6.7 Infiltration BMPs

Figure 6-11: Infiltration Basin
Photo Credit: Pennsylvania Stormwater BMP Manual

Applications

- Mixed-use and commercial
- Roads and parking lots
- Parks and open spaces
- Single and multi-family residential

Performance

- Efficient removal of trash and sediment
- High volume reduction
- Simple; low cost
- Can integrate with parks

Limitations

- Requires large pervious area
- High maintenance requirement; clogging potential is high
- Potential groundwater contamination

6.7.1 Description

Infiltration BMPs included in this manual include infiltration basins, infiltration trenches, and drywells. In general, infiltration BMPs are similar to storm water detention systems but are constructed with a highly permeable base that is specifically designed to infiltrate runoff. It is usually not practical to infiltrate runoff at the same rate that it is generated; therefore, these facilities generally include both a storage component and a drainage component.

Infiltration basins are usually shallow with flat, vegetated bottoms and side slopes and can be incised by excavating a depression below the existing grade or constructed above grade by constructing a perimeter berm.

Infiltration trenches are long, narrow, rock-filled trenches that receive storm water runoff from small drainage areas. These facilities may include a shallow depression at the surface, but the majority of runoff is stored in the void space between the stones and infiltrates through the sides and bottom of the trench.

Drywells are similar to infiltration trenches in their design and function. A dry well is a subsurface storage facility designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low sediment loading. A dry well may be either a small excavated pit filled with aggregate or a prefabricated storage chamber or pipe segment.

Pretreatment BMPs such as vegetated swale filters, Vegetated filter strips, and sediment forebays, basins, and manholes minimize sediment loads to infiltration facilities are recommended to increase longevity and reduce the maintenance burden of infiltration facilities.

6.7.2 Performance, Applicability, and Limitations

Table 6-17 provide a summary of BMP performance, applicability, and limitations for infiltration BMPs. *It is important to note that information in these tables shall be used to provide general guidance for infiltration BMPs and shall not replace the evaluation performed by a water quality professional.*

Performance

Table 6-31 and associated guidance provide general volume reduction capabilities and treatment effectiveness for infiltration BMPs. Refer to Section 6.4 for the process that shall be used for selecting BMPs based on pollutants of concern. Refer to Table 6-1 to determine the ranking of infiltration BMPs for removal of pollutants of concern as compared with other storm water runoff BMPs provided in Chapter 6. Refer to Table 6-2 to assess the applicability of infiltration BMPs for your site based on site suitability considerations as compared with other storm water runoff BMPs provided in Chapter 6. Infiltration BMPs are volume-based BMPs that, depending on site conditions, can be designed to meet all or part of the water quality treatment and volume reduction requirements (see Table 6-31). Infiltration BMPs also assist in meeting the peak runoff discharge rate requirements (see "Additional Control Functions" section below). See Section 6.2 for specific storm water runoff requirements for Tier 3 projects.

Table 6-31: Volume Reduction & Treatment Effectiveness for Infiltration BMPs

Storm Water Runoff BMP	Volume Mitigation (% of inflow)	Treatment Effectiveness for Pollutants of Concern[1]					
		Trash	Nutrients	Bacteria	Metals (particulate and dissolved fractions)	Sediment	Organics (hydro-carbons, oil, and grease)
Infiltration Facilities	●	●	●	●	●	●	●
Volume/Treatment Effectiveness: ● = Very High, ◠ = High, ◎ = Moderate, ◡ = Low, ○ = Very Low							

[1] Effectiveness may change based on design variations; standard BMP designs have been assumed.

Infiltration BMPs are good candidates for the removal of sediment, particulate bound pollutants, and bacteria. Sedimentation of coarse particles shall however, be minimized through the use of appropriate pretreatment devices to prevent clogging. In general, it is assumed that infiltration BMPs located in areas with acceptable infiltration rates and the required minimum depth to groundwater, provide for complete reduction of pollutants before the infiltrated runoff reaches groundwater through sedimentation, filtration, adsorption, and biodegradation which occur as runoff infiltrates through the BMP and then through the subsoil.

Site Suitability Recommendations and Limitations

Table 6-32 and associated guidance provide general considerations for assessing a site's suitability for infiltration BMPs.

Table 6-32: Site Suitability Considerations for Infiltration BMPs

BMP	Tributary Area (Acres)[1]	Site Slope (%)	Depth to Seasonally High Groundwater Table (ft)	Hydrologic Soil Group	Horizontal Setback from Drinking Water Wells (ft)
Infiltration Facilities	< 5 Acres; 217,800 Sq. Ft.	< 7 [2]	> 5	May not be feasible in "C" soils. Not suitable in "D" soils.	100

[1] Tributary area is the area of the site draining to the BMP. Tributary areas provided here shall be used as a general guideline only. Tributary areas can be larger or smaller in some instances.

[2] If site slope exceeds that specified or if the system is within 200 ft from the top of a hazardous slope or landslide area (on the uphill side), a geotechnical investigation and report addressing slope stability shall be prepared by a licensed civil engineer.

Table 6-33 provides additional site applicability considerations for special design districts within the City, including coastal bluff areas and hillside design districts.

Table 6-33: Applicability of Infiltration BMPs for Special Design Districts

Coastal Bluff Area	Hillside Design District
Infiltration BMPs are <u>not</u> permissible in Coastal Bluff Areas.	Acceptable if a geotechnical investigation proves that the facility does not compromise the stability of the site slope or surrounding slopes.

Due to the potential to cause slope instability, impact surrounding engineering structures, and contaminate groundwater, an extensive soil assessment and potential geotechnical investigation for slope stability must be undertaken early in the site planning process to verify site suitability for the installation of infiltration BMPs. Soil infiltration rates and the seasonally high groundwater table depth shall be evaluated to ensure that conditions are satisfactory for proper operation of an infiltration BMP (see Chapter 3).

The applicant must demonstrate through infiltration testing, soil logs, and the written opinion of a licensed civil engineer that sufficiently permeable soils exist on-site to allow the construction of a properly functioning infiltration BMP. An additional geotechnical investigation may be required if the facility is placed in an area that could potential cause slope instability.

The following site suitability and geotechnical recommendations and limitations shall be considered before choosing to use infiltration BMPs.

- In general, tributary area shall be limited to less than 5 acres to limit the size of the infiltration BMP and limit loading rates of sediment which can cause premature clogging. If tributary areas are greater than 5 acres, significant pretreatment shall be provided.

