IN-1. Introduction

Infiltration practices capture and temporarily store runoff before allowing it to infiltrate into the underlying soil over a period of approximately two days.

Infiltration can be used to:

- Partially or wholly manage the first one inch of rainfall on-site – see **Table IN-1**.
- Reduce pollutant loads to meet water quality targets (total maximum daily loads or TMDLs; See **Table IN-2**).
- Meet partial or full storage requirements for local stormwater detention standards
- In limited circumstances, retrofit existing developed areas.

As examples, the photo on the right shows an Infiltration Basin receiving stormwater runoff from an impervious area. The photo on the left illustrates a linear Infiltration Trench that treats parking lot runoff.

Figure IN-1 further illustrates typical Infiltration applications. **Figure IN-2** shows schematics of a typical Infiltration practice. **Tables IN-1 and IN-2** describe Infiltration design parameters and associated volume reduction and pollutant removal performance rates. **Table IN-3** is a design checklist to help guide the design process for Infiltration practices.

IN-1.1. Planning This Practice

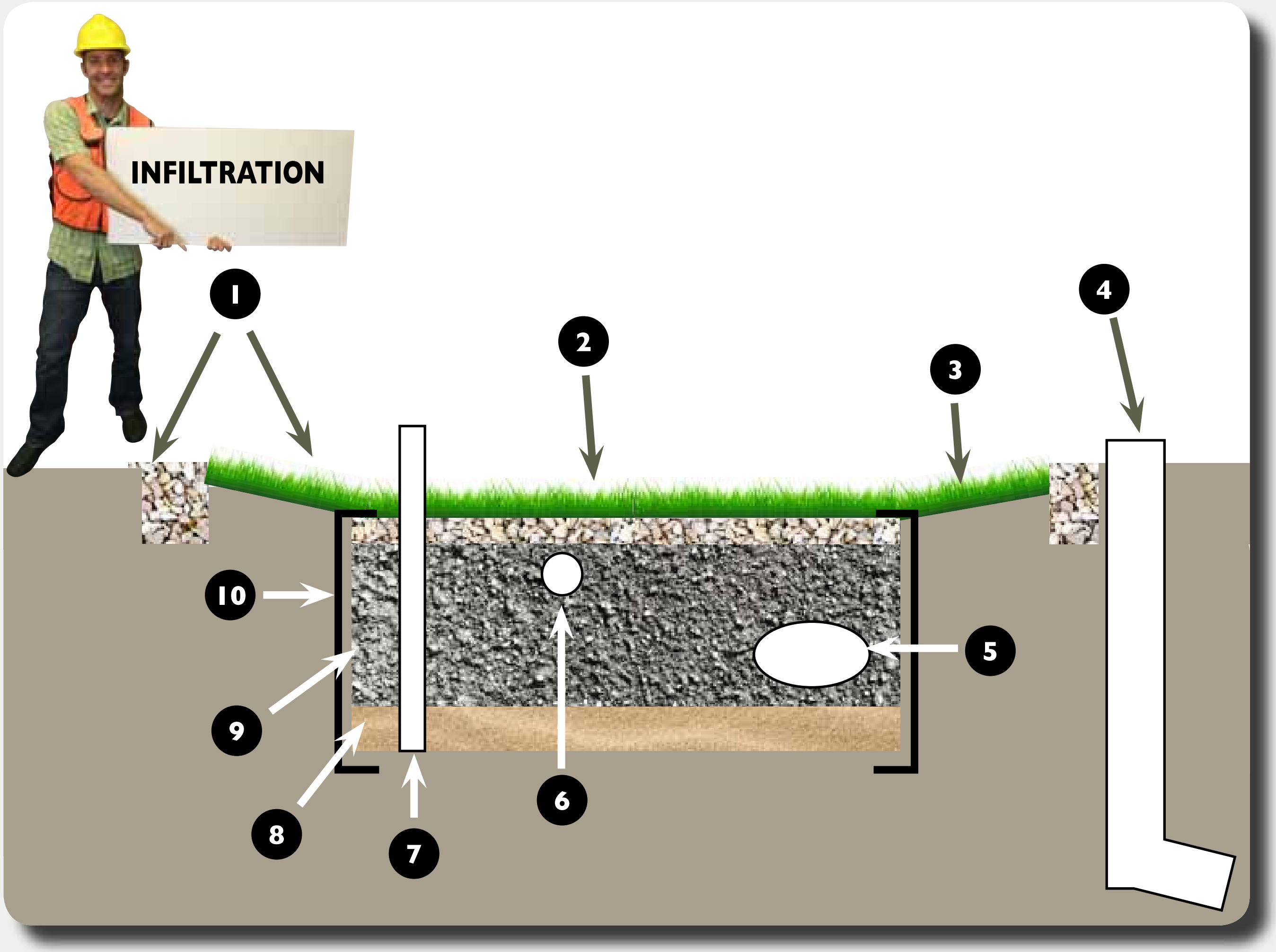
Figure IN-1. Typical Applications for Infiltration Practices

Edge of Parking Lot

In Median Strip

To Treat Roof Runoff or Other Small Areas of Impervious Cover (Micro-Scale)

