Stormwater Standards

Clackamas County Service District No. 1

APPENDIX E

Infiltration Testing Guide

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Infiltration Testing Guide

E.1 General

To properly size and locate stormwater management facilities it is necessary to characterize the soil infiltration conditions at the location of the proposed facility. All projects proposing stormwater BMP facilities designed to infiltrate stormwater runoff, therefore reducing the size of the detention facility and storage volume, must evaluate existing site conditions and determine if the site's infiltration rate is adequate to support the proposed stormwater management facility.

The following sections provide a guidance for standard infiltration testing specifications.

E.2 Basic Method - Open Pit Infiltration Test (Single Lot - Residential Only)

The Basic Method open pit test is applicable only to residential projects on private property. The results of infiltration testing must be documented on the Basic Method Form.

The intent of the open pit test is to determine whether or not the local infiltration rate is adequate to design an infiltration system. The Basic Method infiltration test does not need to be conducted by a licensed professional, but it is recommended.

E.2.1 Basic Method Instructions (Single Lot – Residential)

1. A simple open pit infiltration test is required for each stormwater BMP facility designed to infiltrate stormwater runoff, therefore, reducing the size of the detention facility and storage volume. The test should be in close proximity to the proposed facility location.
2. Excavate a test hole to the depth of the bottom of the infiltration system, or otherwise to 4 feet. The test hole can be excavated with small excavation equipment or by hand using a shovel, auger, or posthole digger.
3. If a layer hard enough to prevent further excavation is encountered, or if noticeable moisture/water is encountered in the soil, stop and measure this depth from the surface and record it on the Simplified Method Form. Proceed with the test at this depth.
4. Fill the hole with water to a height of about 6 inches from the bottom of the hole (or to one-half the maximum depth of the proposed facility), and record the exact time. Check the water level at regular intervals (every 1 minute for fast-draining soils to every 10 minutes for slower-draining soils) for a minimum of 1 hour or until all of the water has infiltrated. Record the distance the water has dropped from the top edge of the hole.
5. Repeat this process two more times, for a total of three rounds of testing. These tests should be performed as close together as possible to portray the soil's ability to infiltrate at different levels of saturation accurately. The third test provides the best measure of the saturated infiltration rate.
6. For each test pit required, submit all three testing results with the date, duration, drop in water height, and conversion into inches per hour. The rate to be used for design will be the lowest rate measured of the three tests performed.

If the results of the Basic Method open pit test show an infiltration rate greater than 0.5-inches per hour, the applicant can proceed with facility design (where applicable).

E.2.2 Professional Method Infiltration Testing

The Professional Method should be used for all public and private developments where the Basic Method is not applicable. The qualified professional must exercise judgment in the selection of the infiltration test method. The three available infiltration testing methods used to determine a design infiltration rate are:

a) Open pit falling head
b) Encased falling head
c) Double-ring infiltrometer

E.2.3 Testing Criteria

1. Testing must be conducted or observed by a qualified professional. The professional must be a Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the State of Oregon.
2. The location and depth of the test must correspond to the facility location and depth.
3. Infiltration testing should not be conducted in engineered or undocumented fill.
4. Boring logs should be provided as supporting information with infiltration and depth to groundwater tests.

Note: All testing data must be documented with the project submittals. The submittals must adequately demonstrate that the proposed facilities 1) are appropriate to the assessment and characterization of the site soils, 2) will work, based on in-situ infiltration tests, and 3) are sized appropriately, based on design infiltration rates.

E.2.4 Depth and Location of Required Tests

Infiltration tests must be performed at the base of the proposed facility.

If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within 4 feet of the bottom of the planned infiltration system, the testing should be conducted within that confining layer.

Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location.

For relatively deep stormwater facilities, a hollow stem auger with an electronic measuring tape can be used, provided there is an adequate seal between the auger and the native soil.