- The upstream tributary area shall be stabilized to minimize sediment delivery to the infiltration BMP.

- Pretreatment for coarse sediment removal is required in all instances. High loading rates may clog quickly if flows are not adequately pretreated.

- Infiltration BMPs require a minimum soil infiltration rate of 0.05 inches/hour. If infiltration rates exceed 2.4 inches/hour, then the runoff shall be fully treated in an upstream BMP prior to infiltration to protect groundwater quality. In addition, shallow confining layers or bedrock may inhibit infiltration. The design infiltration rate shall account for clogging and compaction over time by multiplying the field measured infiltration rate by an appropriate correction factor as described in the design criteria and procedure section below. Preferably, measurements of groundwater levels shall be made during the time when water level is expected to be at a maximum (i.e., toward the end of the wet season). If this is not feasible, indications of the seasonally high groundwater table shall be identified during soil testing (see Chapter 3).

- Groundwater separation must be at least 5 feet between bottom of the basin, trench, or dry well and the measured seasonally high groundwater surface elevation. The separation between the bottom of the facility and bedrock shall be at least 3 feet.

- If the site slope exceeds 7%, a geotechnical investigation and report addressing slope stability is required.

- An infiltration facility must not be located within 50 feet of a 2:1 (H:V) or greater slope. If the infiltration facility is within 200 feet of a hazardous steep slope or mapped landslide area, a geotechnical investigation and report is required.

- Infiltration BMPs shall be located at least 100 feet away from drinking water wells, waterbodies, and septic system leach fields.

- Infiltration BMPs shall be located at least 20 feet from any structural foundation. The 20 foot setback may be reduced to a minimum of 5 feet if geotechnical investigations address the potential impacts of the facility on adjacent structural foundations.

- Infiltration BMPs are not suitable to collect runoff from hotspot sites that use or store chemicals or hazardous materials unless hazardous and toxic materials are prevented from contaminating the runoff. [*Note: Infiltration BMPs are not suitable for industrial sites or locations where spills can occur. In these areas, other BMPs that do not allow for interaction with the groundwater table shall be used*].

- Infiltration BMPs are not suitable for un-remediated “brownfield sites” where there is known groundwater or soil contamination.

Additional Control Functions

Infiltration basins can be designed to provide flow control by providing storage capacity in excess of that provided by infiltration and incorporating outlet controls. The additional storage and outlet structure shall be provided per the requirements outlined in the Dry Extended Detention Basins section of this document (see Section 6.10.3). Note that the selected outlet structure shall not be designed to drain the design volume intended for infiltration and shall be similar to outlet structures that maintain a permanent pool (see Section 6.10.2 – Wet Retention Basins).

Multi-Use Opportunities

Infiltration basins may be integrated into the design of a park or playfield. Recreational multi-use facilities must be inspected after every storm and may require a greater maintenance frequency than dedicated infiltration basins as to ensure aesthetics and public safety are not compromised. Any planned multi-use facility must obtain approval by the affected City and County department(s).

6.7.3 Design Criteria and Procedure

The main challenge associated with infiltration BMPs is preventing system clogging and subsequent infiltration inhibition. Principal design criteria for infiltration BMPs are listed in Table 6-34. Schematics of infiltration BMPs are illustrated in Figure 6-12 (infiltration basins), Figure 6-13, (infiltration trench), and Figure 6-14 (dry well).

Table 6-34: Infiltration BMP Design Criteria

Design Parameter	Unit	Design Criteria	
Water quality design volume, V_{wq}	ft^3	See Section 6.2 and Appendix C for calculating V_{wq}.	
Volume reduction requirement, $V_{reduction}$	ft^3	See Section 6.2 and Appendix C for calculating $V_{reduction}$.	
Design drawdown time	hr	72	
Pretreatment	-	Filter strip, vegetated swale, proprietary device, or sedimentation forebay for all surfaces other than roofs; if sheet flow, max velocity = 1 ft/sec	
Design infiltration rate, k_{design}	in/hr	Shall be corrected for testing method, potential for clogging and compaction over time, and facility geometry	
Maximum depth of facility, d_{max}	ft	Defined by the design infiltration rate and the design drawdown time (includes ponding depth and depth of media)	
Surface area of facility, A	ft^2	Infiltration Basin	Based on depth of ponding
		Infiltration Trench	Based on depth of ponding (if applicable) and depth of trench media
		Dry Well	Based on depth of dry well media
Facility geometry	-	Infiltration Basin	Forebay (if applicable), 25% of facility volume; flat bottom slope

Design Parameter	Unit	Design Criteria	
		Infiltration Trench	Max 24 inches wide and max 5 feet deep; max 3% bottom slope
		Dry Well	Geometry varies; max 10 feet deep; flat bottom slope
Filter media diameter (trenches and dry wells)	inches	1.5 – 3 (gravel); prefabricated media may also be used	
Vegetation	-	Required for infiltration basins	
Underdrain	-	6 inch. minimum diameter; 0.5% minimum slope	
Overflow device	-	Required if system is on-line	

Soil Assessment and Site Geotechnical Investigation Reports

The soil assessment report shall:

- State whether the site is suitable for the proposed infiltration BMP
- Recommend a design infiltration rate (see the "Design Infiltration Rate" section below).
- Identify the seasonally high depth to groundwater table surface elevation
- Provide a good understanding of how the storm water runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

If a geotechnical investigation and report are required, the report shall:

- Provide a written opinion by a professional civil engineer describing whether the infiltration BMP will compromise slope stability.
- Identify potential impacts to nearby structural foundations.

Pretreatment

Pretreatment is required for infiltration BMPs in order to reduce the sediment load entering the facility and maintain the infiltration rate of the facility. Pretreatment refers to design features that provide settling of large particles before runoff reaches a management practice; easing the long-term maintenance burden. Pretreatment is important for most all structural storm water BMPs, but it is particularly important for infiltration BMPs. To ensure that pretreatment mechanisms are effective, designers shall incorporate sediment reduction practices. Sediment reductions BMPs may include vegetated swales, vegetated filter strips, sedimentation basins or forebays, sedimentation manholes and hydrodynamic separation devices. The use of at least two pretreatment devices is highly recommended for infiltration facilities.

