Appendix

G

# Infiltration Guidelines

As a stormwater management method, infiltration means ***retaining or detaining water within soils*** to reduce runoff. Infiltration can be a cost-effective method to manage stormwater – if the conditions on your site allow. These infiltration guidelines identify categories of stormwater infiltration methods, and describe factors that affect the feasibility of their use.

## G.1 Stormwater Controls that Promote Infiltration

A wide-range of site-design measures and stormwater treatment measures allow stormwater infiltration and can be categorized as described below and illustrated in Figure G-1.

A. ***Site design measures*** -- such as clustering development or otherwise laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and using pervious pavement.

B. ***Indirect infiltration methods***, which allow stormwater runoff to percolate into surface soils. The infiltrated water may either percolate down into subsurface soils and eventually reach groundwater, or it may be underdrained into subsurface pipes. Examples of indirect infiltration methods include bioretention areas and vegetated swales.

C. ***Direct infiltration methods***, which are designed to bypass surface soils and transmit runoff directly to subsurface soils and eventually groundwater. These types of devices must be located and designed to limit the potential for groundwater contamination. Examples of direct infiltration methods include infiltration trenches, infiltration basins, and dry wells.

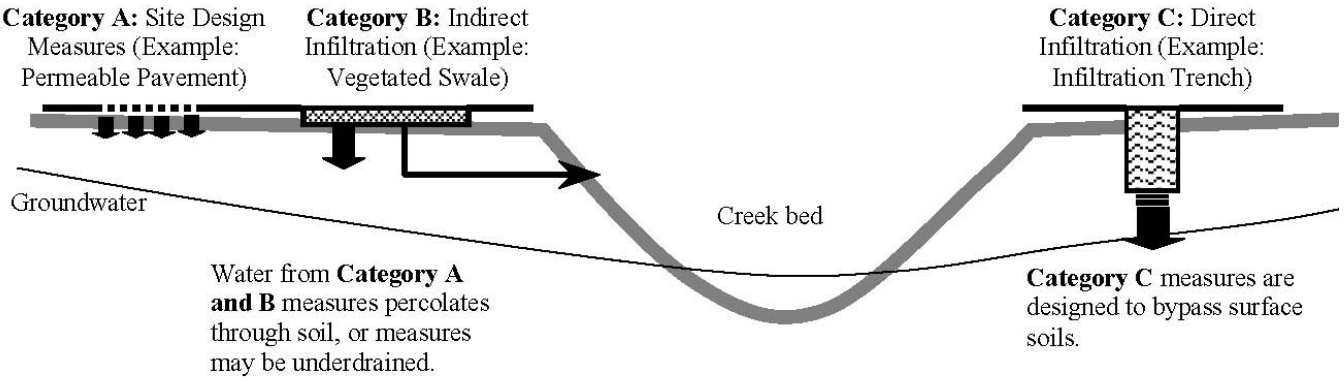


Figure G-2: Stormwater Infiltration Methods (Source: Contra Costa County Clean Water Program, 2005)

Table G-1 describes common stormwater controls and groups them according to whether they meet the above definitions of categories A, B and C. References to the applicable section of Chapter 4 or 6 are given for stormwater controls that have specific technical guidance included in this handbook.

**Table G-1**
**Infiltration Methods in Commonly-Used Stormwater Controls**

| Stormwater Control | Description | Guidance in Section |
|---|---|---|
| ***Category A: Site Design Measures*** | | |
| *Amending Soils* | Soil amendments and tilling enhance or restore permeability and storage in the top layer of soils, reducing runoff. | N/A |
| *Cisterns* | Above ground storage vessels, sometimes with a manually operated valve, store runoff for post-storm discharge to landscaping. | N/A |
| *Disconnected Downspouts* | Instead of connecting directly to storm drains, roof runoff is directed away from the building to nearby landscaped areas. | N/A |
| *Green Roofs* | May be "extensive" with a 3-7 inch lightweight substrate and a few types of low-profile plants; or may be "intensive" with a thicker substrate, more varied plantings, and a more garden-like appearance. | 4.6 |
| *Pervious Pavements* | Special mixes of concrete and asphalt. Require a base course of crushed aggregate and installation by experienced crews. | 4.7 |
| *Site Grading* | Using gentler slopes and concave areas to reduce runoff and encourage infiltration. | N/A |

