

# **APPENDIX K**

## **Post Construction BMP Operation and Maintenance (Guidance for Long-Term Maintenance of BMPs)**

## **Infiltration Basin**

### Inspection and Maintenance

- Inspect following major rainfall events during the first year after installation.
- Inspect annually for settling, cracking, erosion, leakage, condition of the riprap, state of the turf vegetation, and amount of sedimentation. If necessary, repair immediately.
- If the drawdown time is more than 72 hours, maintenance and replacement of the filter media is required.
- Debris and litter shall be periodically removed from the infiltration basin and vegetation shall be mowed when growth exceeds 6 inches in height.
- If bare and eroded areas are present in the drainage area directly adjacent to the infiltration basin, vegetation and/or additional stabilization methods may be required to minimize premature clogging.
- Every 5 to 10 years the area shall be tilled, fine materials removed and the base of the basin regraded.
- Infiltration basins can be joined with detention basins to improve water quality.
- Vegetation installed within the infiltration basin tends to decrease the rate of clogging.
- A pretreatment device, such as an oil and water separator, may be required in areas where petroleum hydrocarbons in stormwater are anticipated.
- If a spill occurs and hazardous materials contaminate soils, sands or gravels in an infiltration basin, the affected areas shall be removed immediately and the appropriate soils and materials replaced as soon as possible.
- Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter strip function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.

## **Infiltration Trench**

### Inspection and Maintenance

- Infiltration trenches shall be kept free of vegetation.
- The City may require the inclusion of a 4 to 6-inch diameter perforated pipe anchored vertically to serve as a monitoring well. A monitoring plan for this well shall be included into the O&M Plan.

## Pervious Pavers

### Inspection and Maintenance

- All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at least quarterly for the first two years from the date of installation, twice per year thereafter, and within 48 hours after each major storm event.
- Blocks shall not be washed to remove debris and sediment in the openings between pavers. Sweeping with suction shall be utilized at least annually. Replace lost sand infill.
- Joints between pavers may require occasional weed suppression.
- Pavers can be removed individually and replaced when utility work is needed.
- Replace surface filter layer by vacuuming out sand media from blocks when it becomes evident that runoff does not rapidly infiltrate into the surface.
- If vacuuming does not adequately remove fill, blocks can be lifted and reset with new joint fill material.
- If soils swell or subside, blocks can be removed individually, the base leveled, and blocks reset.
- For pavers planted with turf, regular turf maintenance will be necessary. However, pesticides, fertilizers and other chemicals can have adverse effects on concrete products, so their use shall be restricted.
- Insects and rodents shall not be harbored at the pervious pavement. Pest control measures shall be taken when insects/rodents are found to be present.
- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the pervious pavement shall be filled and compacted



**Figure 1: Example of an Open Jointed Block Paver installation**

Photo: courtesy of ICP

## Porous Concrete and Porous Asphalt

### Inspection and Maintenance

- Accumulated debris and litter shall be routinely removed as a source control measure.
- Inspect porous asphalt and concrete several times during the first few storms to insure proper infiltration and drainage. After the first year, inspect at least once a year.
- Permeable pavements and materials shall be cleaned with a vacuum-type street cleaner a minimum of twice a year (before and after the rainy season).
- Hand held pressure washers can be effective for cleaning the void spaces of small areas and shall follow vacuum cleaning.
- Maintenance personnel must be instructed not to seal or pave with non-porous materials.
- Pervious pavements must not be sanded in the winter to avoid clogging the void spaces



## **Porous Turf Pavement**

### Inspection and Maintenance

- Porous turf requires regular maintenance associated with regular lawns such as irrigation, mowing, fertilization, aeration, topdressing, reseeding, disease control, insect control, and weed management.
- Soil testing should be conducted at least once every other year to determine proper fertilization, which will help to maintain turf stress tolerance.
- Routine mowing will be required in the growing season. Grass shall be mowed to less than four inches and grass clippings shall be bagged and removed
- Above ground biomass is important in wear tolerance, therefore high mowing can increase a grasses resistance to traffic stress. Mowing patterns should also be altered regularly to limit wear from repetitive wheel action.
- Reseeding may be required to maintain a uniform turf cover.
- Topdressing material should be at least as coarse and open-graded as the root zone.
- Irrigation operations shall follow local water conservation ordinances in effect.
- Traffic routes can be spread out or rotated to give the turf time to recover between uses. Traffic control can also divert traffic away from areas which are showing signs of wear.
- Vegetation, such as trees and shrubs, should not be located in or around the pervious pavement because roots from trees can penetrate the placement, and leaves from deciduous trees and shrubs can increase the risk of clogging the surface.

