ON-SITE STORMWATER DISPOSAL SYSTEM (OSDS) DESIGN AND CONSTRUCTION MINIMUM GUIDELINES AND REQUIREMENTS

Land Use and Transportation
BUILDING SERVICES

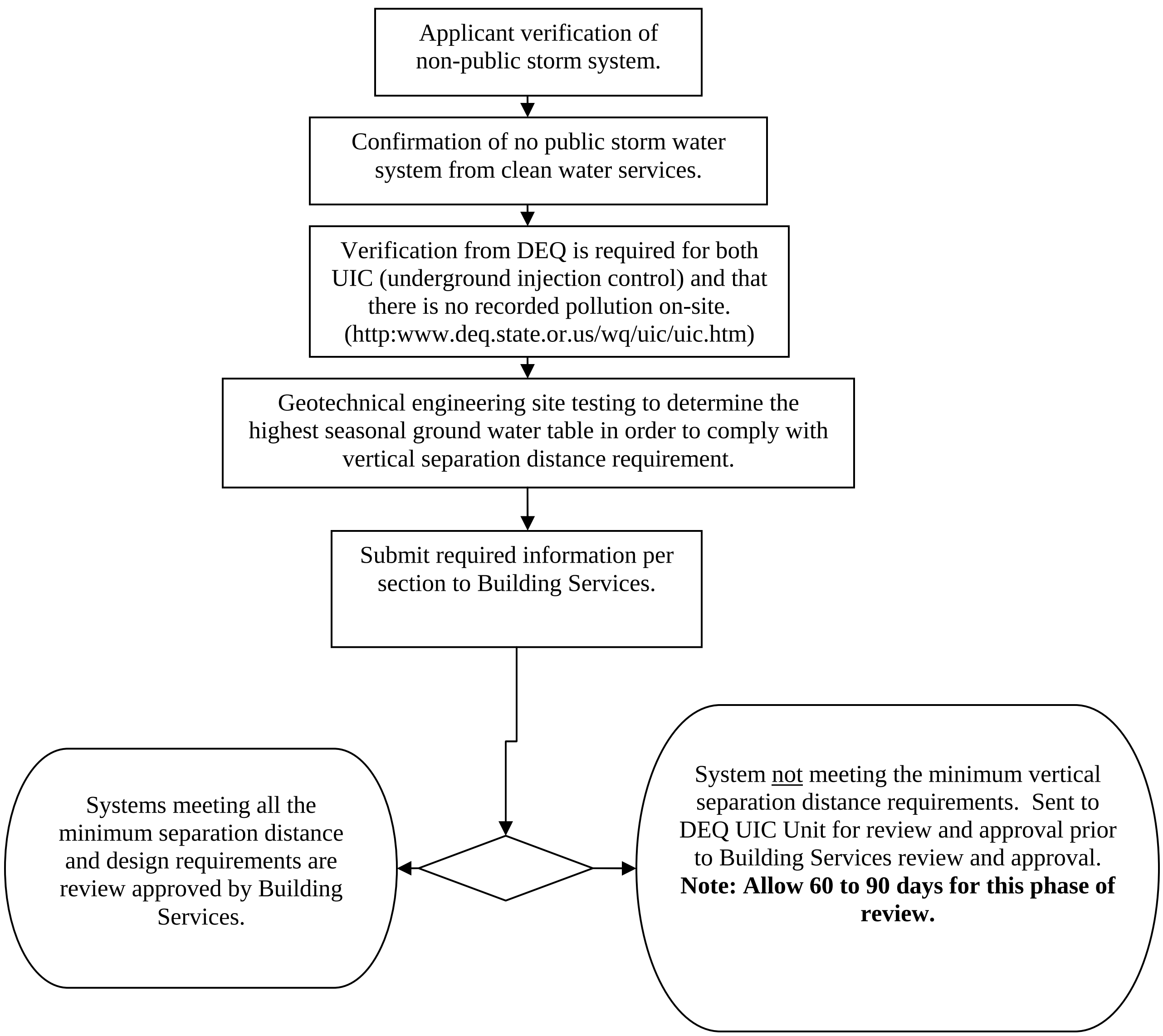
September 26, 2007

Second Edition

BACKGROUND INFORMATION AND APPLICABILITY

The current Metro requirement for high-density housing has encouraged a wave of lot partitions into multiple lots. Unfortunately some of these new partitioned lots require on-site storm-water disposal due to the location of the public storm system or site topography making the connection to the public system not economically feasible. To provide consistent design guidelines for the consultant in designing the on-site disposal system, Washington County Building Services wrote the following document. In formulating these requirements, the inputs from regulatory bodies and private consultants practicing in this area were sought. This final document incorporates most of these comments. **Note:** These provisions are for single residence(s) and minor partitions. It is not applicable to subdivisions, private driveways or roads on commercial projects. For such projects, see DEQ Water Quality Division for requirements.

I Storm Water Infiltration Related System Usage Requirement And Processing Flow Chart



II GENERAL REQUIREMENTS FOR ON-SITE INFILTRATION SYSTEMS

This section presents Washington County Building Services general design requirements applicable to all infiltration facilities within Washington County jurisdiction. The following are the general requirements for determining acceptable soil conditions for an infiltration system and the corresponding design infiltration rate:

A. Soils
The applicant must demonstrate through infiltration testing, soil logs and written opinion of a geotechnical engineer that sufficient permeable soil exists on the site to allow construction of a properly functioning infiltration facility. **The basic requirement is a minimum of three feet of permeable soil below the bottom of the proposed facility. Furthermore, there should be at least five to ten feet of vertical separation as given in Table 3 between the bottom of the facility and the maximum wet-season water table.** Test pits or borings should extend at least five feet below the bottom of the infiltration facility and at least one test hole should reach the water table. If the water table is very deep, the geotechnical engineer shall determine the appropriate depth on a case by case basis and this portion must be substantiated by field boring data. If there is any question about the actual wet-season water table elevation, measurements shall be made during the period when the water level is expected to be at a maximum. Any requirements related to steep slope, landslide hazard or other sensitive area impacts should also be addressed in the soil study.