**Table G-1**
**Infiltration Methods in Commonly-Used Stormwater Controls**

| Stormwater Control | Description | Guidance in Section |
|---|---|---|
| ***Category A: Site Design Measures (continued)*** | | |
| *Site Layout Practices* | Examples: Use compact, multi-story buildings to reduce building footprint, cluster buildings to reduce street length and protect sensitive areas, design narrow streets, use sidewalks on one side of street. | N/A |
| *Turf Block* | A load-bearing, durable surface of impermeable blocks separated by spaces and joints in which soil is planted with turf. | 4.8 |
| *Unit Pavers* | Traditional bricks or other pavers on sand or fine crushed aggregate. | 4.8 |
| ***Category B: Indirect Infiltration*** | | |
| *Vegetated Swale* | Open, shallow channel with thick vegetation that collects and slowly conveys runoff to discharge point. Runoff is treated through settling, filtering, and infiltration. A subdrain may be needed in poorly drained soil. | 6.1 |
| *Vegetated Buffer Strip* | Sloped area with low-growing vegetation that treats runoff by slowing the velocity so sediment and associated pollutants can settle, along with some infiltration. | 6.2 |
| *Tree Well Filter* | A box that contains filtering media in which a small tree or shrub is planted. Water filters through the media and is directed to storm drain. | 6.3 |
| *Flow-Through Planter Box* | Contained planter that receives runoff, which is held in a surface reservoir, infiltrates through a layer of soil, collects in a gravel layer below, seeps into a perforated pipe subdrain, and drains to storm drain. | 6.5 |
| *Bioretention Area* | Briefly ponds stormwater on the surface of a shallow depression and allows it to percolate through permeable soil. May require underdrain if native soils drain poorly. | 6.6 |
| | ***Category C: Direct Infiltration*** | |
| *Infiltration Trench* | A trench with no outlet, filled with rock or open graded aggregate. | 6.7 |
| *Infiltration Basin* | An excavation that exposes relatively permeable soils and impounds water for rapid infiltration. | N/A |
| *Dry Well* | Small, deep hole filled with open graded aggregate. Sides may be lined with filter fabric or may be structural (i.e., an open bottom box sunk below grade). Typically receives roof runoff. | N/A |

Sources: Contra Costa Clean Water Program, 2005; CASQA, 2003; ACCWP, 2006.

## G.2 Factors Affecting Feasibility of Infiltration

A variety of factors may limit or prevent the use of a stormwater control that acts to infiltration stormwater into the soil. Some factors, such as clayey soils or high groundwater, may make direct infiltration infeasible. In these circumstances indirect infiltration methods may be used on the site if an underdrain is provided. Factors affecting the feasibility of stormwater infiltration are listed below.

### Surface Slope

Stormwater infiltration is most feasible on flatter sites. Surface flows applied to slopes may runoff rather than soak into the ground. On hillsides, infiltrated runoff will tend to surface a short distance downslope and may also cause geotechnical instability (see Geotechnical Considerations, below).

### Soil Type

The US Department of Agriculture, Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) classifies soil types into four hydrologic soil groups:

- ***Group A*** soil are typically sands, loamy sands or sandy loams. Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- ***Group B*** soils are typically silt loams or loams. They have a moderate infiltration rate when thoroughly wetted and consist chiefly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse texture.
- ***Group C*** soils are typically sandy clay loams. They have low infiltration rates when thoroughly wetted and consists chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
- ***Group D*** soils are typically clay loams, silty clay loams, sandy clays, silty clays or clays. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

If your site has Group A or B soils, the infiltration rates should be high enough to support a stormwater treatment measure that uses direct infiltration. If the site has Group C or D soils, direct infiltration is generally infeasible, but stormwater treatment measures that use indirect infiltration may be feasible if the existing soil is replaced or amended to allow adequate infiltration, and subdrain may also be needed. Most of San Mateo County has Group C or D soils. If the infiltration rate of native subsurface soils will be used to size a stormwater treatment measure, the soils should be tested by a qualified professional. The professional may be a soils scientist, geologist licensed in California, or registered professional engineer.

### Geotechnical Considerations

Increased water pressure in soil pores reduces soil strength, making foundations more susceptible to settlement and slopes more susceptible to failure. In general, site design measures and stormwater treatment measures that use infiltration must be set back from building foundations or steep slopes. Recommendations for each site should be determined by a ***qualified geotechnical engineer*** based on soils boring data, drainage pattern and the current requirements for stormwater treatment. Implementing the geotechnical engineer's requirements is essential to prevent damage from underground water to surrounding properties, public improvements or slope banks, and even mudslides that can result from accumulated subsurface water.

### Existing Groundwater Pollution

Infiltration should be avoided where it could contribute to the movement or dispersion of existing groundwater contamination. This includes sites listed by the Water Boards' Leaking Underground Storage Tanks (LUST) and Spills, Leaks, Investigations, and Complaints (SLIC) programs.