## **Porous Gravel Pavement**

### Inspection and Maintenance

- Remove accumulated debris and litter as needed.
- Maintenance is required to minimize clogging of the pervious surface.
- Occasional weed suppression may be required.
- Periodic replenishing and/or raking of displaced gravel may be required.
- Inspect sand filter routinely and after rainfall events to insure proper infiltration and drainage.
- Frequently inspect the pavement to insure proper infiltration and drainage during the first wet season, and then once a year following that time.
- Replacement of surface sand filter layer may occur when runoff does not infiltrate readily into the surface.
- Inspect surface gravels once a year. When inspections show accumulation of sediment and debris on top of gravel or slow infiltration, remove and replace top few inches of gravel.

## Biofiltration Basin

### Inspection and Maintenance

Primary maintenance activities include vegetation management and sediment removal. Mosquito control is also a concern in extended detention basins that are designed to include pools of standing water. The typical maintenance requirements include:

- Conduct semi-annual inspection as follows:
  - Evaluate the health of the vegetation and remove and replace any dead or dying plants.
  - Remove any trash and debris.
  - Inspect the outlet, embankments, dikes, berms, and side slopes for structural integrity and signs of erosion or rodent burrows. Fill in any holes detected in the side slopes.
  - Examine outlets and overflow structures and remove any debris plugging the outlets.
  - Identify and minimize any sources of sediment and debris. Check rocks or other erosion control and replace, if necessary.
  - Check inlets to make sure piping is intact and not plugged. Remove accumulated sediment and debris near the inlet. Ensure that engineered energy dissipation is functioning adequately by checking for evidence of local scour around the inlet.
  - Inspect for standing water and correct any problems that prevent the extended detention basin from draining as designed.
  - Confirm that any fences around the facility are secure.
  
- Maintenance activities at the bottom of the basin shall NOT be performed with heavy equipment, which would compact the soil and limit infiltration.
- Harvest vegetation annually, during the summer.
- Trim vegetation at beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and mosquito control reasons.
- Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter strip function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.
- Avoid the use of pesticides and quick release synthetic fertilizers, and follow the principles of integrated pest management (IPM) followed. Check with the local jurisdiction for any local policies regarding the use of pesticides and fertilizers.
- Remove sediment from the forebay when the sediment level reaches the level shown on the fixed vertical sediment marker.
- Remove accumulated sediment and regrade about every 10 years or when the accumulated sediment volume exceeds 10 % of the basin volume.

## Stormwater Planters



**Figure 2: Stormwater Planters installed next to office buildings** (Source: Portland BES)

### Inspection and Maintenance

- Inspections can be reduced to a semi-annual schedule once the landscape detention basin has proven to work efficiently and properly and vegetation is established.
- A health evaluation of trees and shrubs shall be conducted biannually.
- Pruning, weeding and trash removal shall be conducted as necessary.
- Debris should be removed routinely (no less than every 6 months) and upon discovery.
- Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter strip function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.
- Sediment accumulation shall be hand removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick
- Damaged downspout pipe shall be repaired upon discovery.
- Mulch replacement is generally required every 2 to 3 years.
- If a spill occurs and hazardous materials contaminate soils in landscape detention areas, the affected materials shall be removed immediately and the appropriate soils and materials replaced as soon as possible.
- Key inspection/maintenance areas include inlet and overflow areas for potential erosion, the ponding area in basin for trash and debris, and the monitoring well/clean out port for potential early signs of stagnant water in the system if an underdrain system is included.
- If ponding is observed to exceed 72 hours, particularly during the primary mosquito breeding season (June through October), the cause may be clogged filter fabric (if used, which is not recommend), compacted soils from construction activities, improper placement and compaction of the engineered soil mix, or surface clogging with fines from a heavy loading source in the drainage area (e.g., an upgradient dirt lot or a construction site without BMPs). The reason for the extended ponding shall be determined and mitigated (e.g., removal of filter fabric, cleaning of the underdrain

system, replacement of engineered soils, and/or ripping of underlying native soils to re-establish permeability).

- Structural deficiencies in the planter including rot, cracks and failure shall be repaired.
- Insects and rodents shall not be harbored at in stormwater planters. Pest control measures shall be taken when insects/rodents are found to be present.
- If sprays are considered, then a mosquito larvicide, such as Bacillus thurendensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the pervious pavement shall be filled and compacted

## Cistern/Rainwater Capture

### Inspection and Maintenance

- Clean out gutters, inflow and outflow pipes of leaves and debris as needed.
- Make sure gutters and downspouts are free of debris prior to the rainy season. The “first flush”, or the runoff created by the first rainfall event after a long dry spell, will need to be carefully monitored to ensure that the system is working properly.
- Inspect water tanks periodically and any remove debris and sediment that may interfere with the proper function of the system.
- Screen inlet and outlet pipes to keep the system closed to mosquitoes. No opening

shall be greater than 1/16” on systems where water will be retained for more than 72 hours.

- Cap and lock tanks for safety. Caps should have access ports for interior inspection and maintenance.