B. Storm Design Load
The system design shall be based on twenty-four hour duration of a 25 year storm event with a total precipitation depth of 3.90 inches.

III STORM WATER DISPOSAL METHODS

The following on-site storm water disposal methods may be used when appropriate to address on-site storm water problems:

A. Infiltration Trenches & Chambers:
Infiltration trenches can be a useful alternative for developments with site constraints that make other methods difficult. Infiltration trenches may be placed beneath parking areas, along the site periphery or in other suitable linear areas. (Infiltration trenches can be constructed with gravel, perforated pipe or any approved manufactured chambered system.)

B. Drywells:
Where soil conditions allow for percolation, drywells facilitate the infiltration of storm water from private property roof areas into the ground. Drywells are perforated concrete or HDPE cylindrical structures, excavated five to thirty feet deep. Drywells are mainly used where soil layers are of coarse sand or gravel, which allows for easy percolation into the ground. DEQ approval is required prior to Building Services approval.

C. Soakage trenches:
Soakage trenches are horizontal trenches, back-filled with layers of sand filter sand, and then gravel. This method allows for percolation of storm water into the ground. In some cases it may require overflow to additional disposal measures where soils don't percolate sufficiently.

IV HYDRAULIC CONDUCTIVITY

The coefficient of hydraulic conductivity is a characteristic of the soil, which influences the flow of water through its pores. It constitutes an important property of the soil and its value depends largely on the size of the void spaces within the soil, which in turn depends on the size, shape and state of packing of the soil grains.

Several methods of measuring the coefficient of hydraulic conductivity of soils have been developed. The most commonly used test is the percolation test. When properly run, the tests can give an approximate measure of the soil's saturated hydraulic conductivity. The unsaturated hydraulic conductivity's can vary dramatically from the saturated hydraulic conductivity with changes in soil characteristics and moisture content.

Percolation tests conducted in the same soils can vary by 90% or more. This variability can be minimized by accurate measurement of the coefficient of hydraulic conductivity since the reasons for the large variability is attributed to the procedure used, the soil moisture conditions at the time of the test, and the individual performing the test. Despite these shortcomings, the percolation test can be useful if used together with the soil borings data. The test can be used to rank the relative hydraulic conductivity of the soil. Estimated percolation rates for various soil textures are given in Table 1.

