

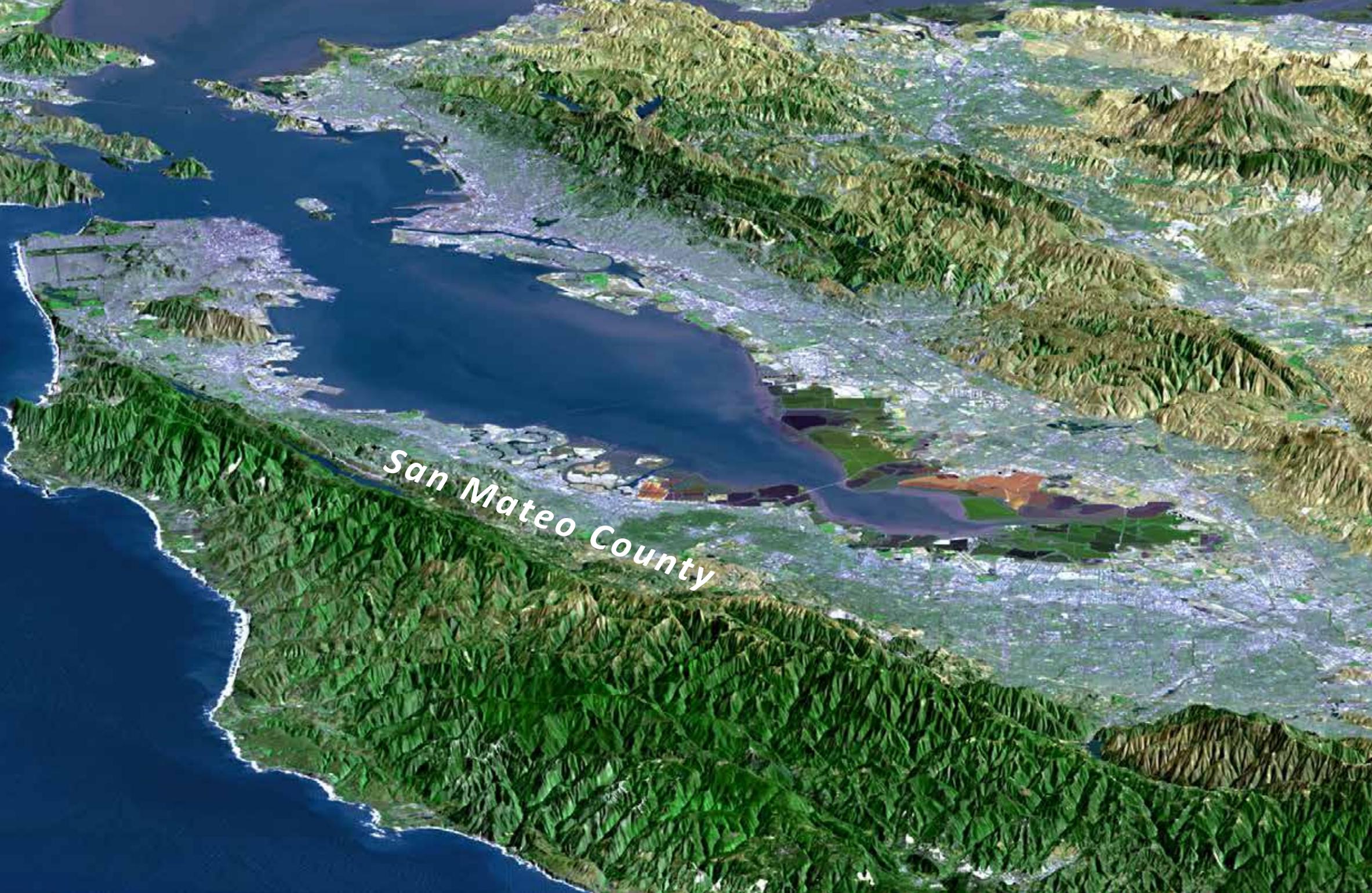
# San Mateo County

## Green Infrastructure Operations and Maintenance Guidebook

First Edition | March 2018



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# Executive Statement

*In 2016, the City/County Association of Governments of San Mateo County (C/CAG) enthusiastically supported the recommendation from its San Mateo Countywide Water Pollution Prevention Program Technical Advisory Committee to develop this San Mateo County Green Infrastructure Operation and Maintenance Guidebook (guidebook).*

*The guidebook provides designers, builders, municipal staff, and other interested groups practical and state-of-the-art information on maintaining ultra-urban low-impact development projects within San Mateo County.*

*Small amounts of rain throughout a watershed incrementally add up to large volumes of water downstream. Similarly, small changes to stormwater runoff treatment in a watershed can cumulatively result in significant improvements to overall watershed health. For this reason, employing green infrastructure systems throughout the county and providing simple and effect ways to maintain this infrastructure, as described in this guidebook, are at the core of creating balanced watershed systems.*

*The guidebook encourages the widespread use of low-impact development for new and retrofit projects. Supporting use of low-impact development for stormwater management is an objective shared by the C/CAG, local communities, and the San Francisco Bay Regional Water Quality Control Board/State Water Resources Control Board, which has adopted low-impact development as one of its core values.*

*Funding for this guidebook came from vehicle registration fees collected in San Mateo County for congestion and stormwater management. These fees were authorized by California Assembly Bill 1546, which was sponsored by Joseph Simitian and adopted in 2004. A continuation of this vehicle registration fee program for an additional four-year period starting in January 2009 was authorized by California Senate Bill 348 (also sponsored by Simitian and adopted in 2008).*

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◀ *California poppies blanket a stormwater curb extension along Hillside Boulevard in South San Francisco.*  
Photo Credit: Urban Rain|Design



# Chapter 1

## Introduction to the Guidebook

- 1.1** *What Is Covered in This Guidebook?*
- 1.2** *Observed Maintenance Needs in San Mateo County*
- 1.3** *Early Intervention and Bay-Friendly Landscape Practices*
- 1.4** *Maintenance Activity Considerations*
- 1.5** *Types of Green Infrastructure Maintenance Programs*

# 1.1 Introduction to the Guidebook

## *What Is Covered in This Guidebook?*



URBAN RAIN DESIGN

▲ Anyone can help in maintaining green infrastructure. This photo shows UC Davis students maintaining a stormwater landscape.

### Guidebook Purpose

Maintaining green infrastructure is not unlike providing health care for ourselves. For example, it is recommended for people to get health and dental check-ups/cleanings on a regular basis. Green infrastructure maintenance is very similar. With proper and regular care, stormwater facilities can last for decades and continually provide water quality and flow reduction benefits. Like our own bodies though, without reminders for regular green infrastructure maintenance, it is sometimes easy to neglect ongoing care or simply not care for it in the correct way. This, of course, can ultimately lead to problems.

The purpose of the O&M guidebook is to provide landscape contractors, designers, municipal staff, and the community-at-large with simple and user-friendly recommendations and reminders on how provide for the successful long-term function of built urban green infrastructure systems in San Mateo County.

### What This Guidebook Covers vs. C.3 Stormwater Technical Guidance

The San Mateo County Green Infrastructure Operation and Maintenance Guidebook is a supplement document to the overarching *C.3 Stormwater Technical Guidance* handbook. The *C.3 Stormwater Technical Guidance* contains extensive information on Operations and Maintenance in both Chapter 8 and Appendix H of the handbook. However, this information has primarily been developed to assure that projects meet specific technical compliance in the Municipal Regional Stormwater Permit (MRP) and establish proper maintenance agreements and party responsibilities. For the more day-to-day guidance on green infrastructure maintenance the San Mateo County Green Infrastructure Operation and Maintenance Guidebook is the preferable resource to follow. This guidebook aims to provide very specific and detailed recommendations on how to maintain urban green infrastructure without the being too technical in nature. It is meant to be a visual “field guide” to discuss common operation and maintenance issues. Anyone wishing to receive more detailed and technical information on operation and maintenance compliance for San Mateo County should reference Chapter 8 and Appendix H of the *C.3 Stormwater Technical Guidance* handbook.

The San Mateo County Green Infrastructure Operation and Maintenance Guidebook is primarily focused on small to moderately sized ultra-urban landscaped-based green infrastructure facilities that employ biofiltration and pervious paving applications found within

streets, parking lots, and development sites. These facilities might include bioretention areas such as vegetated swales, rain gardens, stormwater curb extensions, stormwater planters, green gutters, tree wells, as well as pervious paving systems. While green roofs and cisterns (water harvesting) are becoming more popular green infrastructure systems, because they are not yet widespread, this guidebook will not cover the operation and maintenance of these types of facilities.

### Chapter Summaries

To help you get started, an overview of this guidebooks chapters and appendixes are as follows:

**Chapter 1** describes the common types of green infrastructure maintenance issues found in San Mateo County, what do prepare for when conducting site maintenance, and types of green infrastructure maintenance programs.

**Chapter 2** describes maintenance issues found with the hardscape and functional elements of green infrastructure facilities such as sediment and trash removal, pervious paving cleaning, erosion control and troubleshooting too much or too little standing water within landscape areas.

**Chapter 3** illustrates landscape maintenance related activities such as mulch application, irrigation system checks and repairs, trimming plant material, plant replacement, weeding, fertilization, and maintaining site safety, visibility, and site aesthetics.

**Chapter 4** provides guidance to determine maintenance activities based on observed levels of needs, a detailed annual maintenance plan and monthly maintenance checklists for both hardscape/functional activities and landscape-related activities.

**Chapter 5** describes various design recommendations that can help with easing maintenance and/or improving the long-term performance of green infrastructure facilities.

**Appendixes** includes sample maintenance plans based on specific facility types, and a list of helpful resources.

### Additional Guidance

In addition to this guidebook, the San Mateo Countywide Pollution Prevention Program also has developed a “GreenSuite” of stormwater guidance documents to cover multiple user needs.

The GreenSuite Stormwater Guidance Documents:

San Mateo County Sustainable Green Streets Design Guidebook

San Mateo County Sites and Parking Lots Stormwater Design Guidebook

San Mateo County Stormwater Policy and Overview Guidebook

C.3 Stormwater Technical Guidance Handbook

# 1.2 Introduction to the Guidebook

## Observed Maintenance Needs in San Mateo County

### Sediment Removal Needs

Sediment accumulation within curb cut locations, and even within the entire landscape facility, has been a systemic problem for both green street and parking lot stormwater facilities. The majority of green street projects in San Mateo County are utilizing stormwater curb extensions that typically have a single main curb cut entry along the street curb. These types of stormwater facilities are excellent for capturing stormwater runoff, but they are equally strong in capturing sediment and small trash loads as water is flowing into the landscape. Parking lots that have large amounts of runoff also have issues with sediment loading at curb cuts, however, they typically have more frequently placed curb openings along stormwater facilities that result in more evenly distributed flow and sediment loading. In both parking lots and street applications, the following maintenance issues have been observed in San Mateo County green infrastructure facilities:

- Inadequate or missing hardscape forebays at curb cut locations to help collect sediment that causes excessive build-up or migration of sediment into landscape treatment areas.
- Little or no drop in grade between curb cuts and landscape areas which causes sediment to accumulate and prevent runoff from entering stormwater facilities.
- Too infrequent of maintenance schedule for removing both sediment and trash which causes further accumulation of material.
- Cobble/river rock placed at curb cut entrances causes sediment to build up between rock void space, promotes weed growth, and can inhibit the flow of stormwater if the cobble is placed above the grade of the runoff flow line.

### Hardscape/Structural Maintenance Needs

Because green infrastructure is still a fairly young practice of less than a decade and, without a widespread application throughout San Mateo County, there are not significant signs of hardscape and/or structural breakdown that is occurring. It is observed that pervious paving systems require regular cleaning with several recent projects already showing signs of sedimentation within pervious paving joints. If anything, the maintenance needed from a hardscape/structural sense is correcting poor design elements, such as:

- Inadequate or missing hardscape forebays at curb cut locations to help control erosion, ease sediment removal, and allow runoff to more efficiently enter landscape areas.
- Missing check dams/weirs to help retain water at desired ponding depths or check dams and weirs that do not retain water due to poorly chosen material that are prone to erosion.
- Poorly constructed curb cuts that do not easily allow water to enter the landscape because of hardscape grading issues. Maintenance options include the grinding down of pavement or even replacing the curb cut.
- Poorly installed overflow outlets which may need replacement to assure the desired control of water retention.

### Landscape Related Maintenance Needs

Landscape related maintenance issues of green infrastructure facilities in San Mateo County are quite numerous. Private green infrastructure maintenance does not seem to suffer as much in the form of lack of frequency of maintenance (as many private property owners have established maintenance crews that visit sites regularly), but more so the poor execution of landscape maintenance. Public green infrastructure, such as green streets, suffer from both lack of frequency and poor execution. The most significant landscape maintenance issues in the form of poor maintenance execution include:

- Inadequate or missing mulch layer, wrong type of mulch material, and incorrect placement of mulch material.
- No replacement of dead plant material/poor plant coverage.
- Exposed/broken irrigation systems and improper irrigation coverage.
- Excessive trimming of plant material and/or wrong timing to trim plant material.



