sized such that the operating point is less than the drawdown rate for the basin and a gate valve is provided to adjust flow at system operation point so that the pump will not run out on the curve.
 - c. Pump specification sheet.
 - d. Pump curve with operating point.
 - e. The pump "on" elevation at a minimum of four (4) inches above pump "off" elevation identified on the plans. (6 inches recommended)
 - f. Check valve provided on pump discharge line to prevent backflow when pump is "off".
3. The following pump operating conditions should typically be shown on the pump plan details and pump curve sheet:
 - a. Model number and impeller size
 - b. Operating point,
 - c. TDH at gpm, HP, RPM, volts, amps, phase
 - d. Gate valve, check valve, and discharge line size.

16.4. Construction

Care should be used during installation to minimize compaction of soil on the bottom and walls of infiltration devices since this will reduce the permeability at the soil interface. To avoid compacting the drainage media, light equipment and construction techniques that minimize compaction should be used.

Runoff shall not be directed into an infiltration device until the drainage area is stabilized. A construction sequence must be followed that reflects the need to stabilize the infiltration device. The longevity of infiltration devices is strongly influenced by the care taken during construction.

Infiltration trenches should not be covered by an impermeable surface unless there is suitable maintenance access, the design specifies a H-20 loading capacity, and the application includes a cross-section of the H-20 design. Direct access must be provided to all infiltration devices for maintenance and rehabilitation. OSHA safety standards should be consulted for trench excavation.

A minimum of one observation well shall be included in the design of an infiltration system to periodically verify that the drainage media is fully draining. The monitoring well shall consist of a 4- to 6-inch-diameter, perforated polyvinyl chloride (PVC) pipe

with a locking cap. The well should be placed near the center of the facility or in the general location of the lowest point within the facility, with the invert at the excavated bottom of the facility.

16.5. Maintenance

16.5.1. Common Maintenance Issues

Please refer to Section 7.0, General BMP Maintenance, for information on types of maintenance, typical frequency, and specific maintenance tasks that are common to all BMPs. The following information is maintenance that is specific to infiltration devices.

For the first year of operation, installations should be inspected monthly and after each major storm. After the first year, quarterly inspections, preferably conducted after a storm, are recommended.

Maintenance is very important for infiltration devices. Property owners should be educated in the function and maintenance requirements of infiltration devices. Especially important is the maintenance of vegetated areas that drain to the infiltration system. Areas that are allowed to become bare and unvegetated will contribute excess sediment to the infiltration system and hasten its failure. Any sediment deposits in pretreatment devices should be removed at least annually.

The surface of infiltration systems must be kept in good condition. Colonization by grass or other plants should be discouraged, since this can lead to reduced surface infiltration rates. In many instances, it is convenient to cover infiltration trenches with concrete grid pavers or similar permeable paving systems that can be removed easily and replaced as necessary to service the trench.

In order to monitor performance of the infiltration device, observations should be conducted to determine how long it takes retained water to infiltrate into the soil after a storm event. The determination can be made in two ways. The most informative way is to read the water level several times over a period of days after a large storm. The alternative is a "one-stop" method, where a single reading is taken and compared with the local rainfall record. Although less accurate than the multiple reading method, the one-stop method will still allow significant deterioration in performance to be recognized.

The top several inches of drainage media and the filter cloth along the top of the drainage media should be replaced annually or at least when the dewatering time is longer than 5 days. If after replacing the top media the infiltration rate is still not in the acceptable range, the entire facility must be dismantled and reconstructed.

Proper disposal of the materials removed is necessary; the aggregate and cloth should be appropriately packaged and delivered to the local landfill, if the operating authority approves the disposal.

Since infiltration trenches and infiltration basins have different configurations and maintenance needs, an appropriate sample operation and maintenance table is offered for each one.

16.5.2. Sample Operation and Maintenance Provisions for Infiltration Trenches

Important maintenance procedures:

- The drainage area of the infiltration trench will be carefully managed to reduce the sediment load to the sand filter.
- The water level in the monitoring wells will be recorded once a month and after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County).

The infiltration trench will be inspected **once a quarter and within 24 hours after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County)**. Records of operation and maintenance will be kept in a known set location and will be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.

Table 16-1
Sample Operation and Maintenance Provisions for Infiltration Trenches

BMP element:	Potential problem:	How to remediate the problem:
The entire BMP	Trash/debris is present.	Remove the trash/debris.
The grass filter strip or other pretreatment area	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
	Sediment has accumulated to a depth of greater than six inches.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP.
The flow diversion structure (if applicable)	The structure is clogged.	Unclog the conveyance and dispose of any sediment off-site.
	The structure is damaged.	Make any necessary repairs or replace if damage is too large for repair.
The trench	Water is ponding on the surface for more than 24 hours after a storm.	Remove the accumulated sediment from the infiltration system and dispose in a location that will not impact a stream or the BMP.
	The depth in the trench is reduced to 75% of the original design depth.	Remove the accumulated sediment from the infiltration system and dispose in a location that will not impact a stream or the BMP.
	Grass or other plants are growing on the surface of the trench.	Remove the plants, preferably by hand. If pesticide is used, wipe it on the plants rather than spraying.

Table 16-1, continued
 Sample Operation and Maintenance Provisions for Infiltration Trenches

BMP element:	Potential problem:	How to remediate the problem:
The observation well(s)	The water table is within one foot of the bottom of the system for a period of three consecutive months.	Contact the DWQ Stormwater Unit immediately at 919-807-6300.
	The outflow pipe is clogged.	Provide additional erosion protection such as reinforced turf matting or riprap if needed to prevent future erosion problems.
	The outflow pipe is damaged.	Repair or replace the pipe.
The emergency overflow berm	Erosion or other signs of damage have occurred at the outlet.	The emergency overflow berm will be repaired or replaced if beyond repair.
The receiving water	Erosion or other signs of damage have occurred at the outlet.	Contact the NC Division of Water Quality 401 Oversight Unit at 919-733-1786.