Soil Texture	Permeability (in./hr.)	Percolation (min./in.)
Sand	>6.0	<10
Sandy loams/Porous silt loams/Silty clay loams	0.2-6.0	10-45
Clays, compact/Silt loams/Silty clay loams	<0.2	>45

Table 1: Estimated Hydraulic Characteristics of Soil

If test results agree with this table, the test and boring data are probably correct and can be used in design. If not, either the test was run improperly or soil structure or clay mineralogy has a significant effect on the hydraulic conductivity.

A. Falling Head Percolation Test Procedure:
   Out of the several percolation test procedures currently available, falling head test method is presented here. Though less reproducible than other procedures, it is simple to perform in the field. The falling head procedure is outlined below. Data collected from the percolation test should be tabulated using a form similar to the one illustrated in Figure 1.

3) **Number and Location of Tests:** Commonly, a minimum of **three** percolation tests should be performed within the area proposed for an absorption system. They are spaced uniformly throughout the area. If soil conditions are highly variable, more tests may be required.
4) **Preparation of Test Hole:** The diameter of each test hole should be six inches, dug or bored to the proposed depths at the absorption systems or to the most

limiting soil horizon. Two inches of ½ to ¾ inches gravel are placed in the hole to protect the bottom from scouring action when the water is added.

5) **Soaking Period:** The hole is carefully filled with at least 12 inches of clear water. This depth of water should be maintained for at least four hours and overnight for dry and clay soils. It is extremely 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. In some cases, sandy soils with little or no clay, soaking is not necessary. If, after filing the hole twice with 12 inches of water, the water seeps completely away in less than ten minutes, the test can proceed immediately.
6) **Measurement of the Percolation Rate:** For sandy silt and moist or wet soils, percolation rate measurement can be made after the four hours soaking period. For dry soils and clay soils, percolation rate measurements can be made 15 hours later but no more than 30 hours after the soaking period began. Any soil that sloughed into the hole during the soaking period is removed and the water level is adjusted to six inches above the gravel (or eight inches above the bottom of the hole).

At no time during the test is the water level allowed to rise more than six inches above the gravel. Immediately after adjustment, the water level is measured from a fixed reference point to the nearest 1/16 inches at 30-minute intervals. The test is continued until two successive water level drops do not vary by more than 1/16 inches at least three measurements are made.

After each measurement, the water level is readjusted to the six inches level. The last water level drop is used to calculate the percolation rate. In sandy soils or soils in which the first six inches of water added after the soaking period seeps away in less than 30 minutes, water level measurements are made at 10 minute intervals for a one hour period. The last water level drop is used to calculate the percolation rate.

7) **Calculation of the Percolation Rate:** The percolation rate is calculated for each test hole by dividing the time interval used between measurements by the magnitude of the last water level drop. This calculation results in a percolation rate in terms of min./in. To determine the percolation rate for the area, the rates obtained from each hole are averaged. If tests in the area vary by more than 20 min./in., variations in soil type are indicated. Under these circumstances, percolation rates should not be averaged.

B. Completed Percolation Test Data Form Sample:
The documentation and presentation of infiltration testing results should be completed in a format easily understood. Though the test results specific format is open, the tabular sample format given below in Table 2 is preferred.

Example: If the last measured drop in water level after 30 minutes is 5/8 inches, the percolation rate = (30 min/(5/8 in. 1 = 48 min/in.))

Location: Lot 105, High Point Heights Subdivision	**Date:** 6/28/2003	**Test Hole Number:** 3
Depth to bottom of hole: 28 inches	**Diameter of hole:** 6 inches	**Test Method:**
Tester's Name: C.J. Tester **Tester's Company:** Tester Company **Tester's Contact Number:** 555-1212		

Depth (inches):	**Soil Texture:**
0-4	Black Top Soil
4-12	Brown Sl
12-28	Brn Scl

Time:	**Time Interval (minutes):**	**Measurement, (inches):**	**Drop in water level, (inches):**	**Percolation rate, (minutes per inch):**	**Remarks:**
9:30		44			
10:00	30	43	1		
10:20	20	43	1		
10:50	30	43 1/4	3/4		
11:20	30	43 1/16	15/169		
12:00	40	43 1/4	3/4		
12:30	30	43 3/16	13/16		
1:00	30	43 5/16	11/16		
1:30	30	43 5/16	11/16	44	