E.2.5 Minimum Number of Required Tests

a. Land Division

- An infiltration test in the approximate location of the proposed stormwater infiltration facility.
- No more than five tests are required per development (at the discretion of the qualified professional assessing the site, as well as the District).
- Tests performed at the *Land Division* will be used at the building permit stage as long as the results of the test are submitted with the separate applications and no major changes to the site soil conditions have occurred.
- Where multiple types of facilities are used, it is likely that multiple tests will be necessary, since an infiltration test can test only a single soil stratum. It is highly recommended to conduct an infiltration test at each stratum used for infiltration.

b. Building Permits (Single Lot – Residential Only)

- The Basic Method requires one infiltration test for every proposed facility.

c. Correction (Safety) Factors

Table E-1 lists correction or safety factors to be used. The maximum design infiltration rate is 20-inches per hour.

TABLE E-1. Infiltration Rate Safety Factor

Test Method	Required Correction Factor
Open Pit Falling Head	2
Encased Falling Head	3
Double-Ring Infiltrometer	Public Facilities: 2 Private Facilities: 2

E.2.6 Open Pit Falling Head Procedure

The open pit falling head procedure is based on the Environmental Protection Agency (EPA) Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual,* EPA/625/1-80-012, 1980). The test is performed in an open excavation and, therefore, is a test of the combination of vertical and lateral infiltration.

1. Excavate an approximately 2-foot by 2-foot-wide hole into the native soil to the elevation of the proposed facility bottom (see **Figure E-1**). The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, posthole digger, or hand auger. If smooth auguring tools or a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of

the test hole.

2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.

3. Fill the hole with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

4. Percolation rate measurements must be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period must be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

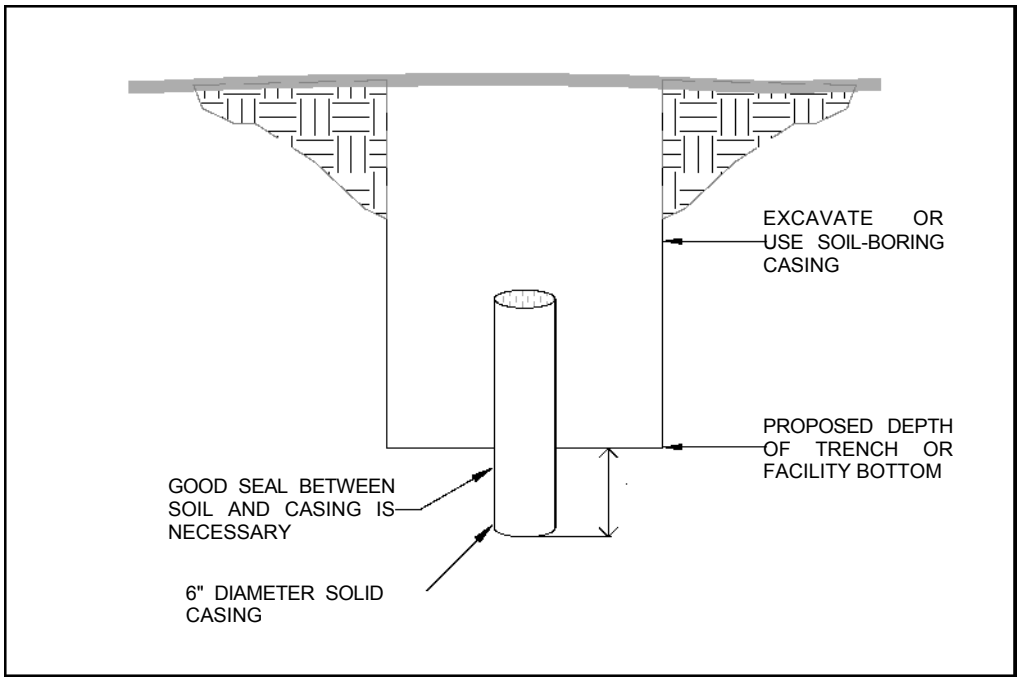

Figure E.1 Encased Falling Head Procedure

5. In sandy soils with little or no clay, soaking is not necessary. If, after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

6. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit is a convenient reference point. The tester and excavator should conduct all testing in accordance with OSHA regulations.

7. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in

slower soils) or until all of the water has drained. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.

8. Successive trials must be run until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials must be conducted. After each trial, the water level is readjusted to the 12-inch level. Enter results into the data table (See **Figure E-2**).

9. The results of the last water level drop are used to calculate the tested infiltration rate. The final rate must be reported in inches per hour. See the calculation following **Figure E-2**.

10. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:

    a. Approximate the area over which the water is infiltrating.

    b. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.

    c. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).