16.5.3. Sample Operation and Maintenance Provisions for Infiltration Basins

Important maintenance procedures:

- The drainage area will be carefully managed to reduce the sediment load to the infiltration basin.
- Immediately after the infiltration basin is established, the vegetation will be watered twice weekly if needed until the plants become established (commonly six weeks).
- No portion of the infiltration basin will be fertilized after the initial fertilization that is required to establish the vegetation.
- The vegetation in and around the basin will be maintained at a height of approximately six inches.

After the infiltration basin is established, it will be inspected **once a quarter and within 24 hours after every storm event greater than 1.0 inches (or 1.5 inches if in a Coastal County)**. Records of operation and maintenance will be kept in a known set location and will be available upon request.

Inspection activities shall be performed as follows. Any problems that are found shall be repaired immediately.

Table 16-2
Sample Operation and Maintenance Provisions for Infiltration Basins

BMP element:	Potential problem:	How to remediate the problem:
The entire BMP	Trash/debris is present.	Remove the trash/debris.
The perimeter of the infiltration basin	Areas of bare soil and/or erosive gullies have formed.	Regrade the soil if necessary to remove the gully, and then plant a ground cover and water until it is established. Provide lime and a one-time fertilizer application.
The inlet device: pipe or swale	The pipe is clogged (if applicable).	Unclog the pipe. Dispose of the sediment off-site.
	The pipe is cracked or otherwise damaged (if applicable).	Replace the pipe.
	Erosion is occurring in the swale (if applicable).	Regrade the swale if necessary to smooth it over and provide erosion control devices such as reinforced turf matting or riprap to avoid future problems with erosion.
The forebay	Sediment has accumulated and reduced the depth to 75% of the original design depth.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP.
	Erosion has occurred or riprap is displaced.	Provide additional erosion protection such as reinforced turf matting or riprap if needed to prevent future erosion problems.
	Weeds are present.	Remove the weeds, preferably by hand. If pesticides are used, wipe them on the plants rather than spraying.

Table 16-2, continued
 Sample Operation and Maintenance Provisions for Infiltration Basins

BMP element:	Potential problem:	How to remediate the problem:
The main treatment area	A visible layer of sediment has accumulated.	Search for the source of the sediment and remedy the problem if possible. Remove the sediment and dispose of it in a location where it will not cause impacts to streams or the BMP. Replace any media that was removed in the process. Revegetate disturbed areas immediately.
	Water is standing more than 5 days after a storm event.	Replace the top few inches of filter media and see if this corrects the standing water problem. If so, revegetate immediately. If not, consult an appropriate professional for a more extensive repair.
	Weeds and noxious plants are growing in the main treatment area.	Remove the plants by hand or by wiping them with pesticide (do not spray).
The embankment	Shrubs or trees have started to grow on the embankment.	Remove shrubs or trees immediately.
	An annual inspection by an appropriate professional shows that the embankment needs repair.	Make all needed repairs.
The outlet device	Clogging has occurred.	Clean out the outlet device. Dispose of the sediment off-site.
	The outlet device is damaged	Repair or replace the outlet device.
The receiving water	Erosion or other signs of damage have occurred at the outlet.	Contact the NC Division of Water Quality 401 Oversight Unit at 919-733-1786.

September 28, 2007 Changes:

1. Major Design Elements:
 - i. Reformatted to include numbered requirements.
 - ii. Added the following requirements from the NC Administrative Code:
 1. “Soils must have a minimum hydraulic conductivity of 0.52 inches per hour to be suitable for infiltration,” per 15A NCAC 02H .1008(d)(6).
 2. “Device must not be sited on fill material,” per 15A NCAC 02H .1008(d)(7).
 3. “Sizing shall take into account all runoff at ultimate build-out including off-site drainage.”
 4. “If the BMP is used for sedimentation and erosion control during construction, it must be cleaned out and returned to the design state.”
 - iii. Separated, “BMP shall be a minimum of 30 feet from surface waters, 50 feet from Class SA waters, and 100 feet from water supply wells,” into two requirements.
2. 16.2: Corrected references to “Regulatory Design Requirements” by changing them to “Major Design Elements”.
3. 16.2: Removed the following incorrect statements, “All of the Regulatory Design Requirements are from the North Carolina Administrative Code,” and “...device must meet all of the Pollutant Removal Credit Design Requirements.”
4. 16.4: Removed a reference to Figure 16-3, which is not included in the manual.
5. 16.4: The July 2007 manual did not allow infiltration trenches under impermeable surfaces. This has been revised as follows: “Infiltration trenches should not be covered by an impermeable surface unless there is suitable maintenance access, the design specifies a H-20 loading capacity, and the application includes a cross-section of the H-20 design.”
6. Figure 16-1a: Renumbered. Previously Figure 16.1
7. Figure 16.1b: Added for clarification (infiltration trench cross-section)
8. Figure 16-2: Added for clarification (infiltration basin cross-section)

July 23, 2009 Changes:

1. 16.3.3: Revisions to the contributing drainage basin and volume.
2. Removed the requirement for 1’ of naturally occurring soil.
3. 16.3.9: Added new requirements for waiving the offline bypass and vegetated filter strip.
4. 16.3.10: Added requirements for pumped infiltration.
5. Fig. 16-2: Added a note that retaining walls are allowed.
6. Made other various corrections and wording changes throughout the chapter.