▲ Street sediment takes over this landscape on a regular basis without adequate prevention and maintenance.



▲ River rock used to minimize erosion inhibits flow and creates sediment accumulation that is difficult to remove.



▲ This poorly designed and compromised curb cut should be replaced with a better design as part of maintenance.



▲ Excessive plant trimming has caused severe plant die back and eventual plant death.



▲ Plants that have died have also never been replaced in this stormwater swale.



▲ Lack of mulch exposes the soil to erosion, causes plant stress, and can expose drip irrigation lines.

# 1.3 Introduction to the Guidebook

## Early Intervention and Bay-Friendly Landscape Practices



▲ This newly installed green infrastructure facility will need regular care in the first years of establishment to ensure optimum performance and a healthy start.



▲ Using Bay-Friendly Landscape Practices should be embraced by both municipal staff and the general public.

### Early Maintenance Intervention for Newly Built Projects

An ounce of prevention is worth a pound of cure. The saying is true for going to the doctor as it is for maintaining green infrastructure systems. With green infrastructure quickly becoming mandatory for many municipalities, we are seeing many new stormwater facilities being installed. It is important to make sure that there is a high-level of maintenance conducted during the first years of post-construction establishment to assure that these facilities have the best start in life. Having a strong maintenance plan, an agreed upon and responsible party for maintenance services, and an engaged owner of the facilities (whether private or public), is absolutely necessary.

Even better than your standard agreement-based maintenance plan would be an “Early Intervention Maintenance Plan,” which would aggressively monitor and perform maintenance for the first two years of a facilities life. This would include more frequent observational visits than the standard recommended maintenance plan and more robust corrective actions, if required.

### Bay-Friendly Landscape Practices

Because green infrastructure is based upon mimicking natural hydrologic systems using a landscaped approach, it is highly recommended that maintenance staff utilize Bay-Friendly Landscape Maintenance practices. Bay-Friendly Landscape Maintenance practices are used to minimize waste, protect air and water quality, conserve energy and water, and protect natural ecosystems. Landscape maintenance should follow an integrated approach, consistent with the principles set forth in the Bay-Friendly Landscape Guidelines, [www.BayFriendly.org](http://www.BayFriendly.org). These seven Bay-Friendly principles are:

#### 1. Landscape locally

The Project landscape is part of a larger natural ecosystem of the San Francisco Bay Area. The materials and methods used to maintain the Project can support the health, diversity and sustainability of the Bay.

#### 2. Landscape for less to the landfill

Reducing waste starts with not generating plant debris in the first place by fertilizing, irrigating and pruning judiciously, grasscycling, mulching and composting plant debris. Using recycled content, salvaged, durable or local materials conserves resources and reduces the amount of energy consumed by the landscape.

#### 3. Nurture the soil

Create a healthy soil that supports a healthy landscape by protecting the soil from compaction and erosion, replenishing organic matter and mulching, using slow-release and organic fertilizers and minimizing use of chemicals that harm beneficial soil organisms.

#### 4. Conserve water

Use California’s water supply efficiently by reducing irrigation requirements, irrigating according to plant need, maximizing irrigation system performance, increasing the water holding capacity of the soil and using recycled water.

#### 5. Conserve energy

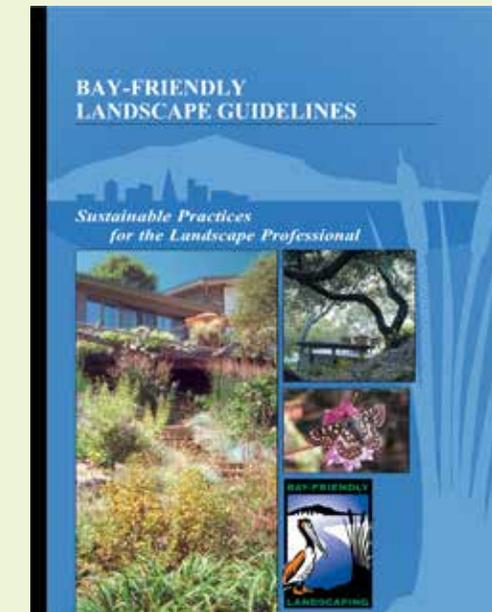
Conventional landscapes are fossil fuel consumptive. Nationally it is estimated that lawn mowers consume 400 million gallons of gas. Look for opportunities to conserve fuel and energy by choosing and maintaining materials and equipment for fuel conservation.

#### 6. Protect water and air quality

Reduce runoff, reduce contaminants in runoff through an integrated pest management (IPM) program, and increase the soil’s ability to remove pollutants from runoff through steps such as mulching bare soil. Reduce air pollution by reducing fossil fuel consumption, recycling plant debris on-site and planting trees to remove CO<sub>2</sub> and absorb air pollutants.

#### 7. Protect and maintain wildlife habitat

The Project may provide food, water, shelter and nesting sites for birds, butterflies, beneficial insects and animals that contribute to the ecological diversity of the Bay. Methods to protect them include minimizing application of chemicals by implementing an integrated pest management (IPM) program, and conserving flowers, berries, fruits, seed heads, low branch cover, and natural vegetation in open space areas.



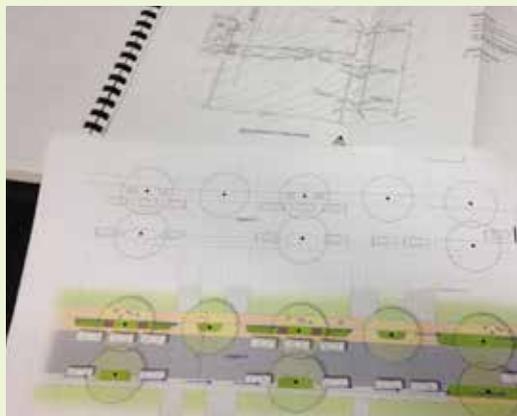
▲ An excellent and free resource to all is the Bay-Friendly Landscape Guidelines (See Appendix on how to obtain).



▲ The seven principles of Bay-Friendly Landscape Practices.

# 1.4 Introduction to the Guidebook

## Maintenance Activity Considerations



▲ Obtain and review all design plans and maintenance logs prior to going to the project site for maintenance activity. Contact project designers with any questions.



▲ Providing extensive photo documentation of after-construction condition and ongoing maintenance activities is a critical tool for observing changes at the project site.

### What to Do Before and While at the Project Site

When maintaining green infrastructure facilities, there are several things that maintenance personnel should do before going to the project site, such as:

- Check weather conditions to make sure that there are ideal conditions for maintenance. There should be no landscape maintenance when the soil is saturated to minimize the potential for soil compaction.
- Check design plans to understand design intent, plant species used, and site grading. It is also useful if digging is required and determine the location of unseen elements such as irrigation lines, underdrains, overflow pipes, etc.
- If possible, meet with the designers to talk over the project's design intent.
- Check maintenance logs to see when past maintenance has been performed, including the last scheduled maintenance activity.
- Notify property owner(s)/city agency and get permission to enter and perform maintenance activities.
- If using a volunteer crew to perform maintenance activities, coordinate with any individuals.
- Visit the site beforehand and determine what tools/safety equipment will be needed for maintenance activities.
- Determine appropriate disposal sites for any debris/landscape materials (see Resources in Appendix B)

### Photo Documentation of Maintenance Activities

It is vital that photographs should be taken after the project has been completed, at the commencement of the maintenance period. Documentation of the existing conditions establishes a maintenance benchmark before damage, disrepair or neglect compromise the appearance and function of the site. Initial photographs of the site should be thorough. After the initial photo documentation, photography is only required during subsequent maintenance visits when evidence of damage, decline, deficiency or vandalism is found.

In general, take photographs with context. Photographs should be in focus, clearly show the subject and be of a high-quality image resolution, i.e. taken with a minimum 5-megapixel camera.

Comprehensive site photographs and photographs of deficiencies should be submitted to the owner in digital format. Provide the digital images in a common format such as a JPEG or PDF. All images should be submitted with a date and time stamp. Other information best submitted with the images includes: the name of the project site, the name of the photographer or an alternative contact person, and a description of the photograph's vantage point, indicating the location and direction from which it was taken.

### Safety and Hazard Considerations When Performing Maintenance

Public stormwater facilities are often located within parking lots, along street corners, within medians, and in other places near moving vehicles. When maintaining these facilities, maintenance personnel are exposed to some risk of being hit by vehicles. To create a safe environment, warning signage should be placed to alert vehicles to the presence of maintenance personnel. Additionally, personnel can wear bright clothing and safety vests while working in these conditions.

Personnel should wear appropriate footwear, such as close-toed shoes not prone to slipping. Clothing should not be overly baggy to avoid fabric getting caught within machinery. Long pants are recommended. Gloves should be worn in situations when cuts, abrasions or chemical usage are likely. For instance, skin can be irritated when exposed to certain weeds. Gloves are recommended during hand weeding. Maintenance personnel should wear eye protection, preferably options with side guards, when exposed to hazards like flying debris or chemicals. Sometimes maintenance tasks require the use of power tools. Often loud, power tools necessitate ear protection in the form of ear plugs or muffs.

When working with new equipment, tools or chemicals, maintenance personnel should be trained by a qualified person in the proper usage of the item. Any equipment, tool or chemical should be implemented based on the manufacturer's instructions. Furthermore, equipment should only be used when working properly. Any defective equipment should be repaired before reinstating its use.

In the case of injury, first aid supplies should be readily available. Any injured personnel should be immediately evaluated for the necessity of ceasing work and obtaining professional medical help.

These safety considerations are not holistic. Any maintenance program responsible for the stormwater facilities should have effective safety procedures in place.

### Data Logs

In addition to photo documentation, maintenance activities should be recorded in written form (i.e. a data log). Information in data logs provides a reference of maintenance activity at a site. If maintenance crews or key personnel changes, the new personnel can access maintenance history, including the types of tasks usually performed on site, typical problems encountered and solutions. Additionally, long-standing maintenance crews don't have to rely on memory to recall maintenance history.

Information typically recorded in data logs includes the following:

- Changes that have been made (i.e. dead plant replaced, irrigation sprinkler head repaired)
- Supplies needed at the next maintenance visit (i.e. quantity of mulch required to restore depleted levels)
- Notate things that need to be closely monitored over the next several site visits (i.e. a struggling shrub gradually being shaded by a maturing tree that may require replacement)

Different logs are available within this document. A comprehensive checklist and schedule of maintenance tasks that need to be completed within specific months over the course of a year is included in Section 4.3. In Appendix A, these maintenance tasks are organized by stormwater facility type. This log lists the routine tasks, however, a separate sheet should be included to list the specific maintenance activities performed, as described above. It is useful, when available, to bring a site plan of the project. The site plan can be used to diagram the specific location at which a maintenance task has been performed (i.e. where a plant has been replaced) to supplement the written description. It is recommended that at each site visit, a data log be recorded.

# 1.5 Introduction to the Guidebook

## *Types of Green Infrastructure Maintenance Programs*

### Types of Maintenance Programs

There are many types of maintenance programs to choose from when caring for green infrastructure facilities. Many property owners, cities, or agencies utilize one or multiple types of programs to assure the best possible performance of their projects. Below lists a few of the most common types of maintenance programs.

#### Private Maintenance Crews

One of the most common types of maintenance programs is to simply hire private landscape construction/maintenance firms to complete maintenance activities. Using private contractors is most prevalent on private property green infrastructure projects but they are also utilized on public green infrastructure projects such as streets and parks. The advantage of using private landscape contractors is that they are professionally licensed to perform landscape maintenance, offer competitive fees for completing work, and can meet the staffing needs in providing maintenance for multiple projects.

#### Public Maintenance Crews

Many individual municipalities have their own city crews to perform routine maintenance on conventional public projects such as streets and parks. With new green streets being installed in San Mateo County, cities are asking park and street maintenance crews to also perform green infrastructure maintenance on top of their regular maintenance duties. While it may be easier to have “in-house” crews work on green infrastructure maintenance, limited budgets and staff shortages are common place.

#### Adopt-A-Rain Garden Public/Private Partnerships

Some cities have found success when facing maintenance budget shortfalls and staffing issues to coordinate with individual volunteers within the community to help maintain publicly owned green infrastructure projects. This public/private partnership, sometimes called “Adopt-a-Rain Garden” allows interested citizens to perform selective green infrastructure maintenance activities such as weeding, plant trimming, sediment and trash removal, and simple observation of performance under the guidance of city staff. This helps reduce the maintenance burden of maintaining public green infrastructure at the city level and helps promote community engagement and environmental stewardship at the individual level. This

volunteer effort can also be in the form of individual businesses or agencies adopting the selective maintenance activities. This type of maintenance program will likely require at least one trained city/agency staff person in green infrastructure maintenance to coordinate the Adopt-a-Rain Garden program.

