

5.6 Infiltration Trenches



An infiltration trench runs horizontally under the ground. Infiltration trenches are best suited for areas where the available area for stormwater management is narrow and limited. Typical dimensions associated with infiltration trenches include widths less than 25 feet and depths ranging from 3 to 12 feet depending on the soil conditions, depth to ground water, and the required stormwater storage. The top layer of gravel must remain exposed and easily identifiable.



This stormwater management approach is not appropriate in areas prone to sink holes.

Advantages:

Infiltration trenches work the best in areas with sandy soils. They provide a great opportunity to recharge the groundwater and provide increased storage capacity compared to some of the other LID SWMF options previously discussed.

Limitations:

Infiltration trenches are not recommended in areas with clay or silt. If the site contains soils with low permeability, the trench width should be increased to provide additional surface area for drainage. They can easily clog with sediments and organic matter, therefore some sort of pre-treatment such as vegetative filter strips are recommended. This stormwater management approach is not appropriate in industrial areas or areas that use pesticides due to the potential for groundwater contamination. If an infiltration trench is the preferred LID SWMF than a geotechnical investigation shall be conducted, **web based soil information is not adequate.**

Design Considerations:

This application is best suited for areas with slopes between 0% through 15%. Sites with sandy soils (HSG A and B) are recommended for this application due to high permeability rates. If the site contains a small fraction of clay or silt, the ranges should be less than 20% clay and 40% silt. Infiltration will decrease if too much sediment builds up in the trench. Generally, shallow trenches with increased widths will be impacted with sediment at a slower rate than a trench that is deep and narrow; this is due to the increased infiltration area available. A 20-foot vegetative buffer will be necessary to mitigate erosion and prevent sediment from entering the system; this will act as your filter strip.



Trenches must be separated from foundations. Please check the current Building Code for minimum distances or contact the Building Department for help.

- A qualified contractor that is familiar with excavations and shoring should prepare the site if the excavation exceeds a depth of four feet.
- A limited geotechnical investigation will be necessary, and the soil borings should extend a minimum of 2-feet below the proposed depth of the infiltration trench.
- The water table and site geology (sub-surface soil profile) will determine the depth that the trench can extend.
- Utilization of an infiltration trench is an excellent way to manage stormwater as long as the water does not have any major contamination. It is best to pre-treat stormwater before it enters the LID SWMF if it originates from paved areas. This can be accomplished with a variety of LID SWMF options that have been introduced in previous sections.
- The natural grade (slope, elevation change) of the property should always be taken into consideration when determining the best location to place a LID SWMF.
- Infiltration trenches should not be placed near trees. The root system of trees will invade the well casing reducing the well capacity and they may damage the system.
- Infiltration trenches need to be placed within the setbacks required by the LDC.
- A minimum of 25 feet between the infiltration trench and any structure should be maintained to avoid damage to the foundation.
- A minimum of 100 feet shall be maintained between surface waters, septic tanks, and private wells.
- Care should be employed to ensure that the native soils in and around the trench are not compacted during construction; this will reduce the infiltration capabilities.
- The trench must be visually identifiable.
- The maximum design water level should be established no less than one foot below the lowest foundation elevation, including neighboring structures.
- Filter / geotextile fabric will need to be installed along the bottom of the trench and along each side to provide a barrier between the native soil and the filter media.
- Infiltration trenches can be constructed with or without an underdrain (a slotted PVC pipe traversing the bottom of the trench). If a PVC pipe is included in the design it will need to be wrapped with filter fabric to keep sand and sediment from entering.
- A minimum 4-inch PVC riser / emergency drain may be installed to convey excess water during extreme storm event. The top elevation of the riser should be set at the design storage volume elevation (this riser will establish the maximum depth of water that will be contained in the trench before it is conveyed to another trench or a different LID SWMF application). The riser should be fitted with a 90 degree elbow to keep debris from entering it.
- A slotted PVC monitoring well terminating just above the lowest filter media should be installed to allow the property owner to monitor the water level in the trench and measure the infiltration efficiency. The contractor should take care not to puncture the filter / geotextile fabric when placing the monitoring well. The bottom of the well will need to be anchored or weighted down to keep it from settling or shifting to one side or another. The monitoring well should be at least a 4-inch slotted PVC pipe with the top elevation set flush with the surface. Additionally, the well should have a locking cap.