**Figure 3: A rainwater capture and reuse system on a residential home.** (Photo: Kennedy/Jenks Consultants)

## Green Roofs

### Inspection and Maintenance

- Upon installation, the green roof system should be inspected monthly for the first year and after each large rainfall event for erosion, plant survival, proper drainage and water proofing.
- Inspections can be reduced to a quarterly schedule once the Green roof system has proven to work properly and vegetation is established.
- If necessary, irrigate in short bursts only (3-5 minutes) to minimize runoff. Irrigation frequencies shall be established by the designer using an automated system.
- Vegetation shall be maintained to provide 90% plant cover
- Clean out drain inlets as needed.
- Remove debris and litter to prevent clogging of drain inlets and interference with plant growth
- Weeding and mulching may be necessary during the establishment period, depending on the planting design.
- Replace or fill in vegetation as needed.
- Fertilization is not necessary and fertilizers shall not be applied.
- Soil substrate/growing medium shall be inspected for evidence of erosion from wind or water. Erosion channels shall be stabilized with additional soil substrate/growth medium and covered with additional plants.
- Inspect soil levels semi-annually to improve plant survival and rainfall absorption.
- If the vegetation used is flammable during the dry season, it shall be mowed or watered as needed to minimize fire potential.
- If soil compacts over time and more is added, it will increase the seismic load of the supporting structure.
- Insects shall not be harbored on the green roof. Standing water shall be eliminated by manual means.
- Spill prevention measures from mechanical systems located on the roofs shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.



Photo: Jonathan Feldman Architecture

**Figure 4: Green roof on Carmel Valley, CA Residence**

## Vegetated Swales

### Inspection and Maintenance

- Proper maintenance includes mowing, weed control, removal of trash and debris, watering during the dry season, and reseeding of non-vegetated areas.
- When mowing grass, never cut shorter than the design flow ( $WQ_F$ ) depth and remove grass cuttings.
- Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned.
- Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Fallen leaves and debris from deciduous plant foliage shall be removed.
- Inspect swales at least twice annually for damage to vegetation, erosion, sediment accumulation and ponding water standing longer than 72 hours.
- Debris in quantities that inhibit operation shall be removed routinely (no less than quarterly), or upon discovery.
- Periodic litter collection and removal will be necessary if the swale is located adjacent to a main road.
- Sediments shall be removed when depths exceed 3 inches.
- Side slopes shall be maintained to prevent erosion that introduces sediment into the swale.
- Swale outlet shall maintain sheet flow of water exiting the swale unless a collection drain is used.
- If a spill occurs and hazardous materials contaminate soils in vegetated swales, the affected areas shall be removed immediately and the appropriate soils and materials replaced as soon as possible.
- Insects and rodents shall not be harbored in the vegetated swales. Pest control measures shall be taken when insects/rodents are found to be present.
- If sprays are considered, then a mosquito larvicide, such as Bacillus thurensensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the pervious pavement shall be filled and compacted



**Figure 5: Grassy Swale**

## Vegetated Filter Strips

### Inspection and Maintenance Guidance Requirements

- The owner/operator of the property must be responsible for maintaining vegetated filter strips.
- Required maintenance includes weed removal as well as mowing and irrigation of grasses.
- Grasses or turf shall be maintained at a desired height of 4 - 6 inches or at a minimum height of 2.
- If turf is used, filter strips shall be irrigated during the dry season.
- Dead vegetation shall be removed to maintain less than 10% of area coverage or when vegetative filter strip function is impaired. Vegetation shall be replaced immediately to control erosion where soils are exposed and within 3 months to maintain cover density.
- Trash, litter, rocks, and branches shall be frequently collected from filter strips, especially those located along highways.
- Fallen leaves and debris from deciduous plant foliage shall be ranked and removed.
- Invasive vegetation contributing up to 25% of vegetation of all species shall be removed and replaced.
- Debris in quantities more than 2" deep or sufficient to inhibit operation shall be removed routinely (no less than quarterly) or upon discovery.
- Regularly inspect filter strips for pools of standing water that may be acting as mosquito breeding habitats.
- Filter strips shall be inspected at least two times a year, preferably before and after the winter/wet season.
- Sediments that accumulate along the upstream edge of filter strips and/or in level spreaders shall be collected and removed at least once a year.
- If a spill occurs and hazardous materials contaminate soils in vegetated filter strips, the affected areas shall be removed immediately and the appropriate soils and materials replaced as soon as possible.
- Insects and rodents shall not be harbored in the vegetated filter strips. Pest control measures shall be taken when insects/rodents are found to be present.
- If sprays are considered, then a mosquito larvicide, such as Bacillus thurensensis or Altoside formulations can be applied only if absolutely necessary, and only by a licensed individual or contractor.
- Holes in the ground located in and around the pervious pavement shall be filled and compacted