Figure IN-2. Schematic of a Typical Infiltration Practice



1. **Pretreatment stone diaphragm & grass filter strip (typ.)** – Section IN-4.2
2. **Surface Cover: river stone; optional grass cover**– Sections IN-4.9
3. **Side Slopes = 4:1 Max** – Section IN-4.7
4. **Overflow Structure for Larger Flows** – Section IN-4.3
5. **Additional Underground Storage (optional)** – Section IN-4.13
6. **Overdrain (optional)** – Section IN-4.12
7. **Observation well** – Section IN-4.11
8. **Sand layer = 6" Min.** – Section IN-4.10
9. **Stone reservoir layer (variable depth)** – Sections IN-4.1 & IN-4.8
10. **Filter Fabric (sides only)** – Section IN-4.14

IN-1.2. Infiltration Design Options & Performance

Table IN-1 describes the design options for Infiltration and its practice performance in terms of reducing the volume associated with one inch of rainfall on the site. There is only one design level for Infiltration practices. **Table IN-2** summarizes pollutant removal performance values for Infiltration designs for the purposes of calculating site-based pollutant load reductions in the context of TMDLs and/or watershed plans.

Table IN-1. Infiltration Design Levels: Descriptions & Performance

Design Level	Description	Applications	Performance[1]
One Design Level	Basic Design -- • At least two forms of pre-treatment (see Section IN-4.2) • Field-measured soil infiltration rate of 0.5 to 4.0 inches/hour (see Appendix B of the Manual)	Sites with soils that are suitable for Infiltration and where the soils can be protected as part of site design and through the construction process.	100% volume reduction for the Design Volume of the practice[2]

[1] Performance achieved toward reducing one inch of rainfall
[2] Design Volume includes the volume of water that can be stored temporarily within the stone reservoir and subsequently infiltrated within 48 hours. The Design Volume can be 100% of that needed to meet the 1-inch performance standard or some proportion of it when used in conjunction with other practices. See Section IN-4.1 for Infiltration sizing requirements

Table IN-2. Pollutant Removal Performance Values for Level 1 and 2 Design

Design Level	Total Suspended Solids (TSS)[1]	Nutrients: Total Phosphorus (TP) & Total Nitrogen (TN)[1]
One Design Level	TSS = 75%	TP = 63% TN = 57%

[1] Total Pollutant Load Reduction = combined functions of runoff reduction and pollutant removal. Pollutant removal refers to the change in event mean concentration as it flows through the practice and is subjected to treatment processes, as reported in Hirschman et al. (2008).

IN-1.3. Infiltration Design Checklist

Table IN-3. Infiltration Design Checklist

CHECKLIST

This checklist will help the designer through the necessary design steps for Infiltration.

- [ ] Conduct a preliminary investigation of site soils using Natural Resources Conservation Service (NRCS) or other sources (e.g., septic tests) to see if soils may be suitable for infiltration – Section IN-3
- [ ] Investigate site designs and layouts that preserve the best infiltration soils for stormwater treatment and whether these soils can be protected during construction
- [ ] Complete Design Compliance Spreadsheet to plan and confirm required Target Treatment Volume, additional practices needed, and overall site compliance – Site Compliance Spreadsheet & **Chapter 3 of Manual**
- [ ] Check other feasibility criteria – Section IN-3
- [ ] Conduct field soil infiltration studies at the specific locations for Infiltration practices – Appendix B of the Manual (this step is critical and can be done at different times during the site planning process)
- [ ] Check Infiltration sizing guidance and make sure there is an adequate footprint (often split into multiple areas) on the site for Infiltration practices– Section IN-4.1
- [ ] Check design adaptations appropriate to the site – Section IN-6
- [ ] Design Infiltration in accordance with design criteria and typical details – Sections IN-2 & IN-4
- [ ] Provide all necessary plan view, profile, and cross-section details along with elevations, materials specifications, grading, and construction sequence notes