#### Gardening/Sustainability Clubs

Similar to the Adopt-a-Rain garden program, having a coordinated group of individuals that help perform green infrastructure maintenance is another option to help spread out maintenance responsibilities. School, church, or UC Master Gardeners are always recruiting individuals to help with community-based volunteer efforts; and green infrastructure maintenance can be a part of this effort. This type of maintenance program will likely require at least one trained club/program staff person in green infrastructure maintenance to coordinate the group effort.

#### Skills Training and Employment for Disadvantaged Citizens

There are cities throughout California that are helping disadvantaged and/or homeless individuals find employment by offering paid job skills training for city beautification/maintenance. This is a great opportunity for cities to create “green jobs” while helping out neighbors in their communities. Davis, California currently offers a similar program called “Davis Pathways to Employment” that provides employment skills training and employment opportunities to persons experiencing homelessness—helping them become self-sufficient, more-connected members of the community.

#### Green Infrastructure Maintenance Training Opportunities

Because green infrastructure is a specialized form of landscape maintenance, it is important to have people adequately trained to perform this maintenance. Even licensed landscape contractors, while well-versed in conventional landscape maintenance, still need extra training in the nuances of green infrastructure maintenance. The National Certification of Green Infrastructure (NCGIP) sets national certification standards for green infrastructure construction, inspection, and maintenance workers. The program provides specific green infrastructure training in the form of workshops to interested agencies and includes a standardized exam for certification. Some cities in the Bay Area are engaging in the NCGIP certification program.



▲ Public works often maintain green infrastructure but are encouraged to seek specific green infrastructure training.



▲ A unique way to maintain the landscape using only human and bike power!



▲ Citizens can help maintain green infrastructure facilities as part of an “Adopt-a Rain Garden” campaign.



▲ Organized groups, such as the UC Master Gardener Program can provide highly-trained volunteer personnel.



▲ The Davis “Pathways to Employment” program helps the homeless find paid work for streetscape maintenance.



▲ UC Davis students, trained by local experts, remove sediment from a green street trench drain.



# Chapter 2

## Hardscape & Functional Maintenance Activities

- 2.1 *Sediment and Trash Removal*
- 2.2 *Pervious Paving Sweeping*
- 2.3 *Erosion Control*
- 2.4 *Troubleshooting Too Much or Too Little Standing Water*

# 2.1 Hardscape & Functional Maintenance

## Sediment and Trash Removal



▲ A stormwater curb extension curb cut full of sediment accumulation.



▲ River rock used to minimize erosion creates pockets of sediment accumulation that is difficult to remove.



▲ A cleaned sediment forebay. The smooth, and hard surface allows for easy removal of sediment and debris.

### Sediment and Trash Accumulation

Sediment is small particulate matter such as soil, small leaf debris, gravel, and road particulates that is transported into vegetated or pervious paving stormwater facilities by means of flowing water. In addition, pollutants such as oil, grease, metals, and other compounds are often found bound to the sediment load. If left to accumulate unmaintained, the sediment will build up over time creating difficult conditions for plant growth, reduce the porosity of both vegetated or pervious paving systems, and can impede the flow of runoff into vegetated systems.

Sediment is more prominent and problematic with street and parking lot conditions where vehicles break down leaf debris, gravel, and soil into fine dust. Some streets and/or parking lots have higher sediment loads than other based on the surrounding conditions and the amount of tree canopy cover. Building sediment from rooftops less common, but does occur. In all cases, a regular schedule of maintenance, responding to the specific sediment loading conditions of the site, should be outlined in the overall maintenance plan.

One of the most common failures of stormwater facilities is having the entry points of stormwater (i.e. curb cuts, trench drains, etc.) blocked with debris. This blockage can be in the form of sediment, leaves, trash, weed growth, or a combination of these elements. It doesn't take much blockage to prohibit water from entering a landscaped area as intended. In fact, just one-quarter inch of sediment or debris build-up can prohibit the flow of runoff into a stormwater facility and render even the best designed facilities functionally useless.

The best means to remove debris from curb cuts is by using non-mechanical tools such as rakes, shovels, and by hand grabbers to lift and remove debris. Be sure to dispose of debris in an appropriate solid waste trash bin. If removing any weeds or overgrown plant material that is blocking entry points of stormwater runoff, dispose of this material in appropriate yard waste/composting bins.

### Sediment Forebays

Sediment forebays are areas immediately downstream of stormwater entry points that allows sediment loads to be deposited prior to entering a landscape system. Sediment forebays are extremely important to limit the amount of sediment impacting vegetated stormwater facilities. Typically made of a concrete slab, pavers, or other hardscape structure, the sediment

forebay is a smooth level area that can easily allow for a flat-bed shovel, rake, or broom to lift out sediment. Alternatively, the hardscape forebay allows for a vacuum hose (e.g. Vactor®) to suction sediment. The use of river rock, or cobble, is not recommended for a sediment forebay at stormwater entry points. While cobbles may be useful for erosion control, the uneven surface and void spaces traps sediment, provides desirable conditions for weed growth, and does not allow for easy removal of the sediment.

Sediment forebays are often recessed 2 to 3 inches below the entry area of stormwater flow to provide capacity for some sediment to build up on the hardscape slab. The size or area of sediment forebays will vary greatly depending on how much sediment load is anticipated, how concentrated the flow of water/sediment is when it arrives at the forebay, and the amount of available space.

### Sediment and Trash Removal Process

Non-mechanical sediment and trash removal uses hand labor to clean vegetated systems. Using rakes, shovels, trash grabbers, and litter bags, debris is scooped out sediment forebays and, if needed, within the vegetated portion of the stormwater facility. This method is just as effective as mechanical sediment removal and it can be done with little up-front expense, training, or specialized equipment.

### Sediment Disposal

Sediment often carries pollutant loads and smaller trash particles that should not be directly disposed of through conventional street-side yard waste bins but can be disposed of in trash bins. If sediment is to be removed by non-mechanical means, it should be picked up from the stormwater facility, stored in plastic buckets, brought to a garbage bin or location where it can be disposed of properly.

### Maintenance Schedule

It is best if sediment and trash be removed on a monthly basis and during dry conditions to minimize the potential for compacting soil during the removal process.

### Helpful Tips

In some cases, excessive sediment from off-site impervious area runoff is unintentionally carried on-site and impacts stormwater facilities. This can be common in industrial areas where there are unimproved gravel road/parking conditions. It is important to identify these problem sources of sedimentation early on, notify the municipality, and ultimately have the property owner address the stormwater runoff and sedimentation issue.

Also, regular street sweeping and leaf pickup by property owners or municipal staff can dramatically reduce the amount of sediment and small trash items from entering stormwater facilities via stormwater runoff.

Organizing regular neighborhood trash pickup, gutter sweeping, and other maintenance events can allow for an overall community service event that brings neighbors together to be good environmental stewards.

# 2.2 Hardscape & Functional Maintenance

## Pervious Pavement Sweeping



URBAN RAIN DESIGN

▲ Sediment build-up within the joints of interlocking concrete pavers.



URBAN RAIN DESIGN

▲ The void space of pervious concrete should be free of sediment and debris by regular sweeping or blowing.



QUADRIGA, INC.

▲ Walk-behind vacuums are one option to help free trapped sediment from pervious pavement.

Permeable paving areas are to be kept free of all trash a debris to maintain permeability. Maintenance activities depend on the type of pervious paving. Two types will be discussed here: permeable pavers and pervious concrete.

### Interlocking Joint Concrete Unit Pavers

Permeable pavers are typically made of an impervious material. It is the space between each paver, filled with a pervious aggregate, that constitutes the pavers' permeability. Proper maintenance of permeable pavers ensures that water may still permeate the paver joints at the designed infiltration rate.

The surface of permeable pavers must be cleaned regularly to remove fine debris and organic material that may otherwise become lodged between pavers. Sweeping and blowing are two suitable cleaning methods. Pavers may also be cleaned with water and brushes, followed by the low-pressure hosing of the surface, taking care not to dislodge aggregate-filled joints. If necessary, replace any displaced aggregate with clean aggregate.

Weed growth may occur at joints. Weeds shall be removed manually. Refer to section 3.8, Non-chemical Weed Removal, for weeding practices.

Despite regular surface maintenance, eventually the aggregate-filled joints may become clogged. An annual infiltration test will determine if the aggregate requires replacement. If the aggregate-filled joints are no longer draining at the intended rate, remove the aggregate to a depth approximately half an inch above the bottom of the pavers and replace with clean, similarly graded aggregate. Do not compact aggregate-filled joints and do not use soaps or detergents.

### Pervious Concrete

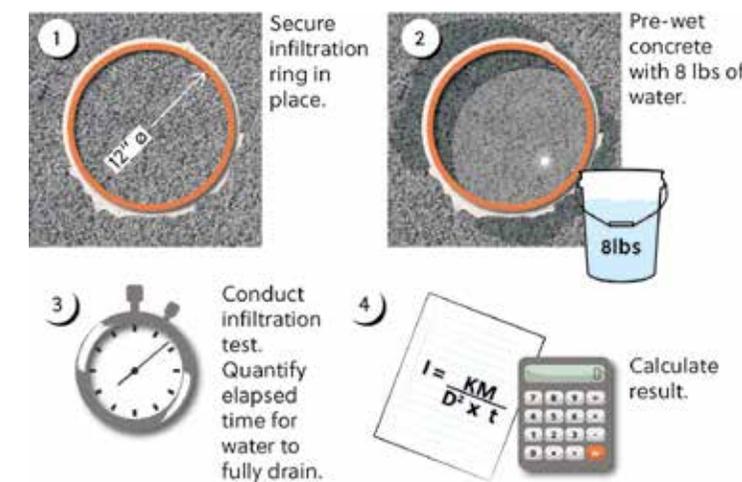
Pervious concrete is a mixture of uniform, large aggregates which bind to form a porous structure. Small pockets of space within the structure allows water to drain directly through the concrete. To maintain the permeability of pervious concrete, sediment must be removed or captured before it can infiltrate too deeply into the pervious concrete matrix.

Routine maintenance will keep pavement clear of particulates. Without regular maintenance, pavement may become severely clogged and require heavier equipment to restore its permeability. Severe storms may also prompt the need for additional maintenance.

Regular maintenance methods include sweeping or blowing. The appropriate equipment depends on the size of the site. Standard walk-behind sweepers and leaf blowers are maneuverable in small sites. Larger sites may accommodate riding or truck-mounted sweepers. Regular maintenance shall occur weekly.

An additional maintenance option is power washing. This method helps to dislodge particles within the top layers of the pervious concrete by either flushing them out of or through the pavement. Where routine sweeping or vacuuming has been neglected, power washing may be necessary to restore adequate infiltration to the pavement. Power washing shall occur periodically.

Where the above three methods fail to restore pervious concrete to its designed infiltration rate, vacuuming can help to free trapped sediment from the pavement. There is a variety of equipment options ranging from walk-behind, ride-on or track-mounted units. Vacuuming may occur annually or as needed.



Infiltration Rate Formula

$$I = \frac{KM}{D^2 \times t}$$

M = mass of water (lbs.)

D = diameter of infiltration ring (in.)

T = time for water to fully infiltrate starting once water hits the concrete (sec.)

K = 126,870 (constant to convert the product into

## Infiltration Rate

### Before you start

Ensure the surface of the pervious concrete where the test is being performed is clean and clear of debris. The infiltration ring should be 12-inch diameter PVC ring or similar.

### Performing the test

- The infiltration ring should be marked with two lines on the interior to help visualize a consistent water level. Mark the first line at 0.4 in. from the bottom of the infiltration ring. Mark the second line 0.6 in. from the bottom of the infiltration ring. Keep water head between the two marked lines during pre-wetting and wetting.
- Secure the infiltration ring in place with plumber's putty.
- Pre-wet with 8 lbs. of water and maintain the water head between the two marks. Record the elapsed time once water hits the surface of the concrete. This number will be used to determine the amount of water to use in the test. If test takes <30 seconds, use 40 lbs. for the actual test. If >30 seconds, use 8 lbs. of water.
- Perform test annually in multiple locations, ideally every 2,500 ft<sup>2</sup>. Average the resulting infiltration rates to produce your final answer.

Per C.3 Technical Guidance all pervious concrete, pervious asphalt, and interlocking pavers should have a minimum infiltration rate of 100 inches/hour when tested.

See ASTM C1701 for complete instructions.

# 2.3 Hardscape & Functional Maintenance

## Erosion Control



▲ Without a hard splash pad, the soil downstream of this weir is experiencing significant erosion.