- Once the filter / geotextile fabric and pipes are secured, a 6-inch layer of sand should be placed in the excavation followed by another layer of filter / geotextile fabric. Clean stone / gravel will fill a majority of the trench followed by another layer of filter / geotextile fabric. The last layer will consist of 2 inches of 1.5-inch to 2.5-inch diameter pea gravel. The pea gravel should extend to natural grade . The infiltration trench should never be covered with concrete.
- An overflow berm set at a predetermined elevation should be constructed on the downhill portion of the site nearest the trench. This will alleviate potential localized flooding if the infiltration trench becomes over saturated.



Photo Source: Village of Palmetto Bay, (2014)

Design Steps:

1. First determine the storage treatment volume, soil conditions, depth to the SHGW, and the natural slope of the property at your location using the methods described in **Section 2** and **Section 3**, this will assist in choosing the optimal location for the LID SWMF.
2. Determine the required storage volume using the approach presented in **Section 3**, for this example we will use 421 ft³ as the storage requirement. You will want to keep a minimum of two to four feet separation between the bottom of the infiltration trench and the SHGW. In this example we will use a depth to SHGW as eight feet. This will make the design depth of the infiltration trench four feet. Using this data, we will determine the required area of the trench.
3. Porosity is the ratio of void volume of total volume, in other words it relates to the amount of water that can be stored between the gravel. In order to get a representative volume for the capacity of the infiltration trench you will need to take into account the average porosity of the filter media (gravel), for this we will use 0.3. This means that the gravel takes up approximately 70% or 0.7 of the infiltration trench.

<i>Required Volume of Stormwater to Be Retained (ft³)</i>	<i>Space Allotted for Filter Media (%)</i>	<i>Required Volume of Stormwater to Be Retained (ft³)</i> <i>Porosity</i>	<i>Total Required Volume To Account for Filter Media (ft³)</i>
421 ft ³	70 %	$\frac{421 \text{ ft}^3}{0.3}$	= 1,403 ft ³

From this, we can see that we need to increase the trench volume to accommodate the space that the gravel will occupy while still meeting the stormwater storage criteria.

4. Next, determine the area required for the infiltration trench if the depth is four feet.
5. Determine the total required volume associated with the filter media.

<i>Total Required Volume - Required Water Volume = Filter Media Volume (ft³)</i>	<i>Depth of Infiltration Trench (ft)</i>
$1,403 \text{ ft}^3 - 421 \text{ ft}^3 = 982 \text{ ft}^3$	4 ft

<i>Required Area of Infiltration Trench (ft²)</i>
$\frac{1,403 \text{ ft}^3}{4 \text{ ft}} = 350 \text{ ft}^2$

If we make the trench the maximum recommended width of 25 feet, than the length would be calculated as follows:

<i>Area of Infiltration Trench (ft²)</i>	<i>Length of Infiltration Trench (ft)</i>
350 ft^2	25 ft

<i>Area of Infiltration Trench (ft²)</i>	<i>= Required Width of Infiltration Trench (ft²)</i>
$\frac{350 \text{ ft}^2}{25 \text{ ft}}$	$= 14 \text{ ft}$

According to the calculations, the infiltration trench will need to have a length of 25 ft, width of 14 ft, and a depth of 4 feet. Additional options would be to install two smaller infiltration trenches, make the trench deeper, or use multiple LID SWMF to meet the storage criteria.