For design specification of selected pre-treatment devices, refer to:

- Vegetated filter strip (Section 6.6.2)
- Vegetated swale filter (Section 6.2.2)
- Proprietary devices (Section 6.11)

Geometry and Sizing

Infiltration Basins

1. Infiltration basins shall be designed and constructed with the flattest bottom slope possible to promote uniform ponding and infiltration across the facility.

2. A sediment forebay is required unless adequate pretreatment is provided in a separate pretreament unit (e.g., vegetated swale, filter strip, hydrodynamic device) to reduce sediment loads entering the infiltration basin. The sediment forebay, if present, shall have a volume equal to 25% of the total infiltration basin volume.

3. The forebay shall be designed with a minimum length to width ratio of 2:1 and must completely drain to the main basin through an 8-inch minimum low-flow outlet within 10 minutes.

4. All inlets shall enter the sediment forebay. If there are multiple inlets, the length-to-width ratio shall be based on the average flowpath length for all inlets.

5. Side-slopes shall be no steeper than 3H:1V.

Infiltration Trenches

1. Infiltration trenches shall be at least 24 inches wide and 3 to 5 feet deep.

2. The longitudinal slope of the trench shall not exceed 3%.

3. The filter bed media layers shall have the following composition and thickness:

    a. Top layer – If storm water runoff enters the top of the trench via sheet flow at the ground surface then the top 2 inches shall be pea gravel with a thin 2- to 4-inch layer of pure sand and 2-inch layer of chocking stone (e.g., #8) or equivalent geotextile fabric layer placed between the top layer and the middle layer to capture sediment before entering the trench. If storm water runoff enters the trench from an underground pipe, pretreatment prior to entry into the trench is required. The top layer over the trench shall be 12 inches of surface soil (i.e., overburden)

    b. Middle layer (3-5 feet of washed 1.5 to 3-inch gravel). Void space shall be in the range of 30 percent to 40 percent.

    c. Bottom layer (6” of clean, washed sand to encourage drainage and prevent compaction of the native soil while the stone aggregate is added).

4. One or more observation wells shall be installed, depending on trench length, to check for water levels, drawdown time, and evidence of clogging. A typical observation well consists of a slotted PVC well screen, 4 to 6 inches in diameter, capped with a lockable, above-ground lid.

Dry Wells

1. Dry well configurations vary but generally they have length and width dimensions closer to square than infiltration trenches. Pre-fabricated dry-wells are often circular. The surface area of the dry well must be large enough to infiltrate the storage volume in 72 hours based on the maximum depth allowable, d_{max}.

2. The bottom slope shall be level.

3. Maximum 10 feet deep.

4. The filter bed media layers are the same as for infiltration trenches unless prefabricated dry wells and/or media are used. The porosity of gravel media systems is generally 30-40% and is 80-95% for prefabricated media systems.

5. If dry well receives runoff from an underground pipe (i.e., runoff does not enter the top of the dry well from the ground surface), a fine mesh screen shall be installed at the inlet. The inlet elevation shall be 18 inches below the ground surface (i.e., below 12 inches of surface soil and 6 inches of dry well media).

6. An observation wells shall be installed to check for water levels, drawdown time, and evidence of clogging. A typical observation well consists of a slotted PVC well screen, 4 to 6 inches in diameter, capped with a lockable, above-ground lid.

Sizing Methodology

Infiltration facilities shall be sized to capture and infiltrate all or part of the volume reduction requirement, $V_{reduction}$ or the water quality design volume, V_{wq}, whichever is larger (see Section 6.2 and Appendix C for further detail). Procedures for sizing infiltration BMPs are summarized below. An infiltration BMP sizing example is provided in Appendix D.

Step 1: Determine the design infiltration rate of the native subsoil

See the Bioretention Area Section 6.6.1 for the method used to determine the design infiltration rate of the native subsoil.

Step 2: Size the infiltration BMP

As with sand filters, infiltration BMPs can be sized using one of two methods: a simple sizing method or a routing modeling method. With either method, the runoff entering the facility must be completely infiltrated within 72 hours. Infiltration basins provide the majority of storage above ground while infiltration trenches and dry wells provide the majority of storage in the voids of the rock fill. The simple sizing procedures provided below can be used for infiltration basins, infiltration trenches, or dry wells. For the routing modeling method, refer to the Bioretention Area Section 6.6.1.

Determine the size of the required infiltrating surface by assuming the design runoff volume (i.e., all or part of the water quality design volume, V_{wq}, or the volume reduction requirement, $V_{reduction}$, whichever is larger) will fill the available ponding depth plus the void spaces based on the computed porosity of the filter media (normally about 32% for gravel). Note, dry wells

generally do not have a ponding depth; therefore, the design runoff volume shall fill the available void spaces based only on the porosity of the filter media.

Determine the maximum depth of runoff that can be infiltrated within the required drain time (72 hr) as follows:

$$d_{max} = \frac{k_{design}}{12} \times t \qquad \text{(Equation 6-21)}$$

Where:

t	=	required drain time (hrs) [Use 72 hours]
k_{design}	=	infiltration rate of underlying soils (in/hr)
d_{max}	=	the maximum depth of water that can be infiltrated within the required drain time (ft)

Choose the ponding depth (d_p) and/or trench depth (d_t) such that:

$$d_{max} \geq d_p \qquad \text{For Infiltration Basins} \qquad \text{(Equation 6-22)}$$

$$d_{max} \geq n_t d_t + d_p \qquad \text{For Infiltration Trenches} \qquad \text{(Equation 6-23)}$$

$$d_{max} \geq n_t d_t \qquad \text{For Dry Wells} \qquad \text{(Equation 6-24)}$$

Where:

d_p	=	ponding depth (ft)
n_t	=	trench fill aggregate porosity (unitless)
d_t	=	depth of trench fill (ft)
d_{max}	=	the maximum depth of water that can be infiltrated within the required drain time (ft)

Calculate infiltrating surface area (filter bottom area) required:

$$A = \frac{V_{design}}{\left(\frac{Tk_{design}}{12} + d_p\right)} \qquad \text{For Infiltration Basins} \qquad \text{(Equation 6-25)}$$

$$A = \frac{V_{design}}{\left(\frac{Tk_{design}}{12} + n_t d_t + d_p\right)} \qquad \text{For Infiltration Trenches} \qquad \text{(Equation 6-26)}$$

$$A = \frac{V_{design}}{\left(\frac{Tk_{design}}{12} + n_t d_t\right)} \qquad \text{For Dry Wells} \qquad \text{(Equation 6-27)}$$

(Adapted from Georgia Stormwater Manual: http://www.atlantaregional.com/environment/georgia-stormwater-manual)

Where:

V_{design}	=	design volume of runoff to be infiltrated (ft^3)
n_t	=	trench or dry well media porosity (unitless); [commonly, n_t = 0.32 for gravel]
k_{design}	=	design infiltration rate (in/hr)
d_p	=	ponding depth (ft)
d_t	=	depth of trench fill (ft)
T	=	fill time (time to fill infiltration BMP with water) (hrs) [use 2 hours for most designs]
A	=	surface area of infiltration BMP (ft^2)

Embankments

1. Embankments are earthen slopes or berms used for detaining or redirecting the flow of water.

2. Top of berm shall be 2 feet minimum below the water quality design water surface and shall be keyed into embankment a minimum of 1 foot on both sides.