4.2.6. Infiltration (IN)

IN-2. Typical Details

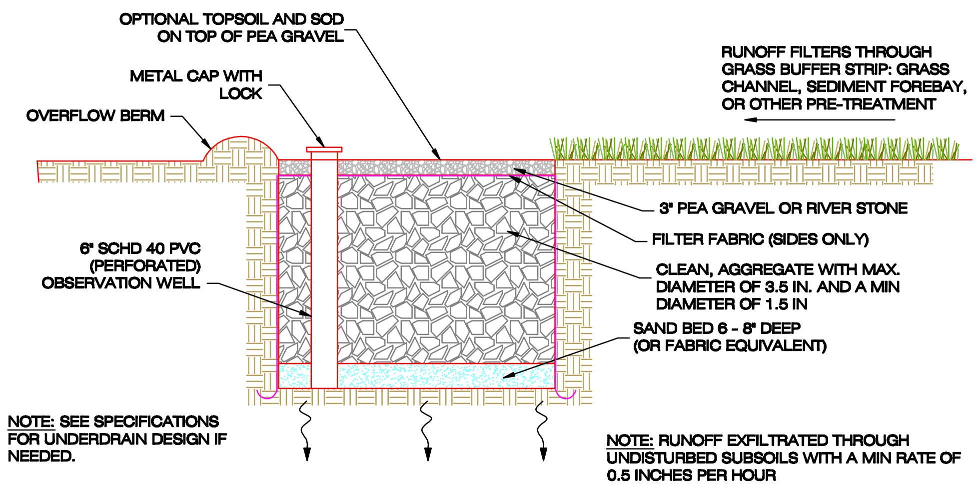


Figure IN-3. Typical Detail of Infiltration Trench

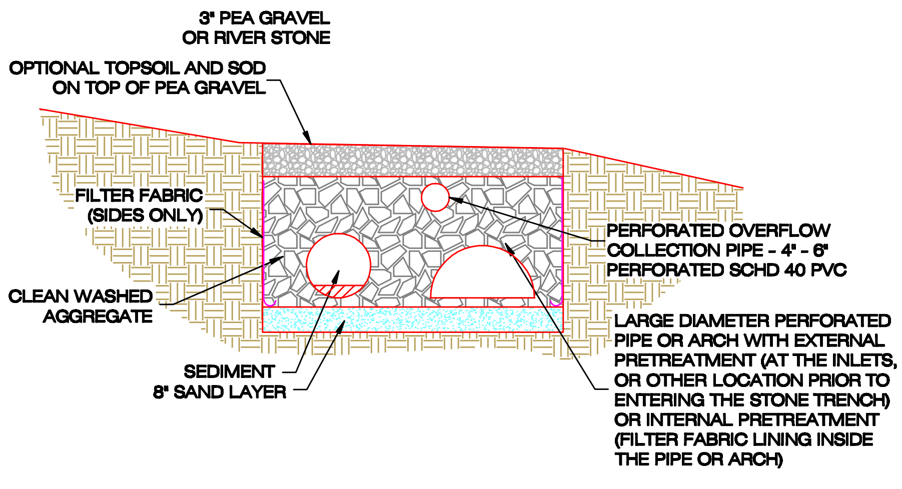


Figure IN-4. Infiltration Section with Supplemental Pipe Storage and Overflow Pipe

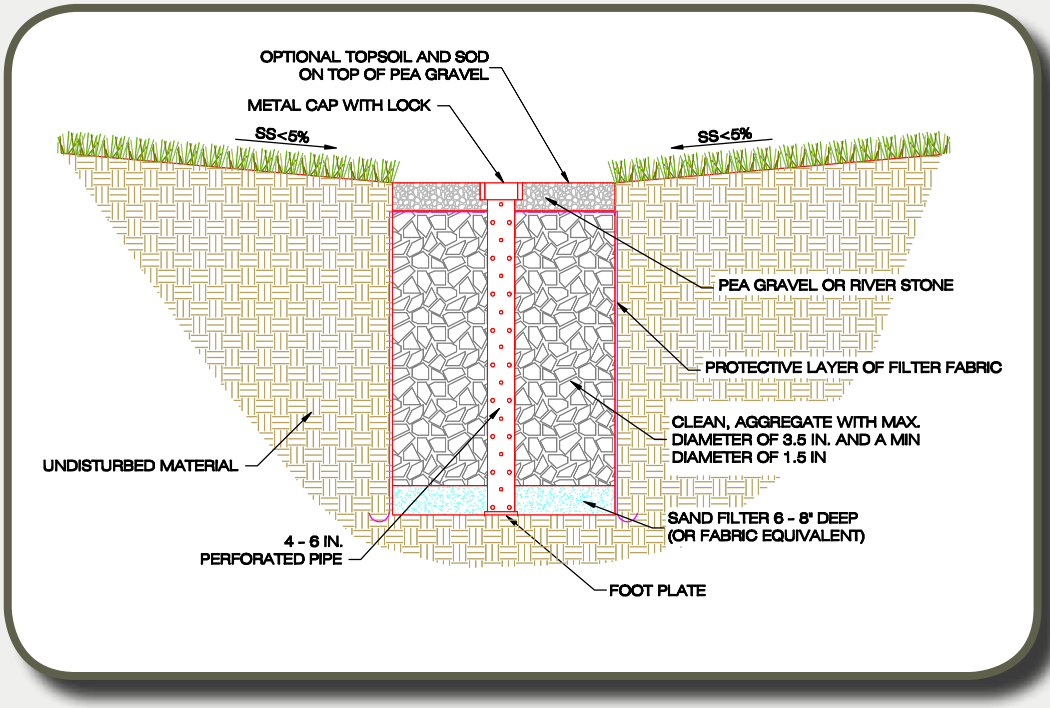


Figure IN-5. Typical detail of observation well

4.2.6. Infiltration (IN)

IN-3. Feasibility Criteria and Design Considerations

Infiltration practices have very high runoff reduction capabilities when sited and designed appropriately. Designers should evaluate the range of soil properties during initial site layout and seek to configure the site to conserve and protect the soils with the greatest recharge and infiltration rates. In particular, areas of Hydrologic Soil Group (HSG) A or B soils shown on NRCS soil surveys should be considered as primary locations for Infiltration practices. Additional information about soil and infiltration are described in more detail later in this section. Key constraints with Infiltration include the following:

Site Topography. Infiltration should be located on relatively flat areas of sites. Practices are best applied when the grade of the area immediately adjacent to the Infiltration practice (within approximately 15 to 20 feet) is greater than 1% and less than 5%. For sites with steep grades, Infiltration should be split into multiple cells with adequate conveyance between the cells to take advantage of relatively flat areas. Unless slope stability calculations demonstrate otherwise, Infiltration practices should be located a minimum horizontal distance of 200 feet from down-gradient slopes greater than 20%.