### Protecting Groundwater

To protect water quality, the Water Board has specific requirements for stormwater treatment measures that function primarily as infiltration devices (such as infiltration basins and infiltration trenches). These stormwater treatment measures meet the definition used in these guidelines of Category C – direct infiltration. The Water Board's requirements for direct infiltration devices are listed in Table G-2.

**Table G-2**
**Criteria for Direct Infiltration Devices**

| | |
|---|---|
| Groundwater separation | ▪ Minimum 10 feet from bottom of infiltration device to seasonal high groundwater in any location. In areas characterized by highly porous soils and/or high groundwater, treatment measure approvals shall be subject to a higher level of analysis (for example, considering the potential for contamination from on-site chemical use, the level of pretreatment prior to infiltration, and similar factors). |
| Land use and vehicle traffic | ▪ Unless pretreatment is provided prior to infiltration, direct infiltration devices shall not be recommended in the following locations:<br>▪ Areas of industrial or light industrial activity;<br>▪ Areas subject to high vehicular traffic: 25,000 or greater Average Daily Traffic (ADT) on a main roadway or 15,000 or more ADT on any intersecting roadway;<br>▪ Automobile repair shops, car washes, fleet storage areas (bus, truck, etc.);<br>▪ Nurseries and other land uses that pose a high risk of contamination, including activities as designated by the local jurisdiction. |
| Water supply wells | ▪ Locate direct infiltration devices a minimum of 100 feet horizontally from any water supply wells. |
| Source control measures | ▪ Implement pollution prevention and source control measures on the site at a level appropriate to protect groundwater quality. |
| Water quality objectives | ▪ The use of infiltration devices shall not cause or contribute to degradation of water quality objectives. |
| Maintenance | ▪ Infiltration devices shall be adequately maintained to maximize pollutant removal capabilities. |

Source: San Francisco Bay Regional Water Quality Control Board, February 2003 (Provision C.3.i of the San Mateo Countywide Municipal Stormwater NDPES permit)

In order to protect underground sources of drinking water, the USEPA regulates some infiltration devices as Class V wells under its Underground Injection Control (UIC) Program. A ***Class V injection well*** is defined as "… any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a

subsurface fluid distribution system."[1] Infiltration trenches are typically not considered Class V injection wells because they are longer than they are wide. The USEPA's regulations state that stormwater drainage wells are "authorized by rule" (40 CFR 144), which means they do not require a permit if they do not endanger ***underground sources of drinking water***, and they comply with federal UIC requirements. For more information, see the USEPA's fact sheet, "When Are Storm Water Discharges Regulated as Class V Wells?" at the following link: http://www.epa.gov/safewater/uic/pdfs/fact_class5_stormwater.pdf.

If your project includes one or more infiltration devices that are regulated as Class V injection wells, you will need to submit basic inventory information about the device(s) to the regional office of the USEPA. Instructions for submitting this information are available on the USEPA Region 9 website at http://www.epa.gov/region09/water/groundwater/uic-classv.html. Project sponsors are responsible for constructing, operating and closing the drainage well in a manner that does not risk contaminating underground sources of drinking water. The USEPA may place additional requirements on the infiltration device. Project sponsors should contact the appropriate USEPA staff, identified on the Internet link provided above, to learn what inventory information should be submitted, and when the submittal should be made.

## G.3 Dealing with Common Site Constraints

The following tips are intended to help manage constraints to infiltration that are common in San Mateo County.

- On sites with ***clay soils*** (Hydrologic Soil Group "C" or "D"), vegetated swales or bioretention areas may be used if drainage is sufficient or underdrains are provided. Some indirect infiltration to groundwater will occur and will enhance the effectiveness of these treatment measures.. Site design measures such as disconnected downspouts and pervious paving may be used if soils are amended and positively drained.
- Infiltration is generally infeasible on ***steep or unstable slopes***. Site design measures that limit impervious area may be appropriate if approved by a geotechnical engineer. Consider detaining runoff in green roofs and cisterns, or using stormwater treatment measures that do not infiltrate water into the natural ground, such as flow-through planters or tree well filters.
- Green roofs, cisterns, flow-through planters, tree well filters, and other stormwater controls that are isolated from underlying soils are also appropriate for areas with ***high ground water*** and/or ***groundwater contamination***.
- A variety of ***site design measures*** can often be used even on sites with the constraints described above, including (but not limited to) amended soils, structural soils, grading landscaping to a concave form, designing taller buildings with smaller footprints, and concentrating development on less sensitive portions of the site.

[1] USEPA Office of Ground Water and Drinking Water, "When Are Storm Water Discharges Regulated as Class V Wells?," June 2003.