▲ It appears that the placement of rock prevents erosion, but runoff is moving around the rock and eroding soil.



▲ This is a better curb cut option with hardscape walls and pea gravel mulch to control erosion.

### Soil Erosion at Entry Points of Runoff

Erosion of soil and movement of mulch is commonly attributed to the lack of solid mulch material and plant root structure within the direct flow path of stormwater runoff. Stormwater flow points such as curb cuts, trench drains, roof downspouts, and downstream check dams and weirs are common areas to find evidence of soil erosion. Erosion is often exasperated in areas of moderate to steeper slopes downstream from curb cuts where water quickly moves along the soil surface.

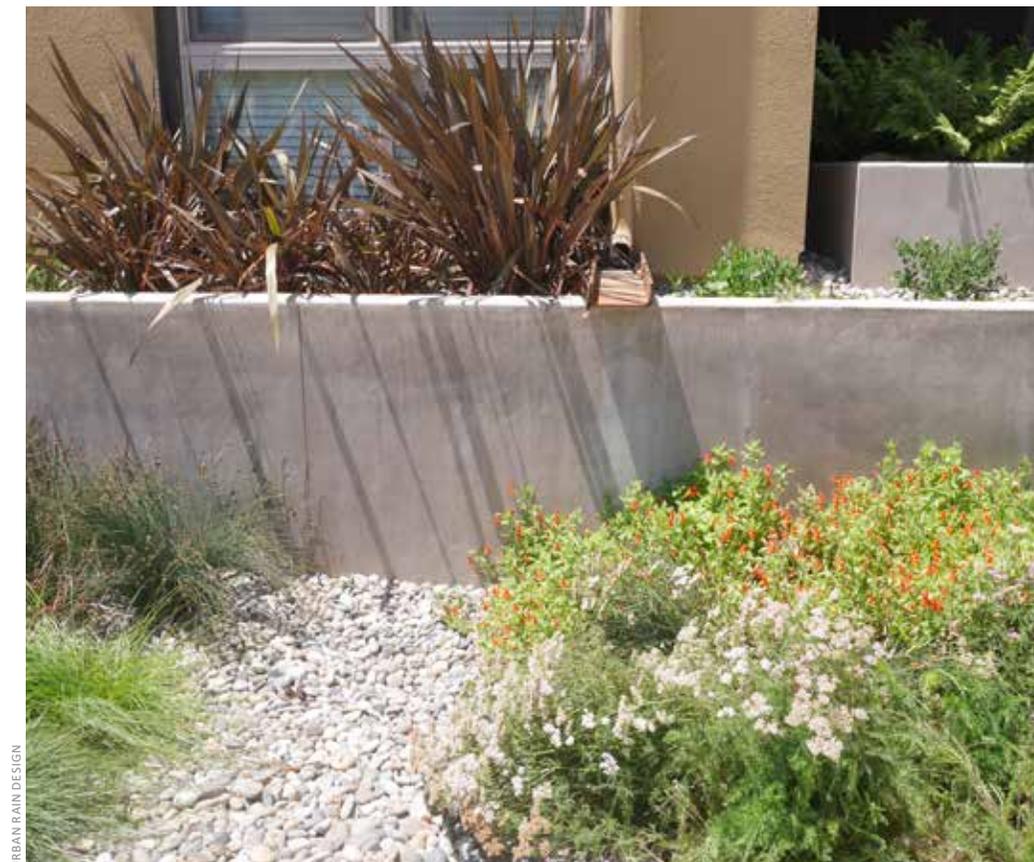
Simply applying a layer of pea gravel mulch or installing a modular concrete splash pad downstream of check dams, weirs, or curb cuts can often remedy areas of erosion. In some cases, especially in areas of steep slopes adjacent to curb cuts, a concrete pad and side walls may need to be constructed to control the direction of water flow and dissipate energy. With any solution it is important to assure that any addition of mulch or hardscape doesn't prevent the water from entering the landscape areas. The ultimate goal is to direct and slow the water down within the landscape, not impede it from entering it.

Disconnecting roof downspouts into landscape areas such as planters, rain gardens, or even conventional landscaping is an excellent strategy in reducing stormwater runoff. However, the disconnection point between the roof downspout and landscape area is often a source point for erosion. This is also compounded with the vertical force of water moving from the building. Hence, these disconnection points should be observed frequently for erosion.

Methods for controlling water flow at building downspouts are similar to controlling water at curb cuts by providing hard surfaces for routing stormwater and/or hard surface splash zones to dissipate the vertical energy of water from the downspouts. Using concrete, metal, stone, and other hardscape materials can be added as a maintenance activity to better route and/or control the energy of water into landscape areas.

### Maintenance Schedule

Routine inspection prior to the oncoming wet season, and after heavy rainfall events, should be done at curb cuts, check dams, weirs, and downspout disconnection areas to notice any signs of erosion of soil or plant damage.



▲ A roof downspout uses a metal channel to direct roof stormwater into a planter area. It is critical that the planter maintains a rock mulch or concrete splash pad to dissipate the vertical energy of water spilling into the landscape area.



▲ A concrete splash pad and pea gravel mulch at the spill point of water reduces the potential of erosion.



▲ A concrete forebay at the street curb cut is placed lower than the gutter grade to disperse water flow.



▲ Smaller rock at the flow line of a vegetated swale reduces to potential of erosion.

# 2.4 Hardscape & Functional Maintenance

## Troubleshooting Too Much or Too Little Standing Water



▲ This stormwater curb extension suffers from poor infiltration to the point where standing water occurs frequently enough to allow for algae growth and invasive plant species to take over the landscape.



▲ Conversely, this stormwater curb extension has no check dams and is graded to retain little stormwater. As a result, most of the runoff simply enters the inlet without any ponding of water.

### Too Much Standing Water

Given that native soil conditions vary considerably in San Mateo County and construction execution may not follow design plans, there is the potential for too much standing water in green infrastructure facilities over a prolonged period of time. Having too much standing water for multiple days after a storm event can cause several potential problems, such as:

- Vector control/Mosquito issues. Standing water should not remain in the treatment measures for more than five days, to prevent mosquito generation.
- Loss of capacity for back-to-back storm events. Ideally green infrastructure facilities would be able to soak in water over a given time between storm events so that there is capacity to capture the next storm.
- Stagnant water/algae growth/root rot. Prolonged standing water can cause algae to bloom and cause anaerobic soil conditions at the root zone leading to rot and mildew on leaves.

In situations where there is too much standing water over a prolonged period of time, it may be necessary to adjust the overflow structure to retain less water and promote more evapotranspiration rather than infiltration. Also, or in addition, the soil grade may need to be raised to retain less water. With projects that utilize an underdrain system, there might be an issue of runoff not being able to enter the underdrain system due to a clogged condition.

### Too Little Standing Water

Conversely, there are projects that simply retain too little stormwater runoff. In most instances it is due to have the overflow structure placed at too low of a grade to retain much water. It may be possible to either raise the overflow structure to increase capacity or install check dams around the overflow structure or at locations upstream to promote more water retention (See Chapter 4). If water is entering underdrain systems at too fast of a rate, it is also possible to install a reduced diameter orifice at the end of the system to control the amount of water enter the underdrain and force the water to move more slowly through the system.

Methods for controlling water flow at building downspouts are similar to controlling water at curb cuts by providing hard surfaces for routing stormwater and/or hard surface splash zones to dissipate the vertical energy of water from the downspouts. Using concrete, metal, stone, and other hardscape materials can be added as a maintenance activity to better route and/or control the energy of water into landscape areas.

### Maintenance Schedule

Routine inspection prior to the oncoming wet season, and after heavy rainfall events, should be done at curb cuts, check dams, weirs, and downspout disconnection areas to notice any signs of erosion of soil or plant damage.

### Testing Soil Infiltration Rate with a Double-Ring Infiltrometer

#### Supplies

- Double-ring infiltrometer: Two impermeable cylinders made of a durable material, such as PVC. See graphic for size requirements.
- Water source
- Timer
- Ruler or measuring tape
- Flat wooden board and mallet to drive cylinders into the ground

#### Prepare cylinders

The small cylinder is concentric within the large cylinder. Place the wooden board across both and drive them evenly into the ground, at least 2 inches deep and at least 6 inches above the surface. The bottom of both cylinders must be at the same depth. The smaller cylinder is used to measure water drop over time. The larger cylinder minimizes lateral water movement.

#### Presoak

During the first 30 minutes:

- Fill both cylinders to the brim.
- Maintain water level above 4 inches for the duration.
- After 30 minutes have passed, refill the cylinders completely.

During the next 30 minutes:

- Notate the water depth at full capacity in inches.
- After 30 minutes have passed, again notate the water depth in inches.
- Determine the difference in water level in inches.

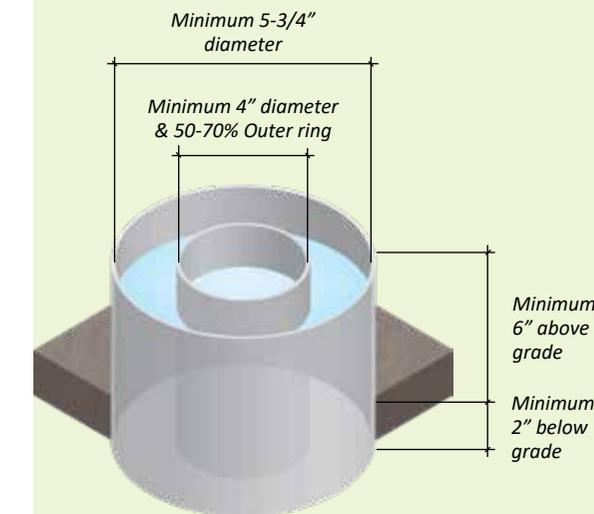
Determine the measurement interval to be used during testing:

- If the difference in water level is greater than or equal to 2 inches, use 10-minute intervals.
- If the difference is less than 2 inches, use 30-minute intervals.

#### Test

Obtain 8 readings or until a stabilized rate is achieved. A stabilized rate is achieved when there is a difference of one-quarter inch or less between the lowest and highest readings taken during four consecutive measurements. To take a reading:

- Fill both cylinders to the brim.
- At the appropriate interval determined during the presoak phase, obtain and record the difference in water level in the inner ring in inches.
- After each reading, stop the timer, refill the cylinders and reset the timer.



▲ Required dimensions of a double-ring infiltrometer.

#### Calculate

The final reading or the average stabilized rate, expressed in inches per hour, represents the infiltration rate.

$$\text{Soil Infiltration Rate (inches/hr)} = \frac{R}{I} \times \frac{60 \text{ min.}}{1 \text{ hr}}$$

R = final reading or average stabilized readings (in.)

I = interval (min.)

Per C.3 Technical Guidance bioretention areas should have an infiltration rate of 5-10 inches/hour when tested.



# Chapter 3

## Landscape Related Maintenance Activities

- 3.1** *Mulch Application*
- 3.2** *Irrigation System Checks and Repairs*
- 3.3** *Trimming Shrubs, Groundcovers, and Grass-Like Plants*
- 3.4** *Pruning Trees*
- 3.5** *Plant Replacement and Landscape Succession*
- 3.6** *Hand Weeding and Using Herbicides/Pesticides*
- 3.7** *Using Organics Fertilizers and Soil Amendments*
- 3.8** *Maintaining Visual Safety and Aesthetics*

# 3.1 Landscape Related Maintenance

## Mulch Application



▲ A rain garden without regular mulch replacement results in plant desiccation and exposed drip irrigation lines.



▲ This green street unfortunately uses organic mulch in the flow path of water which will in time float away.



▲ This green street uses pea gravel mulch in the flow path of water and organic mulch on upland side slopes.

### The Benefits of Using Mulch

Mulch benefits plant health, conserves water, and reduces maintenance requirements. A mulch layer insulates the soil, keeping it cool and alleviating evaporation from its surface. With a soil that remains moist and cool, plants experience less stress. Since the soil retains more of its moisture, less water is needed to irrigate. Additionally, organic mulches such as bark mulch replenish organic material in the soil as they break down and provide a food source for beneficial soil organisms that enrich the soil. Mulch suppresses weed growth, reducing the amount of manpower required to physically remove the weeds. Desired plants then have fewer contenders for water and nutrients. Lastly, mulch shields bare soil from the erosive forces of wind and rain. Overall, mulch ensures that soil remains nurtured which in turn supports a healthy landscape. The benefits of mulch far outweigh the costs of its upkeep.