Available Hydraulic Head. Two or more feet of head may be needed to promote flow through Infiltration practices.

Minimum Depth to Water Table or Bedrock. A minimum vertical distance of 2 feet must be provided between the bottom of the Infiltration practice and the seasonal high water table or bedrock layer.

Soils. Native soils in proposed Infiltration areas must have a minimum field-measured infiltration rate of 0.5 inches per hour (typically HSG A and B soils meet this criterion). Initially, soil infiltration rates can be estimated from NRCS soil data, but designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B of the Manual. Native soils must have silt/clay content less than 40% and clay content less than 20%. Soils investigation must be performed by a qualified soil scientist or geotechnical engineer. Soil boring locations should correspond to the location of the proposed Infiltration device, and should have a minimum of one boring for every 50 feet in length of the Infiltration practice. Infiltration measurements must be taken at and below the proposed invert elevation of Infiltration practices.

Infiltration Design Must Be Considered Early in Site Planning. Soils Intended for Infiltration Must Be Preserved in the Site Design

Early site planning should identify the best soils for Infiltration, and the site design should set these aside for Infiltration practice locations. The site and utility plan and erosion and sediment control plan should identify how the soils will be protected during construction to avoid disturbance and compaction.

Sites that have been previously graded or disturbed do not typically retain their original soil permeability due to compaction. Therefore, such sites are often not good candidates for Infiltration practices unless the geotechnical investigation shows that the soil infiltration rate exceeds 0.5 in/hr.

Contributing Drainage Area. The maximum contributing drainage area (CDA) to an individual Infiltration practice should be less than 2 acres, although smaller CDAs are recommended. The CDA should be as close to 100% impervious as possible. Micro-scale Infiltration practices can also be designed for individual rooftops or other small areas of impervious cover. The design, pretreatment and maintenance requirements will differ depending on the size of the Infiltration practice.

Hotspot Land Uses. Infiltration practices are not intended to treat sites with high sediment or trash/debris loads, because such loads will cause the practice to clog and fail. Infiltration practices should be avoided at potential stormwater hotspots that pose a risk of groundwater contamination.

For a list of potential stormwater hotspots, please consult Chapter 5 of the Manual.

Floodplains. Infiltration practices should be constructed outside the limits of the 100-year floodplain, unless a waiver is obtained from the local authority.

No Irrigation or Baseflow. The planned Infiltration practice should not receive baseflow, irrigation water, chlorinated wash-water or other such non-stormwater flows.

Setbacks. Infiltration practices should not be hydraulically connected to structure foundations or pavement, in order to avoid harmful seepage. Setbacks to structures vary based on the CDA of the Infiltration practice:

- 250 to 2,500 square feet = 5 feet if down-gradient from building; 25 feet if up-gradient.
- 2,500 to 20,000 square feet = 10 feet if down-gradient from building; 50 feet if up-gradient.
- 20,000 to 100,000 square feet = 25 feet if down-gradient from building; 100 feet if up-gradient

Proximity to Utilities. A minimum of 5 feet horizontal distance should be maintained between a utility line and Infiltration practice. No utility line shall be placed over, under or within an Infiltration practice. A minimum of 100 feet horizontal distance shall be maintained between a water supply well and an Infiltration practice.

Underground Injection Permits for Class V Injection Wells

In order for an Infiltration practice to avoid classification as a Class V injection well, which is subject to regulation under the Underground Injection Control (UIC) program, the practice must generally be wider than the practice is deep. If an Infiltration practice is "deeper than its widest surface dimension," or if it includes an underground distribution system then it will likely be considered a Class V injection well. Class V injection wells are subject to permit approval by West Virginia Department of Environmental Protection (WVDEP).

IN-4. Design Criteria

IN-4.1. Infiltration Sizing for Water Quality & Volume Reduction

A Note on Terminology Describing Volume

There are two types of volumes that the designer should consider when designing a best management practice (BMP) plan:

Target Treatment Volume (Tv) = Volume associated with managing 1" of rainfall based on the size and land cover of the CDA, as determined by the Design Compliance Spreadsheet. Any given BMP may treat the full Tv, or only part of it, if used in conjunction with other practices as part of a treatment train.

Design Volume (Dv) = The volume designed into a particular practice based on temporary storage in the stone reservoir (for Infiltration practices), as prescribed in the BMP specification. Infiltration practices can often be part of a treatment train BMP design, with possible upgradient and downgradient practices. In these cases, the Dv of the Infiltration practice will be a subset of the overall Tv for the CDA. The sum of all Design Volumes in the Infiltration practice and other practices in the treatment train should equal the Tv.

See **Chapter 3** for more information on the runoff reduction design methodology.

For the purposes of this sizing section, the sizing relates to the Dv of the Infiltration practice being designed.

The proper approach for designing Infiltration practices is to avoid forcing a large amount of infiltration into a small area. Therefore, as stated in the text box above, individual Infiltration practices that are limited in size due to soil permeability and available space need not be sized to achieve the full 1-inch Target Treatment Volume (Tv) for the CDA, as long as other stormwater treatment practices are applied at the site to meet the remainder of the Tv.