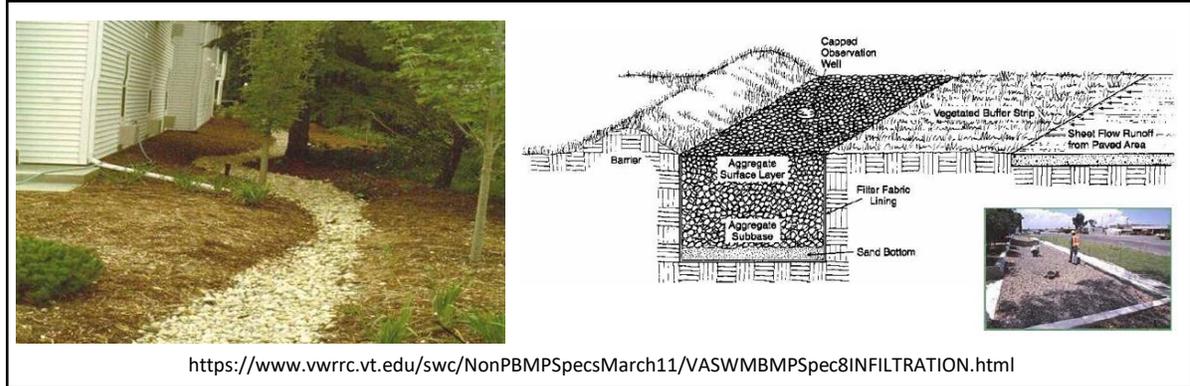
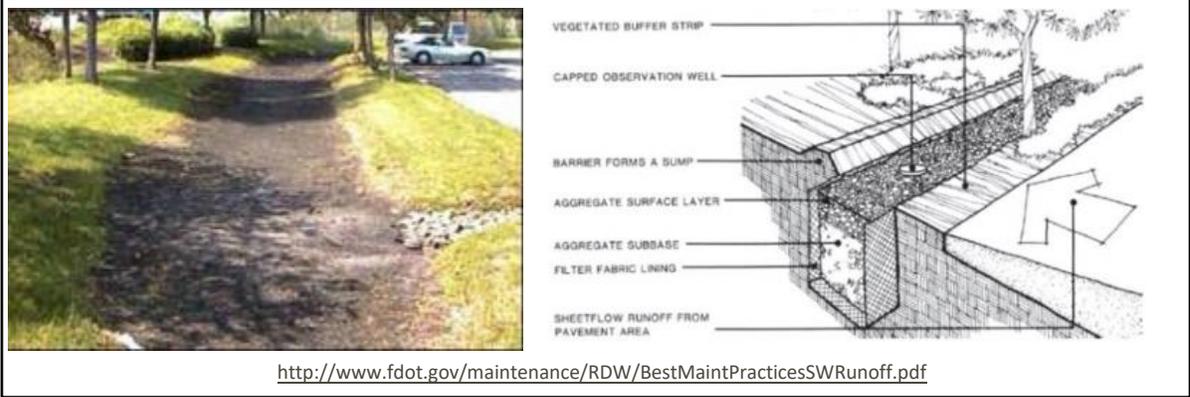
Refer to Calculation Sheet 5.6 included at the end of this section for assistance with designing an infiltration trench.

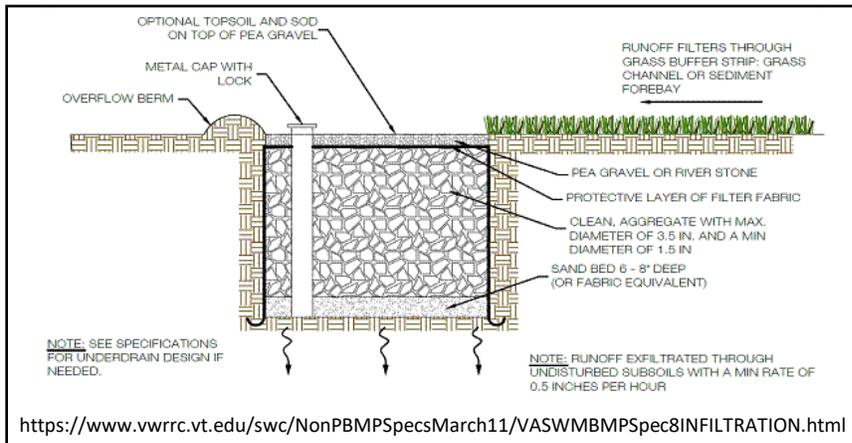
Operation and Maintenance:

Infiltration trenches should be visually inspected during and again shortly after significant rain events. Periodic maintenance of the infiltration trench will be necessary. Check pre-treatment applications for sediment build up and remove excess buildup on a quarterly basis. If sediment becomes an issue this can be resolved by replacing the filter / geotextile fabric closest to the top of the trench, this layer will be the most prone to sediment buildup. The pea gravel should be added / replaced as the filter media (sand and gravel) settles.

Visually inspect the water level in the monitoring well before and after storms to determine that water is infiltrating at an acceptable rate. Infiltration trenches are not intended to permanently retain water. They should drain completely during durations of prolonged dry weather; this allows the soil to aerate. If the trench does not dry out then maintenance is required. A visual inspection of the immediate area around the trench and monitoring well will assist in determining if the trench is draining properly. If soil in the area is frequently saturated and/or the water level in the monitoring well remains at a high level after significant time passes after the storm (48 to 72 hours), then the trench may be clogged or could have been compromised with tree roots. In this case replacement of the gravel, filter / geotextile fabric, and the top 6 inch of pea gravel might be necessary. Walk the perimeter of the trench and look for areas that have washed out or are starting to settle, this could be an indication of soil piping. Maintain the vegetated buffer and remove any trees that may have taken root during the last maintenance inspection.

Infiltration Trench Examples:





Calculation Sheet 5.6 – Infiltration Trench Design:

Only Enter Information In To The Green Boxes - All Other Boxes Are Automatically Calculated

Low Impact Development Calculation Sheet			
Owner			Line 1
Address			Line 2
Phone			Line 3
E-mail			Line 4
Parcel Identification Number			Line 5
Total Proposed Disturbed Area	_____ ac		Line 6
Proposed Impervious Area Totals			
House	_____	ft ²	Line 7
Detached Garage	_____	ft ²	Line 8
Shed	_____	ft ²	Line 9
Driveway	_____	ft ²	Line 10
Patio / Porch / Deck	_____	ft ²	Line 11
Pool	_____	ft ²	Line 12
Misc Description:	_____	ft ²	Line 13
Is Your Property In The Following Locations:			
		Yes	No
ICPAL	If "yes" see section 3.4	<input type="checkbox"/>	<input type="checkbox"/>
Dune Lake	If "yes" see section 3.5	<input type="checkbox"/>	<input type="checkbox"/>
Near a Mosquito Control Ditch	If "yes" see section 3.6	<input type="checkbox"/>	<input type="checkbox"/>
Area Totals			
Total Impervious Area	_____	ft ²	Line 14
		Divide this number by 43,560 and enter in line 14	
Total Impervious Area (acres)	_____	ac	Line 15
Total Impervious Area (acres)	= Total Area (ft ²) * (1 acre/ 43,560 ft ²)		
Total Pervious Area	_____	ac	Line 16
Total Pervious Area (ft ²)	_____	ft ²	Line 17
		Subtract Line 6 from Line 14 and Enter in Line 15	
Total Pervious Area (acres) = Total Area (acres) - Total Impervious Area (acres)			
Next Determine the Volume Required Per the LDC Section 5.06.00			
Total Property (square feet)	_____	ft ²	Line 18

Soils Characteristics

Depth to Seasonal High Groundwater Table _____ ft below ground surface Line 19

Predominant Soil Type

Predominant Soil Type	_____	Value Taken From USGS Soils Survey	Line 20
Infiltration Actual K_{sat}	_____ in/hr	Provided in Table 3	Line 21
Design Infiltration Design K_{sat}	_____ in/hr	Divide Line 24 by 2	Line 22