### Mulch Application

Whatever the variety, mulch needs regular care to create and maintain an even and uniform appearance at each stormwater planter area. A layer of mulch, no less than 3 inches deep, needs to be sustained. Though only 3 inches of mulch is required, maintaining a deeper layer of mulch greatly reduces the labor needed to control weeds, reduces water use and helps the plants stay healthy. Mulch is not required in areas where plant foliage completely covers the soil surface. Maintain a 6 to 12-inch clearance around the base of trees and shrubs. If mulch is placed too close to a tree, excess water build-up can damage its trunk. Keep the root flare of a tree exposed. When applying a mulch layer, it is critical that the mulch material not impede the flow of water through curb cuts. Make sure that the grade of the soil is low enough to add the mulch layer, but not impede water flow.

### Maintenance Schedule

Mulch levels should be monitored during weekly maintenance rounds or whenever site visits occur. Mulch is commonly knocked or washed out of planters. During weekly site visits, the disturbed mulch should be placed back into the planter and smoothed into an even layer. Every month and after large storm events, mulch should be added or redistributed within stormwater planters where the mulch has been reduced to less than 3 inches deep. However, if a large amount of mulch is washed out of a planter, this indicates that the incorrect type of mulch has been applied. If bark mulch or arbor mulch is routinely washed away, remove and replace with a heavier variety of mulch, such as pea gravel.

### Common Types of Mulch Material

**Bark mulch:** Typically made from the bark of conifer trees, bark mulch is shredded or tumbled to a uniform size. It contributes to the organic material in a soil, is readily available, inexpensive and handles foot traffic well. However, in stormwater planters, it can contribute to maintenance issues as it readily floats and is easily displaced. Bark mulch should be placed above the wetted zone of stormwater facilities to limit its potential movement.

**Arbor mulch:** Arbor mulch is composed of tree trimmings from both hard and soft wood that is ground into a consistent size. Arbor mulch is a recycled material and is readily available. It can occasionally be procured at no cost from tree removal services. Unlike bark mulch, arbor mulch contains hard wood. This increase in density, along with material irregularity helps the mulch “knit” together and resist floating. Despite the resistance to floating, arbor mulch should also be placed above the wetted zone of stormwater facilities.

**Pea gravel/Small-size crushed rock:** Pea gravel ranges in size from a 1/8 inch to a 3/8 inch diameter. Pea gravel is an effective option for stormwater planters because of its weight. It is heavier than other mulch types which helps prevent it from washing away. Its weight makes it more difficult and costly to install; however, it will not need to be replaced as often as mulches that decay. Similar to other mulches, pea gravel helps to maintain soil moisture though it does not contribute organic material to the soil. Another maintenance consideration includes the challenge of adding or replacing plants into pea gravel mulch. Additionally, debris can be challenging to remove. Pea gravel mulch is desirable for use in stormwater planters because of its longevity and is not easily displaced from stormwater or maintenance activities.



Uniform Bark Mulch



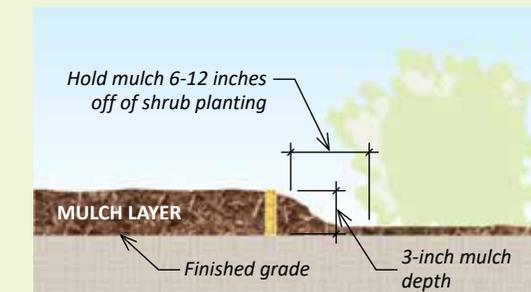
Irregular Arbor Mulch



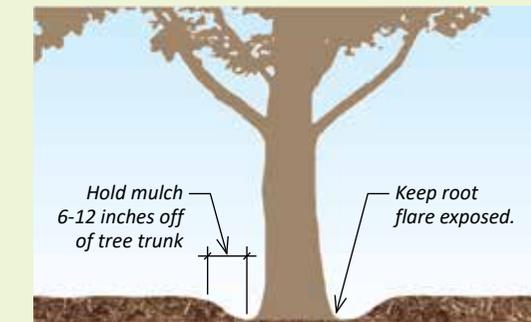
Pea Gravel



▲ Pea gravel mulch used on both the side slopes and wetted area of a vegetated swale prevents erosion.



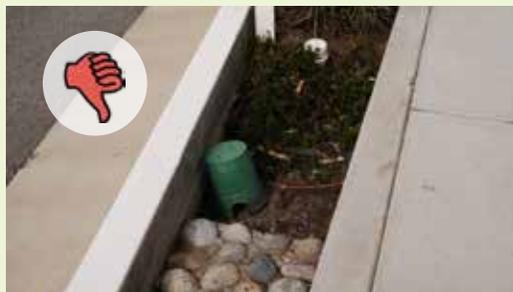
▲ It is recommended that a 3-inch layer of mulch be maintained throughout the year.



▲ Maintain a 6 to 12-inch clearance around the base of trees and shrubs.

# 3.2 Landscape Related Maintenance

## Irrigation System Checks and Repairs



URBAN RAIN DESIGN

▲ A green street with exposed drip irrigation lines and valve box is very susceptible to breakage.



JANINE FERAN

▲ A poorly managed irrigation schedule and/or duration causes wasteful water runoff.



URBAN RAIN DESIGN

▲ Poorly performing irrigation can also quickly cause plant death from under-watering or lack of coverage.

In our California climate, a well-maintained landscape system is dependent on a properly functioning irrigation system. This includes a system that applies water efficiently and is in working order at all times. To ensure that the landscape has the best chance to thrive both the irrigation schedule and overall functional components should be checked regularly by a qualified professional landscape contractor.

### Checking Irrigation Schedule

Irrigation scheduling involves determining the frequency and duration of watering intervals. Site characteristics like weather conditions, soil infiltration rates and drainage patterns affect this determination. Plant characteristics like a species' rooting depth is also an important factor as enough water needs to be applied at each irrigation cycle to wet through the depth of the root zone. Other scheduling factors include the watering requirements for a hydrozone and the application rate and distribution uniformity of an irrigation system within that hydrozone.

Irrigation frequency (number of days/per week) should be based on seasonal evapotranspiration (ET) data (available through CIMIS). Irrigation frequency for each hydrozone shall be adjusted each month to reflect ET expected in the next month. For sites with controllers that monitor ET and adjust schedules automatically, the landscape contractor should program the controller according to manufacturer specifications, and monitor to ensure that frequency is appropriate.

Irrigation duration (number of minutes per watering) within each hydrozone shall be based on the soil infiltration rate, species water requirement and rooting depth within the hydrozone, and the application rate and distribution uniformity of the irrigation system within that zone.

If irrigation runoff or ponding of water occurs, either within the landscape or crossing onto paved surfaces, the application time shall be divided into shorter time intervals and repeated as needed. Runoff indicates that plants are being over watered and is not allowed. Irrigation duration for each hydrozone is to be adjusted monthly as well.

Landscape irrigation shall be scheduled between 10:00 p.m. and 6:00 a.m. to avoid irrigating during times of high wind or high temperatures.

### Checking Irrigation Coverage

The landscape contractor should maintain the irrigation system for optimum performance, as per manufacturer's specifications, by inspecting the entire system on an ongoing basis. This includes cleaning and adjusting all spray and bubbler heads, drip emitters and valves for proper coverage and adjusting for any and all overspray/runoff onto adjacent impermeable surfaces. Runoff of water from irrigation systems into or onto streets, sidewalks, stairs, or gutters is not permitted. The landscape contractor should immediately shut down the irrigation system and make adjustments, repairs, or replacements as soon as possible to correct the source of the runoff. Equally important, is to check irrigation coverage to ensure that plants have enough water distributed to the root zone. Plant material should be carefully observed for signs of wilting, indicating a lack of water or sudden die-off at the base of the plant indicating over-watering.

### Irrigation System Repair

Any irrigation components that are damaged should be replaced or repaired as soon as possible as to not stress plants or waste water. This can only be done by frequent on-site inspection as a break in the system can occur at any time. Common minor repairs include damaged, clogged, or missing sprinkler nozzles/drip emitters, adjustments of sprinkler patterns or arcs, and the adjustment of sprinkler position (i.e. raise, lower, or straighten sprinkler heads), and breaks in drip irrigation supply and distribution lines. When repairs are needed, make sure that repair work is not performed when the soil is saturated either from rainfall, a break in the irrigation system, or an over-irrigated condition to minimize the potential for soil compaction.

### Maintenance Schedule

At least every month the irrigation system should be checked on-site for proper schedule, coverage, and any possible repairs needed. A more extensive annual irrigation system check should be performed prior to the start of the dry season. Every month, adjust the irrigation controller for current water needs of plants. Irrigation system pressure shall be checked and adjusted at least monthly during season of operation. Maintain monthly documentation of irrigation checks and as-built plans of any changes or adjustments to the system.

### Irrigation Check Test

Once a year, at the start of the irrigation season, or as needed conduct an irrigation system check test. The following tasks should be performed:

- Ensure all flush valve/cap locations are visible.
- Ensure valve boxes are visible and can be opened.
- Clean valve boxes of dirt and debris.
- Inspect valves, filters, and pressure regulators for damage or leaks. Check wire splices.
- Flush out the irrigation system and check for proper operation of each valve zone.
- Flush irrigation laterals.
- Inspect and clean filters. Replace damaged or torn filters.
- Clean or replace plugged sprinkler nozzles.
- Make sure plants have adequate numbers of drip emitters.
- Replace irrigation controller and sensor annually, as applicable.
- Test soil sensors per manufacturer's testing instructions.

# 3.3 Landscape Related Maintenance

## Trimming Shrubs, Groundcovers, and Grass-Like Plants



▲ A shrub trimmed too severely shortens the life of the plant and compromises the aesthetics.



▲ This landscape is not trimmed excessively and left to grow more informally.



▲ Even more formal planting arrangements can be trimmed lightly to achieve desired form.

### Trim Selectively and Properly

Bay-Friendly Landscaping suggests that plant trimming and pruning should complement the natural form and strengthen the structural integrity of the plant. It should not be used to dominate plants. Creating straight line hedges and topping plants, especially at the wrong time of year, does more harm than good. The labor required for this type of trimming is not a cost well spent as it is endless, weakens the plant, and generates unnecessary plant debris. Selective trimming and pruning techniques of plant material can maintain adequate sight visibility, help spur new growth and flowering, and allow for better flow of stormwater throughout the landscape.

### Seasonal Trimming

Pruning at different seasons triggers different responses in different species. Late winter or early spring, before bud break, is typically the best time to prune many species because new tissue forms rapidly at this time. Summer pruning tends to suppress growth of both suckers and foliage. Late summer or early fall pruning typically causes vigorous regrowth, which in some cases may not harden off by winter, leading to possible cold damage. Whenever unexpected damage from vandalism or bad weather occurs, plants should be pruned at once.

Pruning for most spring-blooming shrubs should be performed immediately after flowering to avoid reducing the floral display. For shrubs that bloom in spring from buds on one-year-old wood, prune when their flowers fade. Early summer-blooming shrubs should be pruned to early spring, prior to bud set, or in summer immediately following flowering. For shrubs that bloom in late summer or fall on current year's growth, prune in winter.

### Reducing Size and Controlling Form Pruning

In general, shrubs and groundcovers should be allowed to grow unpruned to their natural size and shapes excepted of the plant variety. Shrubs and groundcovers should only be pruned as required for safety, visibility, and plant health. Deciduous shrubs require maintenance pruning to keep them healthy and in scale with their surroundings. Maintenance pruning practices should begin at the time of planting, or after rejuvenation of older shrubs.

For height maintenance of mounding-type shrubs, prune only the longest branches. Make cuts well inside the shrub mass where they won't be visible. This method reduces mounding shrubs by up to one-third their size without sacrificing their shape.

### Ornamental Grasses, Rushes, and Sedges Trimming

Pruning methods for ornamental grasses differ based on whether the grass is an ornamental perennial grass, an ornamental evergreen grass or a grass-like evergreen plant.

Perennial ornamental grasses need to be sheared to maintain their appearance. Foliage should remain throughout winter. Once the grass begins to push new growth, cut back foliage to a height of 6 to 8 inches. Example perennial ornamental grass species include: *Miscanthus*, *Pennisetum*.

Evergreen ornamental grasses should not be cut back annually. Instead, rake or comb through foliage with a rubber coated glove to remove spent foliage. When rejuvenation is required, an evergreen ornamental grass may be cut back to a height of 12 to 18 inches. Example evergreen ornamental species include: *Calamagrostis*, *Muhlenbergia*.

Evergreen grass-like plants may also be raked or combed with a rubber coated glove to remove spent foliage. Some species may not respond to raking or coming as their foliage, even when spent, is strongly attached at the base. For these species, stalks may need to be individually pruned out at the base of the plant. Example grass-like species include: *Dietes*, *Liriope*, *Lomandra*, *Phormium*.

Rushes and sedges that are commonly planted in the wetter and lowest elevation stormwater facilities, should only be trimmed to avoid the plants flopping over and creating overcrowding conditions. If trimming is required for this reason, then only trim a maximum of 1/3 off the top of the plants per year. Trimming rushes and sedges down to the base of the plant each year will cause the plant to degenerate and die from the inside out. Example rush and sedge species include: *Juncus*, *Carex*.