Several equations are needed to size Infiltration practices. The first equation establishes the maximum underground reservoir depth of the Infiltration practice (**Equation IN-1**).

Equation IN-1. Maximum Underground Reservoir Depth for Infiltration Practices

$$d_{max} = \frac{1/2\, i \times t_d}{\eta_r}$$

Where:

dmax = maximum depth of the Infiltration practice (feet)
i = field-verified infiltration rate for the native soils (ft./day)
t_d = maximum drawn down time (normally 1.5 to 2 days) (day)
η_r = available porosity of the stone reservoir (assume 0.35)

This equation makes the following design assumptions:

- Conservative Infiltration Rates. For design purposes, the field-tested subgrade soil infiltration rate (i) is divided by 2 as a factor of safety to account for potential compaction during construction and to approximate long term infiltration rates. On-site infiltration investigations should always be conducted to establish the actual infiltration capacity of underlying soils, using the methods presented in Appendix B.
- Stone Layer Porosity. A porosity value of 0.35 shall be used in the design of stone reservoirs, although a larger value may be used if perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials are installed within the reservoir.
- Rapid Drawdown. Infiltration practices should be sized so that the target runoff reduction volume infiltrates within 36 hours to 48 hours, to prevent nuisance ponding conditions.

Designers should compare these results to the maximum allowable depths in **Table IN-4**, and use whichever value is less for subsequent design.

Table IN-4. Maximum Depth (in feet) for Underground Stone Reservoir

Mode of Entry	Scale of Infiltration: Contributing Drainage Area (CDA)		
	Micro Infiltration (CDA = 250 to 2,500 square feet)	Small Scale Infiltration (CDA = 2,500 to 20,000 square feet)	Conventional Infiltration (CDA = 20,000 to 100,000 square feet)
Underground Stone Reservoir	3.0	5.0	varies

Once the maximum depth is known, calculate the surface area needed for an Infiltration practice using **Equation IN-2**:

Equation IN-2. Underground Reservoir Surface Area for Infiltration Practices

$$SA = \frac{Design\ Volume}{(\eta_r \times d) + \left({}^{1}\!/_{2}\, i \times t_f\right)}$$

Where:

SA	=	Surface area (sq. ft.)
Design Volume	=	Volume (or portion of it) to be treated by Infiltration practice (see Design Compliance Spreadsheet)
η_r	=	available porosity of the stone reservoir (assume 0.35)
d	=	Infiltration depth (ft.) (maximum depends on the scale of infiltration and the results of Equation IN- 1)
i	=	field-verified infiltration rate for the native soils (ft./day)
t_f	=	Time to fill the Infiltration facility (days; typically 2 hours, or 0.083 days)

The Design Volume captured by the Infiltration practice is defined as the volume of water that is fully infiltrated through the practice with no overflow.

The Design Volume can be determined by rearranging **Equations IN-2** to yield **Equation IN-3**.

Equation IN-3. Design Volume Calculation for Underground Reservoir Surface Area for Infiltration Practices

$$Design\ Volume = SA\left[(\eta_r \times d) + \left({}^{1}\!/_{2}\, i \times t_f\right)\right]$$

Infiltration practices can also be designed to address, in whole or in part, the detention storage needed to comply with local stormwater detention requirements. The designer can model various approaches by factoring in storage within the stone aggregate layer, any perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials installed within the reservoir, expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

IN-4.2. Pretreatment

Pre-Treatment is Essential

Every Infiltration system must have at least two pretreatment mechanisms to protect the long term integrity of the infiltration rate and to achieve the runoff reduction rate assigned in Table IN-1.

One of the following techniques must be installed to pretreat the inflow in every Infiltration facility:

- grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- grass channel
- forebay (minimum 25% of the Design Volume)
- gravel diaphragm (minimum 1 foot deep and 2 feet wide and only if sheet flow is established and maintained)
- sand filter cell (see **Specification 4.2.10, Filtration**)

For pre-treatment structures at the edge of pavement (e.g., grass filter strips, gravel diaphragms, flow splitters), it is important that there be a 2 to 4 inch drop from the edge of pavement to the top of the grass or stone in the pre-treatment structure. This is to prevent accumulation of debris and subsequent clogging at the point where runoff is designed to enter the pre-treatment structure (see **Figure IN-6**).

If the infiltration practice serves a CDA greater than 20,000 square feet, a forebay or sand filter cell must be used for pre-treatment (see **Figure IN-7**). The forebay or sand filter cell must have a storage volume equivalent to at least 25% of the total Design Volume for the practice. This volume should be increased to 50% of the Design Volume if the infiltration rate for the underlying soils is greater than 2.0 inches per hour.

Designers should ensure that exit velocities from the pretreatment chamber are not erosive (e.g., less than 6 feet/second for the 15-year storm) and flow from the pretreatment chamber should be evenly distributed across the width of the practice (e.g., using a level spreader or energy dissipater).