Stormwater Volume Requirements

_____ 0.5 in Rainfall Over Disturbed Area	_____ ft^3		Line 23
_____ 1 in Runoff Over Proposed Impervious Surface	_____ ft^3		Line 24
Attenuation Volume	_____ ft^3	Find Largest Value Between Line 23, 24, and 25 And Enter	Line 25
Required Retention Volume	_____ ft^3	The Value On Line 26	Line 26

*****Special Circumstances Only - Verify Your Location****

Section 3.4 Stormwater Volume Requirements for ICPAL

_____ 0.5 in Rainfall Over Disturbed Area	_____ ft^3		Line 27
_____ 1 in Runoff Over Proposed Impervious Surface	_____ ft^3		Line 28
Attenuation Volume	_____ ft^3	Find Largest Value Between Line 27, 28, and 29 And Enter	Line 29
Required Retention Volume	_____ ft^3	The Value On Line 30	Line 30

Section 3.5 Stormwater Volume Requirements for Dune Lake

_____ 0.5 in Rainfall Over Disturbed Area	_____ ft^3		Line 31
_____ 1 in Runoff Over Proposed Impervious Surface	_____ ft^3		Line 32
Attenuation Volume	_____ ft^3	Find Largest Value Between Line 31, 32, and 33 And Enter	Line 33
Required Retention Volume	_____ ft^3	The Value On Line 34	Line 34

Section 3.6 Stormwater Volume Requirements for Mosquito Control Ditch

_____ 0.5 in Rainfall Over Disturbed Area	_____ ft^3		Line 35
_____ 1 in Runoff Over Proposed Impervious Surface	_____ ft^3		Line 36
Attenuation Volume	_____ ft^3	Find Largest Value Between Line 35, 36, and 37 And Enter	Line 37
Required Retention Volume	_____ ft^3	The Value On Line 38	Line 38

Table 3. NRCS Soil Data

Map Unit Symbol	Map Unit Name	HSG	SHGW Elevation (SHGW)	High Water Season	Permeability Rate (Ksat)
5	Chiple sand, 5 to 8 % slopes	A	-2 feet	Dec - Apr	6 in/hr
8	Dorovan-Pamlico association, frequently flooded	B/D	0 (at surface)	Jan – Dec	0.6 in/hr
12	Foxworth sand, 0 to 5 percent slopes	A	-3.5 feet	Jun – Oct	20 in/hr
16	Kureb sand, 0 to 8 percent slopes	A	-5 feet	----	6 in/hr
17	Lakeland sand, 0 to 5 percent slopes	A	-5 feet	----	6 in/hr
18	Lakeland sand, 5 to 12 percent slopes	A	-5 feet	----	6 in/hr
19	Lakeland sand, 12 to 30 percent slopes	A	-5 feet	----	6 in/hr
21	Leon sand, 0 to 2 percent slopes	A/D	0 (at surface)	Jun – Feb	0.6 in/hr
27	Rutlege fine sand, 0 to 2 percent slopes	A/D	0 (at surface)	Dec – May	6 in/hr
30	Tifton fine sandy loam, 5 to 8 percent slopes	B	-3.5 feet	Jan – Feb	0.6 in/hr
36	Pits	-	On-site test	On-site test	On-site test
45	Dirego muck, frequently flooded	A/D	0 (at surface)	Jan – Dec	6 in/hr
49	Eglin sand, 0 to 5 percent slopes	A	-5 feet	----	6 in/hr
50	Mandarin sand, 0 to 2 percent slopes	A	-1.5 feet	Jun – Dec	0.6 in/hr
51	Bigbee loamy sand, 0 to 5 percent slopes, occasionally flooded	A	-3.5 feet	Jan – Mar	6 in/hr
53	Arents, 2 to 8 percent slopes	A	-5 feet	----	20 in/hr
54	Newhan-Corolla sands, rolling	A	-5 feet	----	20 in/hr
55	Beaches	-	0 (at surface)	----	0 in/hr
56	Kureb sand, hilly	A	-5 feet	----	6 in/hr
57	Hurricane sand, 0 to 5 percent slopes	A/D	-2 feet	Nov – Apr	6 in/hr
58	Duckston muck, frequently flooded	A/D	0 (at surface)	Jan – Dec	6 in/hr
62	Resota sand, 0 to 5 percent slopes	A	-3.5 feet	Dec – Apr	20 in/hr
63	Pickney sand, depressional	A/D	0 (at surface)	Nov – Apr	6 in/hr
64	Pamlico muck	A/D	0 (at surface)	Dec – May	0.6 in/hr
69	Floralo loamy fine sand, 2 to 5 percent slopes	C	-1.5 feet	Dec – Mar	0.06 in/hr
99	Water	-	-	-	-
100	Waters of Gulf of Mexico	-	-	-	-