11. Upon completion of the testing, the excavation must be backfilled.

E.2.7 Encased Falling Head Test

The encased falling head procedure is based on a modification of the EPA Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual,* EPA/625/1-80-012, 1980). The most significant modification is that this test is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

1. Embed a solid 6-inch-diameter casing into the native soil at the elevation of the proposed facility bottom (see **Figure E-1**). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be applied to testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger.

2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.

3. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested, and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material.

Percolation rate measurements must be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period must be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

4. To conduct the first trial of the test, fill the pipe to approximately 6 inches above the soil and measure the water level to the nearest 0.01 foot (1/8 inch). The level should be measured with a tape or other device with reference to a fixed point. The top of the pipe is often a convenient reference point. Record the exact time.

5. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all of the water has drained. The infiltration test is continued until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials must be conducted. After each trial, the water level is readjusted to the 6 inch level. Enter results into the Data Table (see **Figure E-2**). At no time during the test is the water level allowed to rise more than 6 inches above the gravel.

6. The result of the last water level drop is used to calculate the tested infiltration rate. The final rate must be reported in inches per hour.

7. Upon completion of the testing, the casings must be immediately pulled, and the test pit must be backfilled.

E.2.8 Double Ring Infiltrometer Test

The double-ring infiltrometer test procedure must conform to ASTM 3385-94. The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established.

This test may be difficult to perform where the tested soil strata are in a pit, since careful regulation of the static volumes is necessary.

E.3 Reporting Requirements

In addition to the information required by the State for a signed and stamped geotechnical report, the following information should be included in the project submittals.

1. Infiltration results in inches per hour.

2. Location and depth of excavation. The excavation should be deep enough to verify that there is a 5-foot separation between the final depth of the facility (rock gallery) and the seasonal high groundwater or soil layer that could reduce the infiltration rate.

3. Summary and discussion of infiltration testing, including number of tests, amounts of water used in each test (inches, gallons, etc.), and time of each test. Testing is required to show that an accurate rate was achieved.

4. Discussion of how the test was performed:
    - Encased falling head
        - Pipe type
        - Embedment depth
        - Size of pipe
    - Double ring infiltrometer
        - Pipe type
        - Embedment depth
        - Size of pipe
    - Open pit (size of area)

5. Soil types with depth

6. Groundwater observations–seasonal high groundwater level estimation

Figure E-2: Infiltration Test Data Table Example

Location: Lot 105, Low Point Heights Subdivision			**Date:** 6/28/2010	**Test Hole Number:** 3	
Depth to bottom of hole: 57 inches			**Diameter of hole:** 0.5 feet	**Test Method:** Encased Falling Head	
Tester's Name: C.J. Tester Tester's Company: Tester Company Tester's Contact Number: 555-1212					
Depth, feet			**Soil Texture**		
0-0.5			Black Top Soil		
0.5-1.0			Brown SM		
1.0-2.2			Brown ML		
2.2-5.1			Brown CL		
Time	**Time interval, minutes**	**Measurement, feet**	**Drop in water level, feet**	**Percolation rate, inches per hour**	**Remarks**
9:00	0	3.75	-		Filled with 6"
9:20	20	3.83	0.08		
9:40	20	3.91	0.08	2.88	
10:00	20	3.98	0.07	2.52	
10:20	20	4.04	0.06	2.16	
10:40	20	4.11	0.07	2.52	
11:00	20	4.17	0.06	2.16	
11:20	20	4.225	0.055	1.98	
					Adjusted to 6" level for Trial #2

Calculation is performed for each water level drop

= (Drop in water level/Time interval) x conversion

= 0.055ft/20min x (12in/ft) x (60min/hr)

= 1.98 inches per hour

The design infiltration rate of two successive trials must have a difference of 5% or less.

Figure E-3: Infiltration Test Data Table

Location:			**Date:**	**Test Hole Number:**	
Depth to bottom of hole:			**Diameter of hole:**	**Test Method:**	
Tester's Name: **Tester's Company:**			**Tester's Contact Number:**		
Depth, feet			**Soil Texture**		
Time	**Time interval, minutes**	**Measurement, feet**	**Drop in water level, feet**	**Percolation rate, inches per hour**	**Remarks**