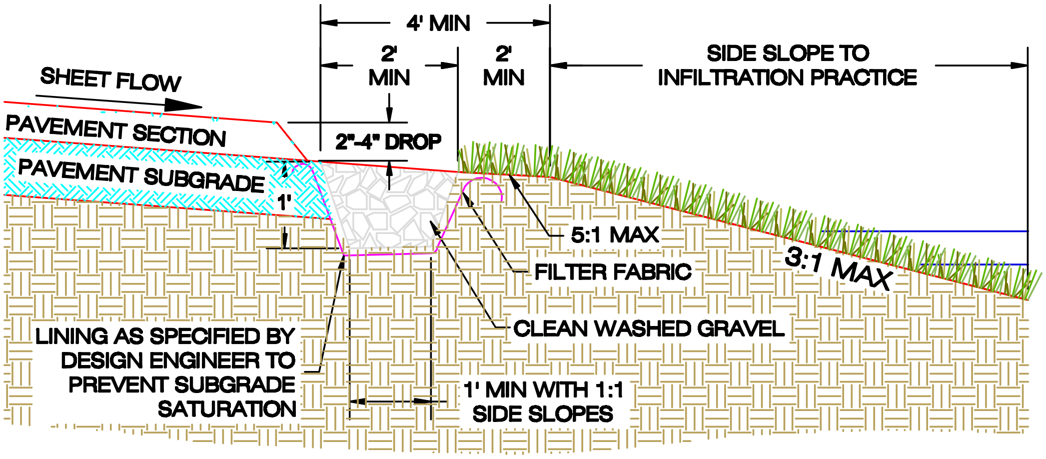


Figure IN-6. Typical Detail for Pre-Treatment at Pavement Edge – A 2 to 4 inch drop from the pavement to the top of stone helps to prevent clogging.

Figure IN-7. Examples of pretreatment forebay (left) and sand filter cell (right)

IN-4.3. Conveyance and Overflow

There are two basic design approaches for conveying runoff into, through, and around Infiltration practices.

1. **Off-line:** Flow is split or diverted so that only the design storm or design flow enters the Infiltration area. Larger flows by-pass the Infiltration bed. Off-line designs can be accomplished by establishing a maximum ponding depth (at which point higher flows are diverted) or a flow diversion or flow splitter at or upgradient of the inlet. Off-line designs are strongly recommended for Infiltration practices with a CDA larger than 0.5 acres so that flows to do not overwhelm or damage the Infiltration area.
2. **On-line:** All runoff from the drainage area flows into the practice. Flows that exceed the design capacity exit the practice via an overflow structure or weir. The following criteria apply to overflow structures:
   - An overflow shall be provided within the practice to pass storms greater than the design storm storage to a stabilized conveyance or storm sewer system. The overflow structure elevation should be above the Infiltration surface so that flows do not bypass the Infiltration treatment.
   - The overflow should be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
   - The overflow capture device should be scaled to the application – this may be a landscape grate or yard inlet for small practices or a commercial-type structure for larger installations.

See Section BR-4.4 in Specification 4.2.3, Bioretention for more details and examples of off-line and on-line designs.

It should be noted that both types of design approaches require attention to safe conveyance of larger flows in adequate conveyances and with adequate freeboard to a receiving waterbody. Drainage design should be based on expected peak discharges assuming that upstream practices may fail and/or provide marginal storage during larger events. These concerns should be addressed in a plan's overall drainage approach.

IN-4.4. Design Geometry

Where possible, Infiltration practices should be designed to be wider than they are deep, to avoid classification as a Class V injection well (see Section IN-3).

IN-4.5. Practice Slope

The bottom of an Infiltration practice should be flat (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater.

IN-4.6. Ponding Depth

The maximum vertical depth over an Infiltration practice is 12 inches.

IN-4.7. Side Slopes

The side-slopes should be no steeper than 4H:1V.

IN-4.8. Stone Layer

Stone layers must consist of clean, washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.

IN-4.9. Surface Stone/Surface Cover

A 3-inch layer of clean, washed river stone or No. 8 or 89 stone should be installed over the stone layer.

As an option, designers may choose to install a layer of topsoil and grass above the Infiltration practice (e.g., on top of the No. 8 or 89 stone; see **Figure IN-8**).

IN-4.10. Trench Bottom

To protect the bottom of an Infiltration Trench from intrusion by underlying soils, a sand layer must be used. The underlying native soils should be separated from the stone layer by a 6 to 8 inch layer of coarse sand (e.g., ASTM C 33, 0.02-0.04 inch).

IN-4.11. Observation Well

Infiltration practices should include an observation well, consisting of an anchored 6-inch diameter perforated PVC pipe fitted with a lockable cap installed flush with the ground surface, to facilitate periodic inspection and maintenance. An observation should be installed for each 50 linear feet of the practice.

Figure IN-8. Example of an Infiltration Trench with Surface Cover

IN-4.12. Overdrain

An optional overflow collection pipe (overdrain) can be installed in the stone layer to convey collected runoff from larger storm events to a downstream conveyance system.

IN-4.13. Underground Storage Layer (optional)

Runoff is stored in the voids of the stones, and infiltrates into the underlying soil matrix. Perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials can be used in conjunction with the stone to increase the available temporary underground storage. In some instances, a combination of filtration and infiltration cells can be installed in the floor of a dry extended detention pond, provided that there is adequate pretreatment and the ponding depth above the Infiltration bed is limited to 1 foot.