### Maintenance Schedule

During monthly site visits, the maintenance staff should determine if pruning is required. Dead, broken or diseased branches need to be removed immediately. Shrubs and groundcovers should be trimmed back from sidewalks, curbs, and paved areas on a quarterly basis. Seasonal pruning depends on the flowering time of the shrub in question. Prune spring & winter-flowering shrubs in early summer as needed to maintain proper shape. Prune summer & fall-flowering shrubs in early winter as needed to maintain proper shape.



▲ Unfortunately, many rushes and sedges are severely cut back to the ground. Eventually these plants will die.



▲ If trimming is needed for rushes, cut back foliage to maintain a height of at least 12-18 inches.



▲ Comb evergreen grasses with a rubber coated glove to remove spent foliage.

# 3.4 Landscape Related Maintenance

## Pruning Trees



▲ A heavily pruned tree weakens the structure, reduces the canopy, and is aesthetically unpleasing.



▲ Proper pruning of trees allows for better form, increases site visibility, and strengthens the structure of the tree.



▲ Creating vertical clearance under trees for vehicles and people is an important maintenance consideration.

### The Purpose of Tree Pruning

Trees require pruning to develop and maintain a healthy structure, to keep them free of disease and pest infestation, and to keep roadways and walkways clear of obstructions. Young trees need to be pruned annually for up to five years after planting. Annual pruning directs tree into the appropriate form for its species and the site as well as develop a strong branch structure. For example, trees with co-dominant trunks and multiple branch attachments need to be pruned over a period of several years to correct these structural defects. The goal is to create a tree that has a strong central trunk with lateral branches spaced vertically and horizontally.

Trees of all ages need to be regularly inspected for crossing, weak, diseased or dead branches so that they may be removed. To pre-empt branch weakening, maintenance staff may also reduce end weight on heavy, horizontal branches.

No more than 20% of its live foliage should be removed or else cause unnecessary stress to a tree. When branches need to be removed or reduced, thinning cuts are preferred to heading cuts. See sidebar on the opposite page for illustrations of thinning and heading cuts. Trees should not be topped as it can cause severe injury to the tree. For the same reason, interior branches should not be stripped out, an injurious method referred to as “lion’s tailing.”

In addition to tree structure and health, branches need to be trimmed so that they do not impede pedestrian or vehicular traffic. Accepted clearances include a 14-foot vertical clearance over roads, a 10-foot clearance above parking spaces and an 8-foot vertical clearance over walkways. Trees should also be pruned to provide access to buildings, utilities and other sites, as needed. Besides what is listed above, trees do not require routine thinning.

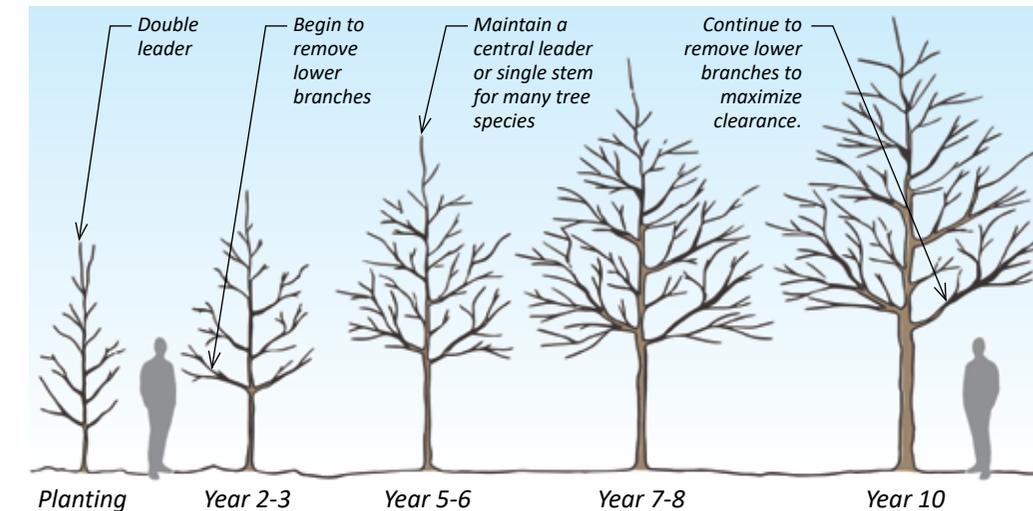
### Pruning Standards

Tree pruning needs to be performed by trained, experienced personnel. While pruning occurs, the presence of an I.S.A.-certified arborist or tree worker is recommended. The arborist must have a State of California Contractor’s License for Tree Service (C-61 D-49). Pruning needs to adhere with the most recent edition of the American National Standard for Pruning (A300) and the International Society of Arboriculture’s Best Management Practices for Pruning.

### Maintenance Schedule

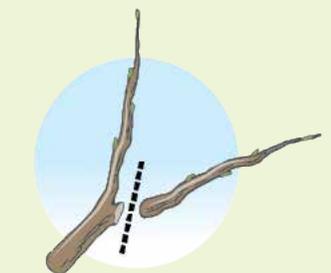
During monthly visits, monitor any broken or fallen branches need to be removed from trees. Also, suckers growing from the base of the tree should be removed.

Arborists will best determine the appropriate months in which tree pruning should occur. There are several occurrences that influence the scheduling. It is important to avoid times of bud break, flowering, and leaf drop. It is also key to avoid peak periods of insect and disease activity for pests to which the tree species is susceptible. Once the appropriate month is determined, annual pruning can commence. Maintenance staff should prune any tree branches that interfere with public safety and remove dead or diseased branches from the trees as described above. Additionally, stormwater planter trees require yearly pruning to encourage strong upward growth.

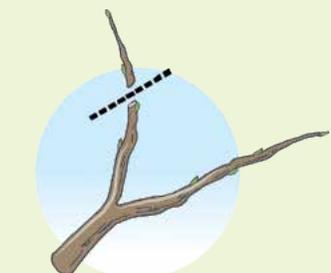


▲ At time of planting, limit pruning. Remove only dead or broken branches. Where multiple leaders occur, reduce to a single top. Remove also narrow, V-shaped crotches. When pruning, avoid removing more than 1/3 of the total number of branches at one time. If the tree is weak, prune even less. Avoid damage to the trunk over the entire life of the tree.

### Types of Pruning Cuts



▲ Thinning cuts remove branches at their points of origin or attachment. Used in moderation, thinning cuts reduce shrub density without stimulating regrowth. Make thinning cuts just above parent or side branches and roughly parallel to them.



▲ Heading cuts stimulate growth of buds closest to the wound. The direction in which the top remaining bud is pointing will determine the direction of new growth. Make heading cuts selectively to reduce tree/shrub height and retain natural form. For heading cuts, prune a quarter inch above the bud, sloping down and away from it. Avoid cutting too close, or steep, or the bud may die. When pruning above a node with two or more buds, remove the inward-facing ones.

# 3.5 Landscape Related Maintenance

## *Plant Replacement and Landscape Succession*



▲ This vegetated swale contains less than 70% coverage of plant material and needs additional plant material added.



▲ This rain garden has about 70% plant coverage which is considered the minimum for functionality.



▲ This rain garden achieves 100% plant coverage within the landscape.

### Plant Replacement Policy

Any trees, shrubs or groundcovers found to be dead, damaged or missing are to be replaced with a plant that is identical in species and cultivar to the original. Once a plant is discovered dead, damaged or missing, the plant should be replaced as soon as possible. It is also important to determine why a plant or plant(s) have died so that any potential fixable causes (i.e. lack of water, too much water, etc.) can be remedied.

It is important to maintain at least a 70% plant coverage within landscaped stormwater facilities. A functioning stormwater system is dependent on the ability of its plant material to uptake water, nutrients and potential pollutants. If by visual assessment, the landscape is determined to have inadequate plant coverage, add plants until the minimum or desirable coverage is achieved. Refer to as-built drawings to determine the types of plants to be added. If drawings are not available, match additional plants to the species already present within the planter area.

If environmental conditions change, plant species selected for the original site conditions may begin to fail. For instance, shrubs planted near a young tree will receive less daylight as the tree grows into its mature canopy. If the shrub is failing and the cause is determined to be due to inadequate sunlight, select and replace with a species that is adapted to the new condition.

### Plant Replacement Guidelines

A site's as-built drawings will be referred to when determining the required container size and spacing of the replacement tree, shrub or groundcover. If as-builts are not available, defer to best practices for the determination. Below lists sizing requirements and minimums.

Replacement trees must be equal in size to the originally installed tree at the time it was planted at the site. Example: if the tree was a 36-inch box size when originally planted the replacement shall be a 36-inch box size. Replacement trees will be no less than a 24-inch box size. Before it is installed, the replacement tree needs to be approved for size, health, root development, structure and appearance by the Owner's Representative. Replacement trees are to be double-staked with 2-inch diameter stakes. Once the tree trunks are larger than 2-inch

caliper and the trees are able to support themselves, the stakes are to be removed. The stakes then need to be removed from the site and disposed of by a legal method. If it is possible, recycle the stakes.

Replacement shrubs must be from at least 5-gallon containers and be at least 18 inches in height when planted, unless otherwise approved by an authorized representative. Replacement groundcover, grasses or perennials must be planted at spacing per installation plan from 1-gallon containers. When replacing any plant material, it is important to determine the location of existing irrigation system components such as drip irrigation lines and spray heads as to not damage these components while digging.

### Landscape Succession

As stormwater landscapes mature over time, some plants species may outperform others from the initial installation date or plants simply die out. This is very common as the landscape is never a static system. Changing micro-climate conditions may require that selective removal and replacement of plants be made. Rarely is there a need to perform a complete replacement of plant material unless there is a significant change in the site conditions.

The most common type of plant succession is where tree canopy expands over time and begins to create increasingly shady conditions for understory shrubs, groundcovers, and grass-like plants. This should be treated as a positive aspect of landscape succession as tree canopy over parking lots, streets, and other hardscape conditions should be encouraged. However, understory plants that initially may have been planted in full sun conditions now have to adapt to part-shade to full-shade conditions. Some plant species are just not that adaptable to sun conditions and may need to be replaced. The situation can be reversed as well if a once deep shade condition (next to a tall building or under a large mature tree) changes and suddenly becomes a full-sun condition. Then shade-tolerant understory plants might need to be replaced with more sun tolerant species.



▲ Planted in 2005, this green street planted a series of street trees in full-sun conditions.



▲ Shown in 2016, this same project's tree canopy growth is so robust that it will eventually require new re-planted shade-tolerant understory plants.

# 3.6 Landscape Related Maintenance

## Hand Weeding and Using Herbicides/Pesticides



▲ Without regular weeding maintenance, a stormwater landscape can quickly be overtaken by undesirable plants.



▲ Hand weeding, on a regular basis, is the most desirable method for controlling weeds.



▲ When weeding by hand, try to extract as much root system as possible.

### Hand Weeding

Weeds in planted areas, sidewalks, curbs, gutters or pavement are to be removed as the weeds emerge. Hand weeding is the preferred maintenance approach to controlling weeds over using herbicides. With weeding, a consistent weeding schedule must be maintained, so that weed growth does not reach a point where herbicide use would be required. When pulling weeds, it is critical to remove as much of the root system as possible as new weeds can grow from root remnants left behind in the soil. Dispose of weeds off-site. The regular maintenance of a mulch layer will help minimize weeds in planted areas.

The opposite page sidebar illustrates common landscape plants that readily self-sow and grow invasively in San Mateo County. These are to be removed immediately from all stormwater facilities. Refer to the California Invasive Plant Council (Cal-IPC) for more information on invasive species.

### Hand Weeding Schedule

Weeding shall occur on a weekly basis or during regular site visits. All visible weeds are to be removed.

### Herbicide Use

Herbicide use should be only used as a method of last resort in response to stormwater landscape taken over by weeds. If necessary, only least toxic herbicides may be used. These include:

- Fatty acid potassium salts (herbicidal soaps e.g. Safer's Superfast Weed and Grass Killer® Dr. Bronner's Peppermint Anti-Bacterial Soap)
- Acetic and citric acids (e.g. Nature's Glory Weed and Grass Killer RTU®)
- Clove, citrus, mint and thyme oil (e.g. Matran II®, Xpress®)
- Low-toxic, low-residual herbicide [e.g. glufosinate-ammonium (Finale®), pelargonic acid (Scythe®)]

Herbicide use shall follow all State restrictions and Manufacturer's directions. Do not use herbicides 48 hours before predicted rain events, or use until 48 hours after rain events. Restricted chemical herbicides may not be used under any circumstances.