3. Typically, the top width of berm embankments is at least 20 feet, but narrower embankments may be plausible if approved by a licensed civil engineer and the Santa Barbara County Flood Control District.

4. Basin berm embankments must be constructed on native consolidated soil (or adequately compacted and stable fill soils analyzed by a licensed civil engineer) free of loose surface soil materials, roots, and other organic debris.

5. Basin berm embankments greater than 4 feet in height must be constructed by excavating a key equal to 50% of the berm embankment cross-sectional height and width. This requirement may be waived if specifically recommended by a licensed civil engineer.

6. The berm embankment shall be constructed of compacted soil (95% minimum dry density, modified proctor method per ASTM D1557), placed in 6-inch lifts.

7. Low growing native or non-invasive perennial grasses shall be planted on downstream embankment slopes. See vegetation specifications below and Appendix G Plant List.

Drainage

1. The bottom of infiltration bed must be native soil, over-excavated to at least one foot in depth and replaced uniformly without compaction. Amending the excavated soil with 2-4 inches (~15-30%) of coarse sand is recommended.

2. The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).

3. The hydraulic conductivity of the subsurface layers shall be sufficient to ensure a maximum 72-hr drawdown time. An observation well shall be incorporated to allow observation of drain time.

4. For infiltration basins, an underdrain shall be installed within the bottom layer to provide drainage in case of standing water. The underdrain shall be operated by opening a valve, which shall be closed during normal operation. Cleanouts shall be provided for the underdrain. See Sand Filter Section 6.6.4 for specifications for underdrains.

Emergency Overflow

1. There must be an overflow route for storm water flows that overtop the facility or in case the infiltration facility becomes clogged.

2. The overflow channel must be able to safely convey flows from the peak design storm to the downstream storm water conveyance system or other acceptable discharge point.

Vegetation

Infiltration Basin

1. A thick mat of drought tolerant grass shall be established on the basin floor and side-slopes following construction. Grasses can help prevent erosion and increase evapotranspiration and their roots discourage compaction helping to maintain the surface infiltration rates. Additionally, the active growing vegetation can help break up surface crusts that accumulate from sedimentation of fine particulates.

2. Grass may need to be irrigated during establishment.

3. For infiltration basins, landscaping is required outside of the basin and must adhere to the following criteria so as not to hinder maintenance operations:

    a. No trees or shrubs may be planted within 10 feet of inlet or outlet pipes or manmade drainage structures such as spillways, flow spreaders, or earthen embankments. Species with roots that seek water, such as willow or poplar, shall not be used within 50 feet of pipes or manmade structures. Weeping willow (*Salix babylonica*) shall not be planted in or near detention basins.

    b. Prohibited non-native plant species will not be permitted. For more information on invasive weeds, including biology and control of listed weeds, look at the encycloweedia located at the California Department of Food and Agriculture website- http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm or the California Invasive Plant Council website at www.cal-ipc.org.

4. See Appendix G for a recommended native plant list for infiltration BMPs, a list of local nurseries where these plants can be purchased, and a list of local and regional on-line resources. The plant list shall be used as a guide only and shall not replace project-specific planting recommendations provided by a landscape professional including recommendations on appropriate plants, fertilizer, mulching applications, and irrigation requirements (if any) to ensure healthy vegetation growth. See Section 5.11 for more information on landscaping/planting recommendations and Section 5.10 for more information on soil amendment recommendations.

Infiltration Trench and Dry Well

1. Infiltration trenches shall be kept free of vegetation.

2. Trees and other large vegetation shall be planted away from trenches and dry wells such that drip lines do not overhang infiltration beds.

Maintenance Access

Infiltration Basin

1. Infiltration basins require maintenance access provisions similar to dry extended detention basins (see Section 6.10.3).

2. A maintenance access road(s) shall be provided to the drainage structures associated with the basin (e.g., inlet, emergency overflow, or bypass structures). Manhole and catch basin lids must be in or at the edge of the access road.

3. An access ramp to the basin bottom is required to facilitate the entry of sediment removal and vegetation maintenance equipment without compaction of the basin bottom and side slopes.

4. Access roads shall meet the following design criteria:

5. A graded 16-foot wide maintenance ramp shall be provided that extends to the bottom of the sand filter near the outlet.

6. A 16-foot wide commercial driveway approach shall be provided where curb and gutter front the maintenance ramp.

Infiltration Trench and Dry Well

1. The facility and outlet structures must all be safely accessible during wet and dry weather conditions.

2. An access road along the length of the trench or dry well is required unless the trench is located along an existing road or parking lot that can be safely used for maintenance access.

3. If the infiltration facility becomes plugged and fails, then access is needed to excavate the facility to remove and replace the top layer or the filter bed media, as well as to increase all dimensions of the facility by 2 inches to provide a fresh surface for infiltration. To prevent damage and compaction, access must be able to accommodate a backhoe working at “arms length”.

6.7.4 Construction Considerations

The use of treated wood or galvanized metal anywhere inside the facility is prohibited. The use of galvanized fencing is permitted if in accordance with the Fencing requirement above.