IN-4.14. Filter Fabric

Woven, monofilament filter fabric may be placed on the side slopes of the infiltration practice. In no case shall filter fabric be used along the bottom surface of the practice.

IN-4.15. Infiltration Landscaping Criteria

Infiltration practices can be effectively integrated into the site plan and aesthetically designed with adjacent native landscaping or turf cover, subject to the following additional design considerations:

- Infiltration practices should NEVER be installed until all up-gradient construction is completed AND pervious areas are stabilized with dense and healthy vegetation.
- Vegetation associated with the Infiltration practice buffers should be regularly mowed and maintained to keep organic matter out of the Infiltration device and maintain enough vegetation to prevent soil erosion from occurring.

4.2.6. Infiltration (IN)

IN-5. Materials Specifications

Table IN-5 provides materials specifications for Infiltration practices.

Table IN-5. Infiltration Material Specifications

Material	Specification	Notes
Surface Layer (optional)	Topsoil and grass layer	
Surface Stone	3-inch layer of river stone or pea gravel.	This provides an attractive surface cover that can suppress weed growth.
Stone Layer	Clean, aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.	

Material	Specification	Notes
Observation Well	Vertical 6-inch Schedule 40 PVC perforated pipe, with a lockable cap and anchor plate.	Install one per 50 feet of length of Infiltration practice.
Overflow collection pipe (optional)	Use 4-inch or 6-inch rigid schedule 40 PVC pipe, with 3/8" perforations at 6 inches on center, with each perforated overflow pipe installed at a slope of 1% for the length of the Infiltration practice.	
Trench Bottom	6 to 8 inch sand layer (e.g., ASTM C 33, 0.02-0.04 inch)	
Filter Fabric (sides only)	Woven, monofilament filter fabric may be placed only on the side slopes.	
Buffer Vegetation	Keep adjacent vegetation from forming an overhead canopy above Infiltration practices, in order to keep leaf litter, fruits and other vegetative material from clogging the stone.	

4.2.6. Infiltration (IN)

IN-6. Design Adaptations

IN-6.1. Karst Terrain

Karst regions are found in much of the Ridge and Valley and Panhandle. Karst complicates both land development and stormwater design. Large-scale Infiltration practices (with CDAs larger than 20,000 square feet) **should not be used** in karst regions due to concerns about sinkhole formation and groundwater contamination. Micro- or small-scale Infiltration areas are permissible, and the following design modifications should be considered (CSN, 2009):

- The surface area of the Infiltration practice should be maximized vis-à-vis the depth. It is recommended that the stone reservoir layer be 24 inches or less.
- Soil borings and/or geotechnical studies must indicate at least three feet of vertical separation exist between the bottom invert of the Infiltration practice and the karst bedrock layer.
- In many cases, Bioretention is a preferred stormwater alternative to Infiltration in karst areas.
- Infiltration is prohibited if the CDA is classified as a severe stormwater hotspot (see **Chapter 5** of the Manual).

IN-6.2. Steep Slopes

Forcing conventional Infiltration practices in steep terrain can be problematic with respect to slope stability, excessive hydraulic gradients and sediment delivery. Unless slope stability calculations demonstrate otherwise, it is generally recommended that Infiltration practices should be located a minimum horizontal distance of 200 feet from down-gradient slopes greater than 20%. Micro-scale and small-scale Infiltration can work well, as long as their smaller up-gradient and down-gradient building setbacks are satisfied.

IN-6.3. Cold Climate and Winter Performance

Infiltration practices can be designed to withstand more moderate winter conditions. The main problem is caused by ice forming in the voids or the subsoils below the practice, which may briefly result in nuisance flooding when spring melting occurs. The following design adjustments are recommended for Infiltration practices installed at higher elevations:

- The bottom of the practice should extend below the frost line.
- Infiltration practices are not recommended in the right-of-way immediately adjacent to roadsides that are heavily sanded and/or salted in the winter months (to prevent movement of chlorides into groundwater and prevent clogging by road sand).
- Pre-treatment measures can be oversized to account for the additional sediment load caused by road sanding (up to 40% of the Design Volume).
- Infiltration practices must be set back at least 25 feet from roadways to prevent potential frost heaving of the road pavement.

IN-6.4. Stormwater Retrofitting

As a stand-alone practice, Infiltration is likely to be used rarely in a retrofit context due to the disturbed soils in many developed areas. Adequate soil and geotechnical tests must be conducted to verify that the underlying soil is suitable for Infiltration and that infiltrated water will not cause problems for existing building foundations, road sections, and other infrastructure elements. In cases where this can be verified, Infiltration may be a cost-effective retrofit practice.

For more information on retrofitting, see the Center for Watershed Protection's manual, ***Urban Stormwater Retrofit Practices*** (Schueler et al., 2007).

4.2.6. Infiltration (IN)

IN-7. Construction & Installation

IN-7.1. Infiltration Construction Sequence

Infiltration Construction Sequence

Infiltration practices are particularly vulnerable to failure during the construction phase for two reasons. First, if the construction sequence is not followed correctly, construction sediment can clog the practice. In addition, heavy construction can result in compaction of the soil, which can then reduce the soil's infiltration rate. For this reason, a careful construction sequence needs to be followed. Ideally, the Infiltration practice should remain outside of the limit of disturbance during construction.