### Pesticide Use

The term pesticide applies to insecticides, fungicides and other substances used to control pests. Pesticides are potentially hazardous to human and environmental health. The necessary precautions must be taken to ensure the protection of the public, maintenance personnel and the environment.

Bay-Friendly Landscaping emphasizes Integrated Pest Management (IPM) practices to control pests and diseases in the landscape. IPM uses cultural, mechanical, physical and biological control methods before using pesticides. Chemical controls are applied ONLY when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. Pesticides are not to be applied on a prescheduled basis. When pesticides are required, the least toxic and least persistent pesticide that will provide adequate pest control is to be applied. Least-toxic pesticides have a high LD-50, low residual and narrow range of toxicity. Refer to OMRI (Organic Material Review Institute) for a list of pesticides that meet these requirements.

Chemicals should be applied in a safe manner and according to label instructions and local, State and Federal requirements. All chemical applications should be performed by a licensed, trained technician. A Pest Control Operator license is required by the State of California. Additionally, a California Chemical Applicators license is required by maintenance personnel for chemical applications.

### Chemical Use Record-Keeping and Reporting

All herbicide and pest management activities should be documented and reported to the Project Site Owner. Each record should include the following information: target pests/weeds, type and quantity of the chemical used, site of the chemical application, date the chemical was used, name of the chemical applicator, application equipment used, and prevention and other non-chemical methods of control used. The pest/weed management record will be submitted to the Owner after any application of chemicals.

A Chemical Work Report shall be completed for each chemical application. A Chemical Usage Report should be submitted to the County Agricultural Department. Copies are to be sent to the Owner's representative as part of the monthly maintenance report, if applicable.

### Common Invasive Species



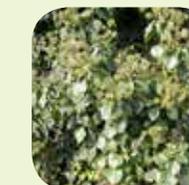
*Cortaderia selloana*  
Pampas Grass



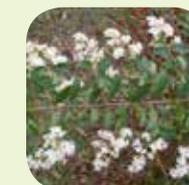
*Cytisus scoparius*  
Scotch Broom



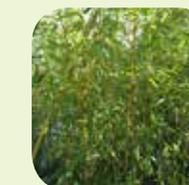
*Genista monspessulana*  
French Broom



*Hedera helix*  
English Ivy



*Ligustrum sinense*  
Privet



*Phyllostachys spp.*  
Bamboo



*Stipa tenuissima*  
Mexican Feathergrass



*Vinca minor*  
Periwinkle

# 3.7 Landscape Related Maintenance

## Using Organic Fertilizers and Soil Amendments



▲ A rain garden with compacted soils cannot maintain long term function.



▲ A landscape with adequate mulch reduces the potential for soil structure damage.



▲ A soil sample taken each year will determine what type of soil conditions exist and recommend any fertilizers.

### General Soil Management

Landscape-based stormwater facilities depend on soils that are biologically active and held together by plant roots. Maintenance activities are to be implemented to nurture biological activity, provide organic material and protect soil from damage. The most common type of soil damage includes over-compaction and soil erosion.

Soil should be protected from compaction by assuring the pedestrian and vehicular traffic be confined to paved areas. Soil shall be protected from erosion by maintaining a vegetative cover over the soil to a possible extent and maintaining a 3-inch layer of mulch, see Section 3.1. Also, use of leaf blowers should be minimized in planting beds to limit the movement of soil and mulch.

### Soil Analysis Determines Fertilizer

A healthy landscape, consistent with Bay-Friendly Landscaping, relies on organic fertilizers and soil amendments from natural sources that release elements slowly, which is preferred. Additional amendments and fertilizers that are approved for use by the Organics Materials Research Institute (OMRI) for use in crop production are approved for use in the landscape.

Soil samples of the landscape need to be submitted annually for testing to an accredited and approved testing laboratory. A minimum of two separate agronomy reports should be prepared for the site and will include soil pH, basic and minor nutrients, salinity, organic content, percolation rate and a textural analysis. Each of the samples should consist of a composite of three shovelfuls of soil. The annual soil reports should be conducted during late winter. The types and quantities of fertilizer and/or soil amendments to be applied should be determined from the results of the soil analysis and shall be based on an 'organic' approach to soil management. Additional soil reports can be requested as required to resolve ongoing soil problems.

An appropriate amount of fertilizer should be applied to supply the specified quantity of nutrient as determined by soil analysis and/or plant tissue analysis. Fertilizer should be applied and maintained to prevent pollution of surface and groundwater and to avoid creating a nitrogen draft in the soil or toxicity to plants.

### Fertilizer Application Schedule

Fertilizers shall be applied on a prescription basis only. Application frequency shall be determined by plant need and assessed through soil and/or tissue analysis. The following maximum annual number of applications are provided as a guideline:

- Trees, shrubs and woody groundcovers: once per year
- Herbaceous ground covers, perennials and grasses: two times per year

Apply granular fertilizer to planting areas in late winter or early spring. Be sure to make application prior to a moderate rainfall so the rain will wash the fertilizer in.

### Soil Amendment Use

Soil should be amended based on the pH and soil chemistry recommendations of the soils report. When required, apply amendments to the existing soil and gently work into the top 2 inches of soil, avoiding disturbing the roots of existing plants. Once amendment is complete, reapply the specified mulch layer.

### Common Organic Soil Conditioners, Amendments and Fertilizers

**Sphagnum Peat Moss:** absorbs water, slowly releasing it for use by plant roots. It lightens clay soil, providing aeration, and adds mass to sandy soil, helping prevent the leaching of nutrients.

**Compost:** Made from decayed organic materials such as straw, corn cobs, food wastes, poultry litter, grass clippings, leaves, and manure. Composts improve soil structure and slowly release nutrients to plant roots.

**Lime:** Added to raise soil pH, reducing acidity.

**Sulfur:** Added to lower soil pH, increasing acidity.

**Organic Granular Fertilizer:** Application rates per soil report recommendations.

### What Do the Three Numbers on Fertilizer Labels Mean?

The three numbers on fertilizer labels represents the value of the three primary nutrients used by plants. These macro-nutrients are nitrogen (N), phosphorus (P) and potassium (K) or NPK for short.

All plants need nitrogen, phosphorus and potassium to grow. The following is a brief description of what each of these macro-nutrients do to help plants thrive:

**Nitrogen (N)** – nitrogen is largely responsible for the growth of leaves on the plant.

**Phosphorus (P)** – Phosphorus is largely responsible for root growth and flower development.

**Potassium (K)** – Potassium is a nutrient that helps the overall functions of the plant perform correctly.

For each fertilizer, whether organic or chemical-based, the NPK values are shown as a ratio. Knowing the NPK values of a fertilizer can help you select one that is appropriate for your plant growth needs.

There are many different types of NPK values for fertilizers. The higher the number, the more concentrated the nutrient is in the fertilizer. For example, numbers on fertilizer listed as 20-5-5 has four times more nitrogen in it than phosphorus and potassium. A 20-20-20 fertilizer has twice as much concentration of all three nutrients than 10-10-10. The fertilizer numbers can be used to calculate how much of a fertilizer needs to be applied to equal 1 pound of the nutrient you are trying to add to the soil. Conducting a soil test will help determine what balance of fertilizer numbers will be appropriate for the landscape's needs and deficiencies. (from [www.gardeningknowhow.com](http://www.gardeningknowhow.com))

# 3.8 Landscape Related Maintenance

## Maintaining Visual Safety and Aesthetics



▲ Choose low-growing plant material and place trees outside of the site distance triangle.



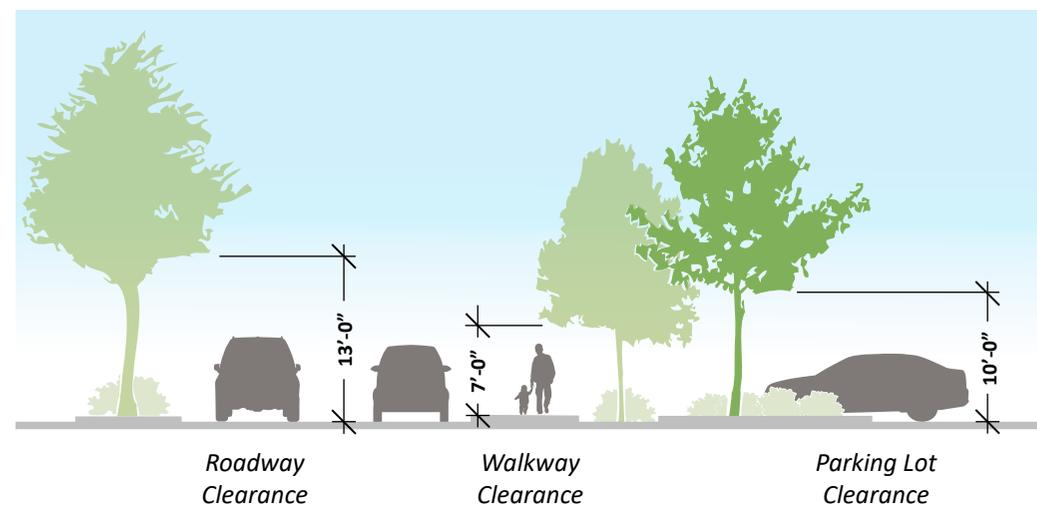
▲ This green street allows for street trees to be limbed up to provide adequate height clearance for pedestrians.



▲ The plant species in this parking lot swale have been intentionally chosen to as low-growing species that help increase site visibility.

### Visibility Throughout Site

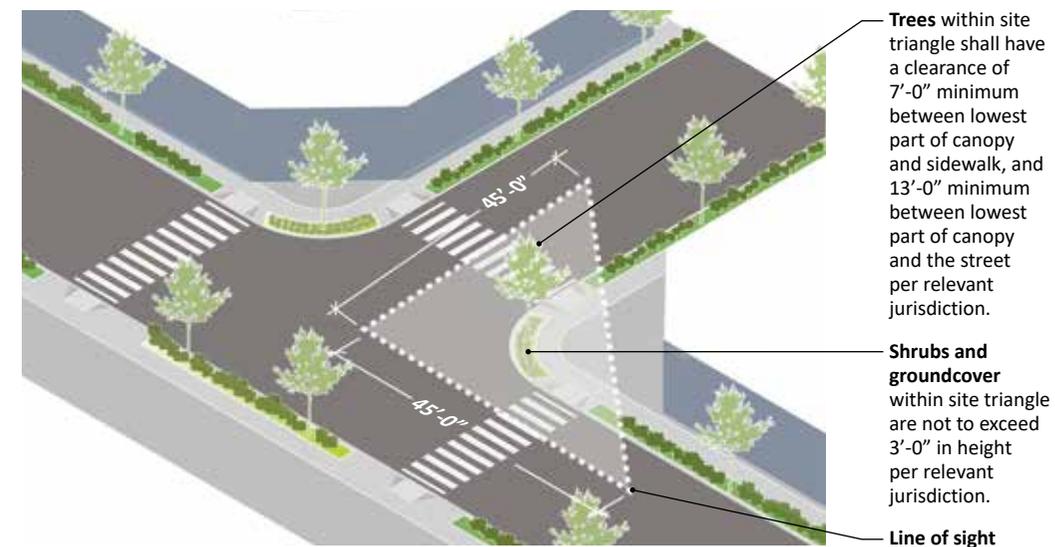
Safety in a landscape is dependent on visibility throughout a site, whether spaces be observable from the street or public areas. As a rule, there should be a window of visibility between 3 and 7 feet above the ground plane. This requires shrubs, grasses and groundcovers to be kept to a height of 3 feet. The best way to achieve this, without having to rely on pruning, is to select smaller plant species and cultivars that have a maximum height less than or equal to 3 feet. Trees need to be pruned so that their lowest branches are at a height greater than or equal to 7 feet. Where height restrictions allow, plants should be maintained in their natural habit. Do not hedge, box or button plants. Refer to sections 3.3 and 3.4 on shrub and tree trimming, respectively.



### Site Triangles

Visibility needs to be maintained at street intersections to maintain pedestrian and vehicular sight lines. This area, to be kept clear of obstructions and visual impediments, is called a sight triangle. Consult Appendix A, Intersection Site Distance Evaluation Procedures, of the City of San Mateo document titled, "City of San Mateo Curb Marking Policy and Procedures," for more information on sight triangles. This document describes the clearance size of a sight triangle,

dependent on the speed and location of vehicles relative to the intersection. Planting within the determined sight triangle must be lower than three feet or limbed to a height greater than 7 feet.