To preserve and avoid the loss of infiltration capacity, the following construction guidelines must be specified:

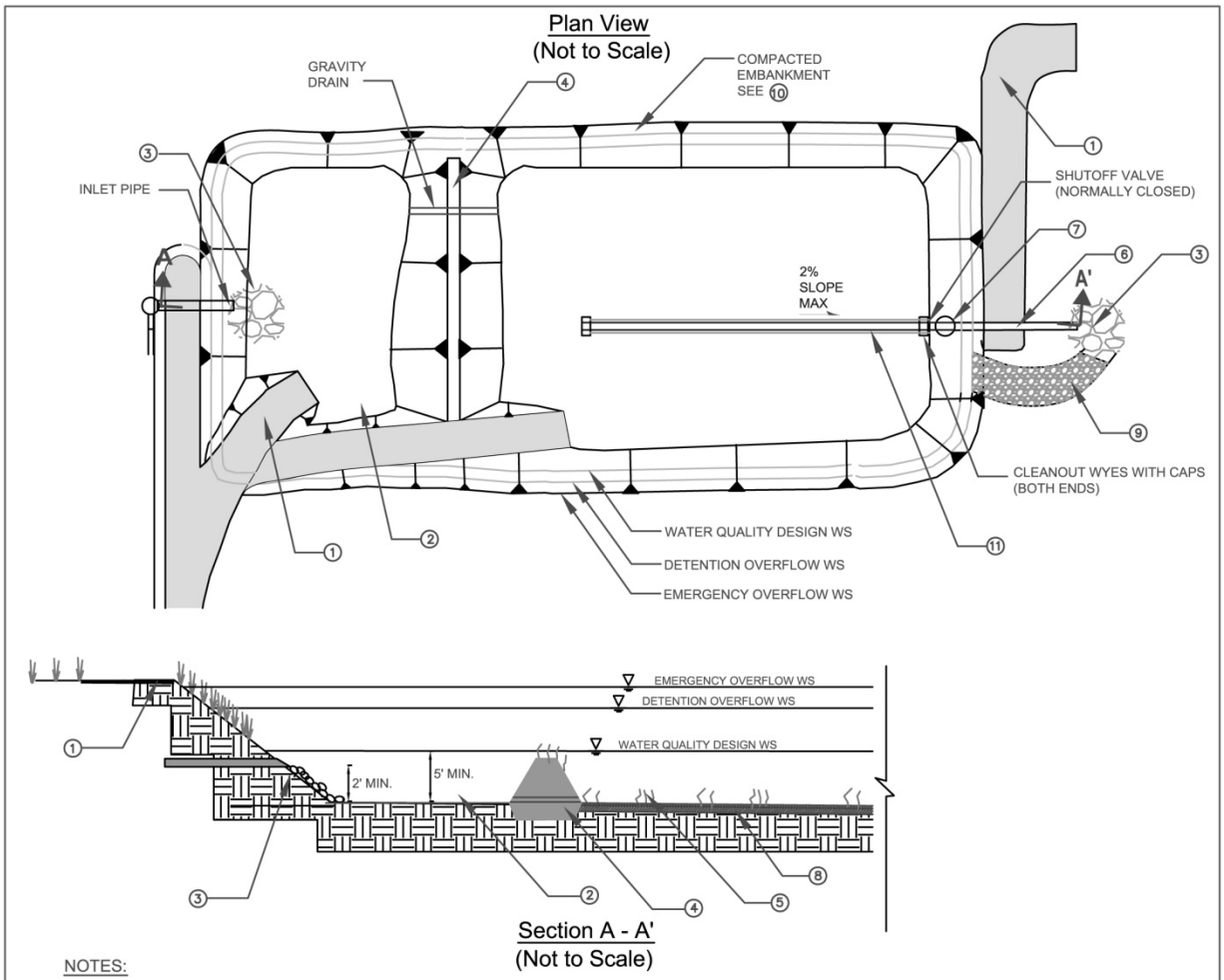
1. The entire area draining to the facility must be stabilized before construction begins. If this is impossible, a diversion berm must be placed around the perimeter of the infiltration site to prevent sediment entrance during construction.

2. Infiltration BMPs shall not be hydraulically connected to the storm water conveyance system until all contributing tributary areas are stabilized as shown on the Contract Plans and to the satisfaction of the Engineer. Infiltration BMPs shall not be used as sediment control facilities.

3. Compaction of the subgrade with heavy equipment shall be minimized to the maximum extent possible. If the use of heavy equipment on the base of the facility cannot be avoided, the infiltrative capacity shall be restored by tilling or aerating prior to placing the infiltrative bed.

4. The exposed soils must be inspected by a civil engineer after excavation to confirm that soil conditions are suitable.

Figure 6-12: Infiltration Basin Schematic



NOTES:

1. MAINTENANCE RAMP SHOULD BE PAVED. WIDTH SHALL BE A MINIMU OF 16' AND SLOPE SHALL NOT EXCEED 12%. MAINTENANCE RAMP SHOULD PROVIDE ACCESS TO BOTH THE FIRST CELL AND MAIN BASIN.
2. UPSTREAM PRETREATMENT SHALL BE PROVIDED. SEDIMENT FOREBAY WITH VOLUME EQUAL TO 25% OF TOTAL INFILTRATION BASIN VOLUME MAY BE USED IN LIEU OF UPSTREAM PRETREATMENT. DEPTH SHALL BE 4' TO 8' PLUS AN ADDITIONAL 1 FOOT MIN SEDIMENT STORAGE DEPTH.
3. RIPRAP APRON OR OTHER ENERGY DISSIPATION.
4. EXTEND EARTHEN BERM ACROSS ENTIRE WIDTH OF THE INFILTRATION BASIN.
5. INFILTRATION BASIN BOTTOM AND SIDE SLOPES SHALL BE PLANTED WITH DROUGHT TOLERANT VEGETATION. DEEP ROOTED VEGETATION PREFERRED FOR BASIN BOTTOM. NO TOPSOIL SHALL BE ADDED TO INFILTRATION BASIN BED.
6. SIZE OUTLET PIPE TO PASS 100-YEAR PEAK FLOW FOR ON-LINE INFILTRATION BASINS AND WATER QUALITY PEAK FLOW FOR OFF-LINE INFILTRATION BASINS. OUTLET PIPE DIAMETER SHALL BE A MINIMUM OF 18".
7. WATER QUALITY OUTLET STRUCTURE. SEE FIGURE 6-25 AND FIGURE 6-26 FOR DETAILS.
8. OVER EXCAVATE BASIN BOTTOM 1 FOOT. RE-PLACE EXCAVATED MATERIAL UNIFORMLY WITHOUT COMPACTION. AMENDING EXCAVATED MATERIAL WITH 2" - 4" OF COARSE SAND IS RECOMMENDED FOR SOILS WITH BORDER LINE INFILTRATION CAPACITY.
9. INSTALL EMERGENCY OVERFLOW SPILLWAY AS NEEDED. SEE FIGURE 6-32 FOR DETAILS.
10. EMBANKMENT SIDE SLOPES SHALL BE NO STEEPER THAN 4H:1V BOTH OUTSIDE AND INSIDE. FENCING SHOULD BE PROVIDED FOR EMBANKMENT SLIDE SLOPES GREATER THAN 6H:1V OR DEPTH EXCEEDS 2'.
11. INSTALL OPTIONAL 6" MINIMUM DIAMETER PERFORATED PIPE UNDERDRAIN. INSTALL AT 0.5% MINIMUM SLOPE.