Table 2: Sample Percolation Test Data Form

V INFILTRATION TESTING PROCEDURE

1) Excavations shall be made to the bottom elevation of the proposed infiltration facility. The measured infiltration rate of the underlying soil shall be determined using either the **EPA Falling Head Percolation Test Procedure** (*Design Manual – Onsite Wastewater Treatment and Disposal Systems*, EPA, 1980) or the **Double Ring Infiltrometer Test** (ASTM D3385). Other proven methods may be used if it can be substantiated by case studies by the engineer to yield better or comparable results to the two methods mentioned above.
2) The test hole or apparatus shall be filled with water and maintained at depths above the test elevation for the saturation periods specified for the appropriate test.
3) Following the saturation period the rate shall be determined in accordance with the specified test procedures with a head of six inches of water.
4) The engineer shall perform sufficient tests to determine a representative infiltration rate for the site, but at least **three tests shall be performed for each proposed infiltration facility site,** and at least two tests for each lot shall be performed and for a closed depression, minimum of three tests.
5) Soils shall be logged for a minimum of five feet below the bottom of each proposed infiltration facility.

The logs shall describe the SCS series of the soil, indicate the textural class of the soil horizons throughout the depth of the log, note any evidence of high groundwater level (such as mottling), and estimate the maximum groundwater elevation, if within the limits of the log.

VI INFILTRATION SYSTEM DESIGN, LAYOUT AND SETBACKS

A. General Design Criteria

The following are the design requirements for infiltration facilities:

1) The proposed **trench bottom** must be at least three feet above the seasonal high groundwater level and three feet below finished grade.
2) There must be at least three feet of **permeable soil** beneath the trench bottom.
3) The infiltration surface elevation (bottom of trench) must be in **native soil** (excavated at least one foot in depth).
4) Infiltration trenches are **not allowed on slopes greater than 25%** (4:1). A geotechnical analysis and report may be required on slopes over 15% or if located within 200 feet of the top of a steep slope or landslide hazard area.
5) Trenches shall be a minimum of 24 inches wide.
6) Trenches shall be backfilled with 1 1/2 - 3/4 inch washed rock, completely surrounded by filter fabric and overlain by a minimum one foot of compact backfill.
7) Level six inch minimum diameter rigid perforated distribution pipes shall extend the length of the trench. Distribution pipe inverts shall be a minimum of two feet below finished grade. Provisions (such as clean-out wyes) shall be made for cleaning the distribution pipe.
8) Two feet minimum cover shall be provided in areas subject to vehicle loads.
9) Trenches shall be spaced no closer than five feet, measured on center.
10) Install design to intercept solids from entering the infiltration system, i.e. catch basin.
11) The bottom of the trench should be relatively level.

B. Layout and Setback Vertical Separation Requirements

1) The system soils report must address any potential impact of infiltration on ground water quality and steep slope stability.

Items Requiring Setbacks	
To Buildings	10 feet
To Property Lines	10 feet
To Water Wells	500 feet
To Underground Oil Tanks	Roof Areas: 25 feet Driveways: 50 feet
Infiltration Trenches	5 feet
Septic System Drainfields:	
Slopes less than 3%	20 feet
Slopes greater than 3%	
Uphill	50 feet
Downhill	10 feet

Table 3: Horizontal Separation Distance: Minimum Setbacks

Please note: This may be reduced if the system soils report addresses potential impacts of trench phreatic surface (temporary water table) on structures so located and approval from DEQ VIC section.

2) Vertical Separation Distance Requirements:

To protect ground water from pollutants and to avoid direct discharge of collected storm water into ground water system, the following minimum vertical distances are required between the infiltration system bottom elevation and the highest seasonal ground water table. By using the distance ranges as given in the table, the proposed system provides an effective natural alteration zone in the sub-surface of 5 to 10 feet of unsaturated zone to protect ground water.