Site Characteristics		
Total Disturbed Area	_____ ft ²	Line 1
Impervious Area	_____ ft ²	Line 2
Impervious Surface Ratio (ISR)	_____	Line 3
Soil Characteristics		
Soil Type - Refer to Section 2.4		Line 4
Rainfall Intensity	_____ 0.43 in/hr	Line 5
Infiltration Rate - Refer to Table 3	_____ in/hr	Line 6
Design Infiltration Rate (Divide By 2)	_____ in/hr	Line 7
Rainfall Depth	_____ 8.73 in	Line 8
Reduced Rainfall Depth	_____ in	Line 9
Attenuation Calculation		
Design Factor - Choose One Based On The ISR Calculated In Line 3	_____	Line 10
ISR Less Than 0.4	1	
ISR Between 0.4 and 0.7	1.2	
ISR Greater Than 0.7	1.4	
Design Rainfall Depth	_____ in	Line 11
Design Rainfall Depth (Conversion)	_____ ft	Line 12
Required Storage Volume	_____ ft ³	Line 13

Site Characteristics

Total Disturbed Area	_____ ft ²	Line 1
Impervious Area	_____ ft ²	Line 2
Impervious Surface Ratio (ISR)	_____	Line 3

Soil Characteristics

Soil Type - Refer to Section 2.4		Line 4
Rainfall Intensity	_____ 0.61 in/hr	Line 5
Infiltration Rate - Refer to Table 3	_____ in/hr	Line 6
Design Infiltration Rate (Divide By 2)	_____ in/hr	Line 7
Rainfall Depth	_____ 14.7 in	Line 8
Reduced Rainfall Depth	_____ in	Line 9

Attenuation Calculation

Design Factor - Choose One Based On The ISR Calculated In Line 3	_____	Line 10
ISR Less Than 0.4	1	
ISR Between 0.4 and 0.7	1.2	
ISR Greater Than 0.7	1.4	
Design Rainfall Depth	_____ in	Line 11
Design Rainfall Depth (Conversion)	_____ ft	Line 12
Required Storage Volume	_____ ft ³	Line 13

*****Only Enter Information In To The Green Boxes - All Other Boxes Are Automatically Calculated*****

Site Characteristics

Total Disturbed Area	<input type="text"/>	ft ²	Line 1
Depth To SHGW	<input type="text"/>	ft	Line 2
Infiltration	<input type="text"/>	in/hr	Line 3

Treatment Volumes

Design Volume (largest value from Site Characteristics sheet)	<input type="text"/>	ft ³	Line 4
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Infiltration Trench Design

Additional Volume Requirement	<input type="text"/>	ft ³	Line 5
Total Required Volume of Infiltration Trench	<input type="text"/>	ft ³	Line 6
Depth of Infiltration Trench	<input type="text"/>	ft	Line 7
Required Area	<input type="text"/>	ft ²	Line 8
Proposed Width of Infiltration Trench	<input type="text"/>	ft	Line 9
Required Length	<input type="text"/>	ft	Line 10
Recovery Time	<input type="text"/>	hr	Line 11



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