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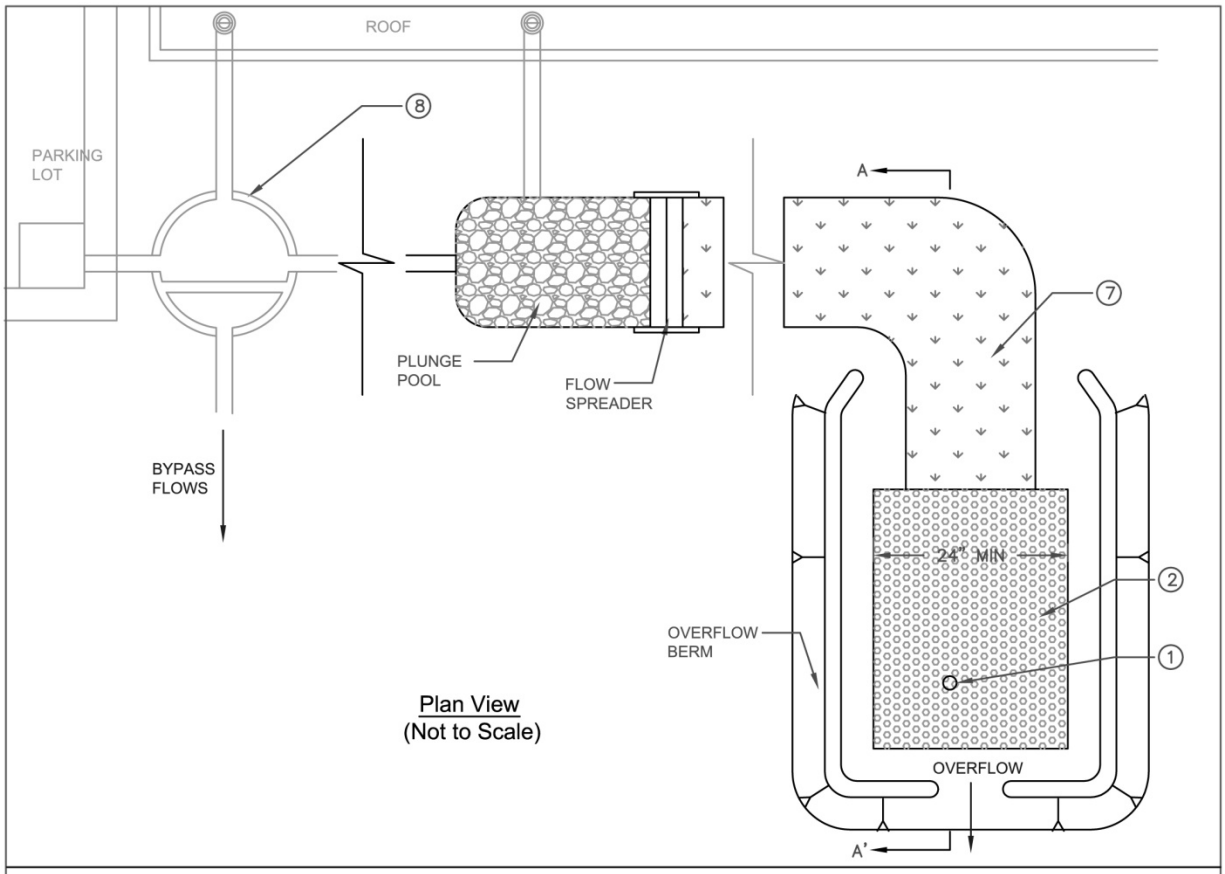
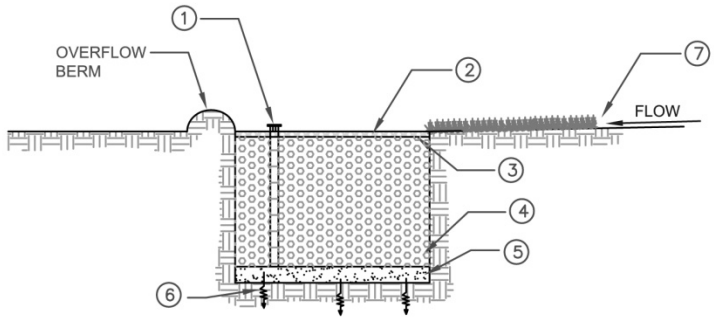
Figure 6 - 12
INFILTRATION BASIN

Figure 6-13: Infiltration Trench Schematic





Section A-A'
(Not to Scale)

NOTES

1. OBSERVATION WELL WITH LOCKABLE ABOVE-GROUND CAP.
2. 2" PEA GRAVEL FILTER LAYER.
3. PROVIDE FILTER FABRIC OR CHOKING STONE LAYER IF NO PRETREATMENT IS PROVIDED.
4. 3' - 5' DEEP TRENCH FILLED WITH 1.5" - 3.0" DIAMETER CLEAN GRAVEL WITH 30% - 40% VOIDS.
5. 6" DEEP SAND FILTER LAYER, CHOKING STONE LAYER, OR FABRIC EQUIVALENT.
6. RUNOFF INFILTRATES THOUGH UNDISTURBED SUBSOILS AT A MINIMUM RATE OF 0.5" PER HOUR.
7. RUNOFF FILTERS THROUGH GRASS FILTER STRIP OR VEGETATED SWALE.
8. OPTIONAL FLOW CONTROL DEVICE FOR OFF-LINE CONFIGURATIONS.