During site construction, the following steps are absolutely critical:

- Avoid excessive compaction by preventing construction equipment and vehicles from traveling over the proposed location of the Infiltration practice.
- Keep the Infiltration practice "off-line" until construction is complete. Prevent sediment from entering the Infiltration site by using super silt fence, diversion berms or other means. In the erosion and sediment control plan, indicate the earliest time at which stormwater runoff may be directed to an Infiltration practice. The erosion and sediment control plan must also indicate the specific methods to be used to temporarily keep runoff from the Infiltration site.
- Infiltration practice locations should never serve as the sites for temporary sediment control devices (e.g., sediment traps, etc.) during construction.
- Upland drainage areas need to be completely stabilized with a thick layer of vegetation prior to commencing excavation for an Infiltration practice.

IN-7.2. Infiltration Installation

The actual installation of an Infiltration practice is done using the following steps:

Step 1. Excavate the Infiltration practice to the design dimensions from the side, using a backhoe or excavator. The floor of the pit should be completely level, but equipment should be kept off the floor area to prevent soil compaction.

Step 2. Install filter fabric on the trench sides. Large tree roots should be trimmed flush with the sides of Infiltration Trenches to prevent puncturing or tearing of the filter fabric during subsequent installation procedures. When laying out the filter fabric, the width should include sufficient material to compensate for perimeter irregularities in the trench and for a 6-inch minimum overlap at the top of the trench. The filter fabric itself should be tucked under the sand layer on the bottom of the Infiltration Trench. Stones or other anchoring objects should be placed on the fabric at the trench sides, to keep the trench open during windy periods. Voids may occur between the fabric and the excavated sides of a trench. Natural soils should be placed in all voids, to ensure the fabric conforms smoothly to the sides of excavation.

Step 3. Scarify the bottom of the Infiltration practice, and spread 6 inches of sand on the bottom as a filter layer.

Step 4. Anchor the observation well(s), and add stone to the practice in 1-foot lifts.

Step 5. Use sod, where applicable, to establish a dense turf cover for at least 10 feet around the sides of the Infiltration practice, to reduce erosion and sloughing. Sod should not be used over the Infiltration bed itself. For designs that call for a turf cover over the Infiltration bed, seeding and use of a biodegradable erosion control matting are good alternatives for establishing the turf cover.

Step 6. Conduct the final construction inspection, then log the GPS coordinates for each Infiltration facility and submit them for entry into the local maintenance tracking database.

An example construction phase inspection checklist is available in Appendix A of the Manual.

4.2.6. Infiltration (IN)

IN-8. Maintenance Criteria

Maintenance is a crucial element that ensures the long-term performance of Infiltration practices. The most frequently cited maintenance problem for Infiltration practices is clogging of the stone by organic matter and sediment. The following design features can minimize the risk of clogging:

Stabilized CDA. Infiltration systems may not receive runoff until the entire CDA has been completely stabilized.

No Filter Fabric on Bottom. Do not install geotextile or filter fabric along the bottom of Infiltration practices. Experience has shown that these fabrics are prone to clogging.

Direct Maintenance Access. Infiltration systems must be covered by a drainage easement to allow inspection and maintenance. Access must be provided to allow personnel and construction equipment to perform non-routine maintenance tasks, such as practice reconstruction or rehabilitation. While a turf cover is permissible for small-scale Infiltration practices, the surface must never be covered by an impermeable material, such as asphalt or concrete.

Maintenance agreements and plans must be executed between the owner and the local authority. The agreements will specify the property owner's primary maintenance responsibilities and authorize local agency staff to access the property for inspection or corrective action in the event that proper maintenance is not performed.

Effective long-term operation of Infiltration practices requires a dedicated and routine maintenance inspection schedule with clear guidelines and schedules, as shown in **Table IN-6** below. Where possible, facility maintenance should be integrated into routine landscaping maintenance tasks.

Table IN-6. Recommended Maintenance Tasks for Infiltration Practices

Maintenance Tasks	Frequency
• Replace pea gravel/topsoil and top surface filter fabric (when clogged). • Mow grass surface over (if applicable) as necessary and remove the clippings.	As needed
• Ensure that the CDA, inlets, and facility surface are clear of debris. • Ensure that the CDA is stabilized. Perform spot-reseeding if where needed. • Remove sediment and oil/grease from inlets, pre-treatment devices, flow diversion structures, and overflow structures. • Repair undercut and eroded areas at inflow and outflow structures.	Quarterly
• Check observation wells 3 days after a storm event in excess of 1/2 inch in depth. Standing water observed in the well after three days is a clear indication of clogging. • Inspect pre-treatment devices and diversion structures for sediment build-up and structural damage. • Remove trees that start to grow in the vicinity of the Infiltration facility that may drop leaf litter, fruits and other vegetative materials that could clog the Infiltration device.	Semi-annual inspection
• Clean out accumulated sediments from the pre-treatment cell.	Annually

It is highly recommended that annual site inspections be performed for Infiltration practices to ensure the practice performance and longevity. An example maintenance inspection checklist for Infiltration systems can be found in **Appendix A of the Manual**.

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