Drainage Area	Distance Between System and Highest Seasonal Ground Water Table
Roofs	5 feet
Driveways	10 feet

Table 4: Minimum Vertical Separation Distance

VII INFILTRATION TESTING AND DOCUMENTATION OF TEST RESULTS

For the purposes of storm water management facility sizing, it is often necessary to know the infiltration rate of the soil at the actual facility location.

A. Infiltration Testing:
   1) For all infiltration facilities, a minimum infiltration rate of 0.5 inches per hour is required.
   2) For any given site, the number of test borings required is determined by the size of the proposed facility; however the minimum test performed should not be less what is given in section 4.4.
   3) A qualified professional shall conduct testing. This professional shall either be a registered professional engineer in the State of Oregon or an engineering geologist licensed in the State of Oregon

B. Measured Infiltration Rates:
   Infiltration rate tests are used to help estimate the maximum sub-surface vertical infiltration rate of the soil below a proposed infiltration facility. The tests are intended to simulate the physical process that will occur when the facility is in operation: therefore, a saturation period is required to approximate the soil moisture conditions that may exist prior to the onset of a major winter runoff event.

C. Documentation of Test Results:
   Infiltration testing data shall be documented, which shall also include a description of the infiltration testing method, if completed. This is to ensure that the tester understands the procedure. **Note: All field testing must be done in the proposed area of the facility.**

VIII GENERAL INFILTRATION SYSTEM DESIGN CRITERIA

A. Methods of Analysis:
The sections and lengths of trenches shall be determined using the hydrologic analysis. The **stage/discharge** curve shall be developed from the design infiltration rate recommended by the geotechnical engineer. **Storage volume** of the trench system shall be determined considering void space of the washed rock backfill and maximum design water surface level at the crown of the distribution pipe. At any given stage, the discharge can be computed using the **area of pervious surface** through which infiltration will occur multiplied by the recommended design infiltration rate (in appropriate units). The area of pervious surface apart from dry wells is the trench bottom area only.

B. Design Infiltration Rates:
In the past, many infiltration facilities have been built which have not performed as the designer intended. This has resulted in local ponding and additional expenditures to correct problems. Monitoring of actual facility performance has shown that the full-scale infiltration rate is far lower than the rate determined by small-scale testing. Actual measured facility rates of 10% of the small-scale test rate have been seen. It is clear that great conservatism in the selection of design rates is needed particularly where conditions are less than ideal. Ideally, the design infiltration rate shall be determined using an analytical groundwater model to investigate the effects of the local hydrologic conditions on facility performance. However, for one to three lot projects the use of the simplified analysis method described below is acceptable.

C. Simplified Method:
A simplified method may be used for determining the design infiltration rate by applying correction factors to the measured infiltration rate. The correction factors account for uncertainties in testing, depth to the water table or impervious strata, infiltration receptor geometry, and long-term reductions in permeability due to biological activity and accumulation of fines.

Equation 1 has been developed to account for these factors. It estimates the maximum design infiltration rate (I_{design}).

$$I_{design} = I_{measured} \times F_{testing} \times F_{geometry} \times F_{plugging} \qquad (1)$$

Where correction factor

$F_{testing}$ accounts for uncertainties in the testing methods.
For the EPA method, $F_{testing} = 0.30$; for the ASTM D3385 method, $F_{testing} = 0.50$

$F_{geometry}$ accounts for the influence of facility geometry and depth to the water table or impervious strata on the actual infiltration rate. A shallow water table or impervious layer will reduce the effective infiltration rate $F_{geometry}$ must be between 0.25 and 1.0 as determined by the following equation:

$$F_{geometry} = 4(D/W) + 0.05$$

Where D = depth from the bottom of the proposed facility to the maximum wet-season water table nearest impervious layer, whichever is less and W = width of the facility.

$F_{plugging}$ accounts for reductions in infiltration rates over the long term due to plugging of soils. This factor is:

- 0.7 for loams and sandy loams
- 0.8 for fine sands and loamy sands
- 0.9 for medium sands
- for coarse sands or cobbles, or any soil type in an infiltration facility preceded by a water quality facility

Limitation: The design infiltration rate I_{design} **must not exceed 5 inches/hour** regardless of how high the actual testing value may have been. To use any value higher than 5 inches/hour, a more detailed analysis method beside the simplified shall be submitted.