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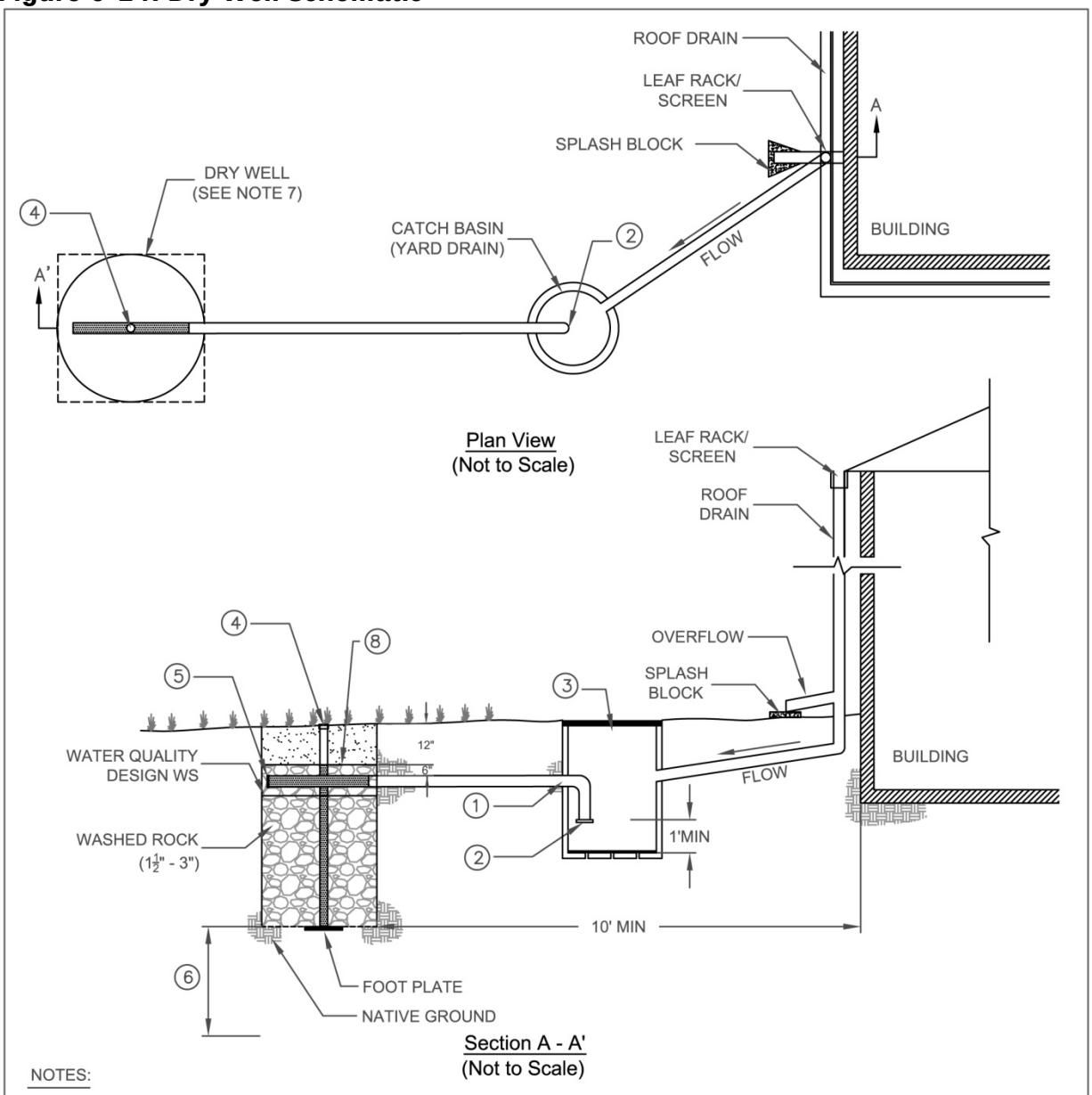
Figure 6 - 13
INFILTRATION TRENCH

Figure 6-14: Dry Well Schematic



NOTES:

1. MINIMUM 4" - 6" DIAMETER PVC PIPE. INSTALL AT FLAT SLOPE.
2. INSTALL FINE MESH SCREEN AT INLET TO DRY WELL. SET INLET ELEVATION AT 1' MINIMUM ABOVE CATCH BASIN BOTTOM.
3. CATCH BASIN (YARD DRAIN) INSTALLED WITH A SOLID LID FLUSH WITH GROUND SURFACE.
4. 4-6" VERTICAL PERFORATED PVC INSPECTION WELL WITH SCREW LID (NUT DOWN) FLUSH WITH GROUND SURFACE.
5. CAP END OF 4-6" HORZONTAL PERFORATED PVC DISPERSION PIPE.
6. MINIMUM 10' ABOVE SEASONAL HIGH GROUNDWATER TABLE AND 3' ABOVE BEDROCK.
7. DRY WELL CONFIGURATION MAY VARY (E.G. PRE-FAB MAY BE CIRCULAR).
8. FILTER FABRIC OR CHOKING STONE LAYER SHALL BE PLACED ON TOP OF THE DRY WELL TO SEPARATE IT FROM THE TOPSOIL AND PREVENT CLOGGING.

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Figure 6 - 14
DRY WELL

6.7.5 Operations and Maintenance

General Requirements

Infiltration facility maintenance shall include frequent inspections to ensure that water infiltrates into the subsurface completely within the recommended infiltration time of 72 hours or less after a storm (see Appendix H for an infiltration BMP inspection and maintenance checklist).

Maintenance and regular inspections are of primary importance if infiltration BMPs are to continue to function as originally designed. A specific maintenance plan shall be formulated specifically for each facility outlining the schedule and scope of maintenance operations, as well as the data handling and reporting requirements. The following are general maintenance requirements:

1. Regular inspection shall determine if the pretreatment sediment removal BMPs require routine maintenance.

2. If water is noticed in the basin more than 72 hours after a major storm or in the observation well of the infiltration trench or dry well more than 48 hours after a major storm, the infiltration facility may be clogged. Maintenance activities triggered by a potentially clogged facility include:

3. Check for debris/sediment accumulation, rake surface and remove sediment (if any) and evaluate potential sources of sediment and debris (e.g., embankment erosion, channel scour, overhanging trees, etc). If suspected upland sources are outside of the City's jurisdiction, additional pretreatment operations (e.g., trash racks, vegetated swales, etc.) may be necessary.

4. For basins, removal of the top layer of native soil may be required to restore infiltrative capacity.

5. For trenches and drywells, assess the condition of the top aggregate layer for sediment buildup and crusting. Remove top layer of pea gravel and sediment capture layer (i.e., sand and chocking stone layer or geotextile fabric) and replace. If slow draining conditions persist, entire trench or dry well may need to be excavated and replaced.

6. For trenches and drywells, if there is a tear in the filter fabric (if applicable), repair or replace.

7. Any debris or algae growth located on top of the infiltration facility shall be removed and disposed of properly.

8. Facilities shall be inspected annually. Trash and debris shall be removed as needed, but at least annually prior to the beginning of the wet season.

9. Site vegetation shall be maintained as frequently as necessary to maintain the aesthetic appearance of the site, and as follows:

10. Vegetation, large shrubs, or trees that limit access or interfere with basin operation shall be pruned or removed.

11. Slope areas that have become bare shall be revegetated and eroded areas shall be regraded prior to being revegetated.

12. Grass shall be mowed to 4”-9” high and grass clippings shall be removed.

13. Fallen leaves and debris from deciduous plant foliage shall be raked and removed.

14. Invasive vegetation, such as Alligatorweed (*Alternanthera philoxeroides*), Halogeton (*Halogeton glomeratus*), Spotted Knapweed (*Centaurea maculosa*), Giant Reed (*Arundo donax*), Castor Bean (*Ricinus communis*), Perennial Pepperweed (*Lepidium latifolium*), and Yellow Starthistle (*Centaurea solstitalis*) must be removed and replaced with non-invasive species. Invasive species shall never contribute more than 25% of the vegetated area. For more information on invasive weeds, including biology and control of listed weeds, look at the encycloweedia located at the California Department of Food and Agriculture website- http://www.cdfa.ca.gov/phpps/ipc/encycloweedia/encycloweedia_hp.htm or the California Invasive Plant Council website at www.cal-ipc.org.

15. Dead vegetation shall be removed if it exceeds 10% of area coverage. Vegetation shall be replaced immediately to maintain cover density and control erosion where soils are exposed.

16. For infiltration basins, sediment build-up exceeding 50% of the forebay capacity shall be removed. Sediment from the remainder of the basin shall be removed when 6 inches of sediment accumulates. Sediments shall be tested for toxic substance accumulation in compliance with current disposal requirements if land uses in the catchment include commercial or industrial zones, or if visual or olfactory indications of pollution are noticed. If toxic substances are encountered at concentrations exceeding thresholds of Title 22, Section 66261 of the California Code of Regulations, the sediment must be disposed of in a hazardous waste landfill and the source of the contaminated sediments shall be investigated and mitigated to the extent possible.

17. Following sediment removal activities, replanting and/or reseeding of vegetation may be required for reestablishment.

Maintenance Standards

A summary of the routine and major maintenance activities recommended for infiltration BMPs is shown in Table 6-35. Detailed routine and major maintenance standards are listed in Table 6-36 and Table 6-37.

Table 6-35: Infiltration BMP Maintenance Quick Guide

Inspection and Maintenance Activities Summary	
Routine Maintenance	• Remove trash and debris as required • Repair and re-seed erosion near inlet if necessary • Remove any visual evidence of contamination from floatables such as oil and grease • Observation of drawdown times of BMP surface or within observation wells as applicable • Clean underdrain (if present) and outlet piping to alleviate ponding and restore infiltrative capacity. • Check for debris/sediment accumulation, rake surface and remove sediment (if any) and evaluate potential sources of sediment and debris • Remove minor sediment accumulation in pretreatment BMP and at the surface of the BMP, if applicable • Remove debris and obstructions near inlet and outlet structures as needed • Mow routinely to maintain ideal grass height and to suppress weeds • Periodically observe function under wet weather conditions • Photographs taken before and after maintenance is encouraged
Major Maintenance	• For basins, remove top layer of native soil to restore infiltrative capacity. Add soil amendments to promote infiltration • For trenches and drywells, remove top layer of pea gravel and sediment capture layer (i.e., sand and chocking stone layer or geotextile fabric). If slow draining conditions persist, entire trench or dry well may need to be excavated and replaced. • For trenches and drywells, if a tear is found in the geotextile filter fabric, if applicable, repair or replace. • Facilities shall be inspected annually prior to the beginning of the wet season. • For infiltration basins, remove sediment when build-up exceeds 50% of the forebay capacity. Sediment from the remainder of the basin shall be removed when 6 inches of sediment accumulates. • Following sediment removal activities, replanting and/or reseeding of vegetation may be required for reestablishment.

Table 6-36: Routine Maintenance – Infiltration BMPs

Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed	Frequency
Trash & Debris	Any trash and debris which exceed 5 cubic feet per 1,000 square feet (one standard garbage can). In general, there shall be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.	Annually prior to wet season. After major storm events (>0.75 in/24 hrs) if spot checks indicate widespread damage/ maintenance needs. Litter removal is dependent on site conditions and desired aesthetics and shall be done at a frequency to meet those objectives.
Inlet erosion	Visible evidence of erosion occurring near inlet structures.	Eroded areas repaired/reseeded	
Visual contaminants and pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present.	
Slow drain time	Standing water long after storm has passed (after 48 to 72 hours), or visual inspection of wells (if available) indicates that design drain times are not being achieved.	Water drains within 48 to 72 hours. Drainage pipe is cleared, accumulated litter on surface is removed, and top 1-2" of pea gravel and sediment capture layer is replaced.	
Inlets blocked	Trash and debris or sediment blocking inlet structures.	Inlets clear and free of trash and debris.	
Appearance of poisonous, noxious or nuisance vegetation	Excessive grass and weed growth. Noxious weeds, woody vegetation establishing, Turf growing over rock filter.	Vegetation is mowed or trimmed to restore function. Weeds are removed to prevent noxious and nuisance plants from becoming established.	Monthly (or as dictated by agreement between County and landscape contractor).

Table 6-37: Major Maintenance – Infiltration BMPs

Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed	Frequency
Standing Water	Standing water long after storm has passed (after 24 to 48 hours), or visual inspection of wells (if available) indicates that design drain times are not being achieved	Design infiltration rate restored, either through excavation and replacement of filter media or surface sediment removal. If applicable, underdrain cleaned, reset or replaced.	As needed
Tear in Filter Fabric	When there is a visible tear or rip in the filter fabric allowing water to bypass the fabric.	Filter fabric repaired and/or replaced.	
Sediment Removal	Sediment build-up in forebay exceeds 50% of the forebay capacity and/or 6 inches of accumulation in the basin.	Sediment is removed, capacity of forebay and/or basin restored, and areas are replanted and/or reseeded as necessary to reestablish vegetation.	