D. Other Performance Based Design Approach
Performance design where an engineered system is proposed that does not adhere to this policy. It must be presented for approval with performance design parameters and supporting design calculations test data and may be subject to a performance test.

IX CONSTRUCTION GUIDELINES AND PERFORMANCE TESTING

A. Construction Guidelines:
Excavation of infiltration facilities should be done with minimal disturbance and compaction of the completed infiltration surface. If the bottom of the facility will be less than three feet below final grade, the facility area should be cordoned off so that construction traffic does not traverse the area. The geotechnical engineer should inspect the exposed soil after excavation to confirm that soil conditions are suitable.

B. System Acceptance:

- **Simplified Method**

The design is based on the simplified method, before acceptance of the facility by Building Services. **A field observation report from the engineer is required prior to the final inspection of the system by Building Services.**

- **Other: Performance Based Design**

If the facility performance is not satisfactory, the facility may need to be modified or expanded as needed in order to make it function as designed. Where the design is based on the performance based design, before acceptance of the facility by Building Services, the completed facility must be tested and monitored to demonstrate that the facility performs as designed. **A field observation report from the engineer is required prior to the final inspection of the system by Building Services.**

X MAINTENANCE INFORMATION

The information contained in maintenance Table 2 is the minimum and should be put on the plans. The design engineer may modify it or add to its content to reflect site specific conditions.

Storage Area, and Catch Basins Maintenance Program

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash & Debris (Includes Sediment)	Trash or debris of more than 1/2 cubic foot of the catch basin opening or is blocking capacity of the basin by more than 10%	No trash or debris located immediately in front of catch basin opening.
		Trash or debris (in the basin) that exceeds 1/3 the depth from the bottom of basin to invert the lowest pipe into or out of the basin.	No trash or debris in the catch basin.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerout gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
		Deposits of garbage exceeding one cubic foot in volume.	No condition present which would attreact or support the breeding of insects or rodents.
Catch Basin (Leaf/Debris Interceptor)	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (intent is to make sure all material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab.	Frame is sitting flush on top slab.
	Cracks in Basin Walls/Bottom	Cracks wider than 1/2 inch and longer than 3 feet, any evidence of soil particles entering catch basin through cracks, or maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
	Sediment/ Misalignment	Basin has settled more than 1 inch or has rotated more than 2 inches out of alignment.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation or root growth present.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed.
	Sediment	Any sediment and debris-filling vault to 10% of depth from sump bottom of outlet pipe or obstructing flow into the connector pipe.	

Table 2: Infiltration Trenches

XI REPORT SUBMISSION REQUIREMENTS

The Geotechnical engineer shall **provide two copies of the report stamped and wet-ink signed**. The report shall state whether the **site is suitable for the proposed infiltration facility and shall recommend a design infiltration rate.**

Please include all supporting information including calculations and a site plan showing the proposed building footprint, location of infiltration system and related setbacks.

A. Copy of approved DEQ permit.

B. Geotechnical Engineer's Report:
   - Project location and description including vicinity and site maps.
   - Infiltration test pit locations shown on the site plan.
   - Testing methodology.
   - Completed copy of percolation test data form shown on page 12.
   - Infiltration system design rate including all the appropriate factors of safety.
   - System construction observation and verification.

C. Civil Engineer's Report:

The following items should be included in the report to be submitted to Building Services for review:

- Purpose of report.
- Design methodology and parameters.
- Infiltration system storage volume calculations.
- Infiltration system pipes sizing.
- Down stream impact review on adjacent properties if any.
- Setback requirements review and system location.
- Maintenance program put on plans.
- Detailed plans showing:
  1. System layout
  2. Pipe sizes
  3. Catch basin size
  4. Cross sectional views
- System construction observation and verification.

PERCOLATION TEST DATA FORM

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 (inches):	**Soil Texture:**

Time:	**Time Interval (minutes):**	**Measurement, (inches):**	**Drop in water level, (inches):**	**Percolation rate, (minutes per inch):**	**Remarks:**

Percolation rate = ___________________ minutes per inch