### Aesthetics

Proper maintenance practices help secure beautiful landscape aesthetics. For instance, an ample layer of mulch creates visual uniformity and neatness in the landscape. A functioning irrigation system operates undetected; drip tubing is buried, irrigation water is contained within the landscape and plants thrive. The selective and the correct trimming of shrubs and grasses strengthens health and maintains the natural form of the plant. Similarly, a tree that has been pruned to maintain strong structure is aesthetically pleasing. Inadequate plant coverage within a stormwater facility compromises not only functionality but also compromises aesthetics. Where bare spots are conspicuous, an abundantly planted landscape appears lush. Rampant weeds detract from the landscape but consistent weeding maintains tidiness. Lastly, healthy soil secures plant health and, when required, the application of fertilizer helps plants flourish.



▲ Keeping plant material below 3 feet high at intersections provides a safe visibility triangle.



▲ The selective trimming of plants, allowing them to grow naturally, complements the natural form of the plant.



▲ A landscape maintained with proper plant coverage appears lush.



# Chapter 4

## Maintenance Activity Schedules & Checklists

- 4.1 *Maintenance Quality Observation Levels*
- 4.2 *Landscape and Hardscape Maintenance Checklist*
- 4.3 *Annual/Monthly Maintenance Schedule*

# 4.1 Maintenance Activity Schedules & Checklists

## Maintenance Quality Observation Levels

### MULCH APPLICATION

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

**Condition:** A 3-inch layer of mulch is maintained and kept at proper distances from shrub and tree plantings.

**Continued Actions:** Monthly observation for adequate mulch coverage. Monthly mulch addition, as necessary.

Mediocre, Modify Maintenance Routine



QUADRIGA INC.

**Condition:** The mulch layer is depleted. Mulch has been knocked or washed out of the landscape.

**Immediate Actions:** Add or redistribute bark mulch where it has been reduced to less than 3 inches deep. Place mulch that has been knocked or washed out of planters back into place.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Mulch layer is absent.

**Immediate Actions:** Add a 3-inch layer of mulch. If mulch was once present, determine if a new type of mulch is needed to ensure longevity.

### HAND WEEDING

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Little to no weeds visible within the planting area, sidewalks, gutters and pavement.

**Continued Action:** Monthly hand weeding, as necessary.

Mediocre, Modify Maintenance Routine



PHILADELPHIA WATER DEPARTMENT (FLICKR)

**Condition:** Several weeds can be found throughout the site.

**Immediate Actions:** Remove all visible weeds located in planted areas, sidewalks, gutters and pavement. Remove as much of the root system as possible. Dispose of weeds off-site.

Poor, Overhaul Maintenance Routine



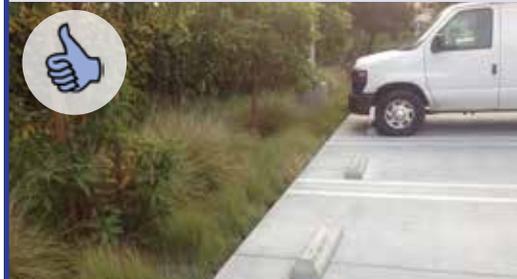
URBAN RAIN DESIGN

**Condition:** Landscape is overrun with weeds.

**Immediate Actions:** Remove all visible weeds by hand, if possible. Herbicides should be used only as a last resort. Use only the least toxic herbicides. Develop a plan with the Owner before use.

### PLANT COVERAGE

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Landscape achieves 100% plant coverage.

**Continued Action:** Monthly observation for proper coverage. Twice yearly plant addition in April and October, as necessary.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Landscape has about 70% plant coverage, achieving the minimum requirement for functionality.

**Immediate Actions:** If, by visual assessment, the planter is determined to have inadequate plant coverage, schedule the installation of additional plants. Refer to as-built drawings for plant species and size.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Landscape has less than 70% plant coverage.

**Immediate Actions:** Schedule the installation of additional plants. Refer to as-built drawings for plant species and size. Replace ill-adapted plants with a species better adapted to permanently altered environmental conditions.

### PLANT HEALTH

Good, Continue Maintenance Routine



AARON VOLKENING (FLICKR)

**Condition:** All plants are healthy, disease-free and suited to the environmental conditions.

**Continued Action:** Monthly site inspection for any plants that are dead, damaged, diseased, stressed or missing.

Mediocre, Modify Maintenance Routine



CHRIS HAMBY (FLICKR)

**Condition:** Few plants show signs of struggle, disease, pest-infestation or are broken.

**Immediate Action:** Analyze struggling plants for cause of struggle and correct. Remove struggling plants unlikely to recover or plants likely to infect surrounding plants. Replace with a healthy plant.

Poor, Overhaul Maintenance Routine



CHRIS HAMBY (FLICKR)

**Condition:** Plants are unhealthy, damaged, missing or dead.

**Immediate Action:** Analyze struggling plants for cause of struggle and correct, if possible. Remove struggling plants unlikely to recover or plants likely to infect surrounding plants. Replace with a healthy plant.

# 4.1 Maintenance Activity Schedules & Checklists

## Maintenance Quality Observation Levels

### OVERALL TREE HEALTH

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Trees of all ages are healthy. Branches are strong and are pruned as necessary to reduce weight.

**Continued Actions:** Monthly removal of unhealthy branches and suckers, as necessary. Branch reduction once yearly in early June, as necessary.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Trees show signs of struggle, trunk damage, weak branches or have suckers growing from trunk.

**Immediate Actions:** Analyze trees for cause of struggle and correct. Remove dead, damaged or diseased branches of trees. Adjust tree grates. Remove suckers.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Trees are unhealthy, damaged, missing or dead.

**Immediate Actions:** Analyze trees for cause of struggle and correct. Remove trees unlikely to recover. Replace removed or missing trees with a healthy tree.

### VISUAL SAFETY & PUBLIC SAFETY

Good, Continue Maintenance Routine



MONTGOMERY CO. PLANNING COMM. (FLICKR)

**Condition:** Visibility is maintained throughout the site including proper clearances and site triangles.

**Continued Actions:** Monthly observation of site visibility. Monthly removal of vegetation that interferes with public safety, as necessary.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Plant material partially obstructs visibility. Safety is compromised.

**Immediate Action:** Trim any tree branches or shrubs that interfere with public safety, including visibility clearances.

Poor, Overhaul Maintenance Routine



ALAN STANTON (FLICKR)

**Condition:** Overgrowth results in poor visibility. The site is perceived as unsafe.

**Immediate Action:** Trim any tree branches or shrubs that interfere with public safety, including visibility clearances.

### STRUCTURAL TREE PRUNING

Good, Continue Maintenance Routine



CHRIS HAMBY (FLICKR)

**Condition:** Young trees are structurally pruned annually. Branch structure is strong.

**Continued Action:** Annual pruning of trees up to 5 years old; Prune spring- and winter-flowering shrubs and trees in June; Prune summer- and fall-flowering shrubs and trees in December.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Young trees aren't pruned annually. Branch structure is impacted.

**Scheduled Action:** Instate annual pruning for the remaining years of young tree development.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Young trees are never structurally pruned. Branch structure is poor and cannot be sustained.

**Immediate Action:** Determine if branch structure can be corrected without compromising tree health. If not, monitor branches for weaknesses necessitating removal and replacement of tree.

### TRIMMING GRASSES AND GRASS-LIKE PLANTS

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Plants appear natural in appearance and are lightly trimmed to maintain at least 12 inches of height.

**Continued Action:** Seasonal trimming, as necessary.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Plants are overly or improperly trimmed.

**Immediate Action:** Stop trimming procedure to allow for plants to regenerate leaves, and evaluate future trimming procedures.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

**Condition:** Plants are excessively and improperly pruned.

**Immediate Action:** If improper trimming has resulted in severely compromised plant structure or plant death, replace plants and evaluate future trimming procedures.

# 4.1 Maintenance Activity Schedules & Checklists

## Maintenance Quality Observation Levels

### TRIMMING FOR PEDESTRIAN CIRCULATION

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Plants are in scale with their surroundings and do not impede pedestrian circulation.

*Continued Action:* Monthly pruning, as necessary.

Mediocre, Modify Maintenance Routine

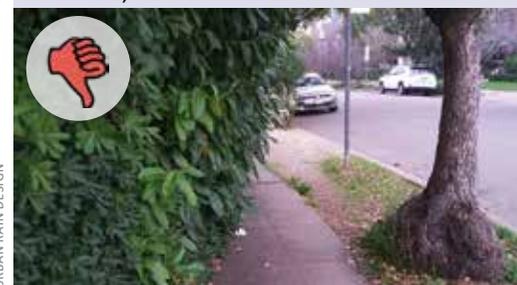


URBAN RAIN DESIGN

*Condition:* Slight overgrowth overlaps walkway edges.

*Immediate Action:* Trim shrub branches and groundcovers back from all sidewalks, curbs and paved areas. Cut the edges of groundcovers at an angle for a more natural appearance and healthier plants.

Poor, Overhaul Maintenance Routine



SEECLICKFIX.COM

*Condition:* Pervasive overgrowth crowds landscape area and pedestrian walks.

*Immediate Action:* Trim shrub branches and groundcovers back from all sidewalks, curbs and paved areas. Cut the edges of groundcovers at an angle for a more natural appearance and healthier plants.

### IRRIGATION SCHEDULING

Good, Continue Maintenance Routine



CENTER FOR NEIGHBORHOOD TECH. (FLICKR)

*Condition:* Irrigation schedule matches the seasonal water needs of planting.

*Continued Action:* Quarterly adjustment of irrigation controller for current water needs of plants. Correct both frequency and duration of irrigation run times.

Mediocre, Modify Maintenance Routine



MIKE BOUCHER (FLICKR)

*Condition:* Mismatched irrigation schedule. Plants begin to show signs of struggle.

*Immediate Action:* Adjust irrigation controller for current water needs of plants. Correct both frequency and duration of irrigation run times.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Irrigation schedule severely mismatched to current watering needs. Plants are dying or dead.

*Immediate Action:* Adjust irrigation controller for current water needs of plants. Correct both frequency and duration of irrigation run times. Replace dying or dead plants.

### IRRIGATION COMPONENTS CONDITION

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* All irrigation system components are in working order and adequately protected.

*Continued Action:* Monthly check for condition of irrigation components.

Mediocre, Modify Maintenance Routine

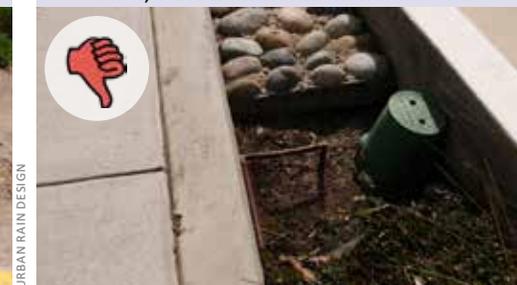


URBAN RAIN DESIGN

*Condition:* Irrigation lines/valves are exposed and prone to damage and/or vandalism.

*Immediate Action:* Correct/repair any minor breaks in irrigation components.

Poor, Overhaul Maintenance Routine



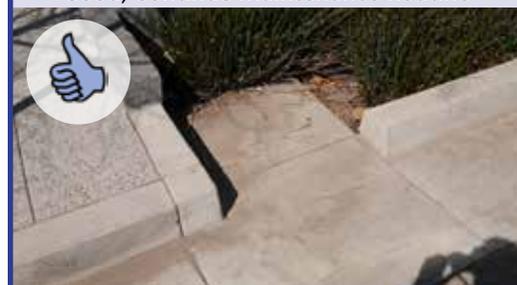
URBAN RAIN DESIGN

*Condition:* Irrigation system components are damaged/compromised due to exposure and damage.

*Immediate Action:* Replace irrigation components for proper irrigation function.

### SEDIMENT LOAD MANAGEMENT AT CURB CUTS

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Sediment is removed from curb cut area on a regular basis.

*Continued Action:* Maintain current sediment removal maintenance program.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Sediment build up is occurring but not yet impacting the flow of water entering the landscape.

*Immediate Action:* Remove sediment build up. Determine source of sediment load and take corrective action and/or modify maintenance program.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Sediment build up is severe enough to impede flow and inhibit landscape infiltration.

*Immediate Action:* Remove sediment build up. Determine source of sediment load and take corrective action and/or modify maintenance program. May need to also replace plant material and mulch/soil layers.

# 4.1 Maintenance Activity Schedules & Checklists

## Maintenance Quality Observation Levels

### TRASH REMOVAL

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Landscape is free of any large or small trash.

*Continued Action:* Continue monthly trash removal maintenance program.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Landscape has some trash captured, but it is of minimal size and quantity.

*Immediate Action:* Remove all trash. Modify maintenance schedule.

Poor, Overhaul Maintenance Routine



ALAN STANTON (FLICKR)

*Condition:* Landscape contains considerable amount of trash to impact aesthetics and public health.

*Immediate Action:* Remove all trash. Modify maintenance schedule. Locate source of trash production and take corrective actions.

### CURB CUT EROSION CONTROL

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Curb cuts are properly graded and armored for erosion control.

*Continued Action:* Curb cuts are maintained to control soil/mulch erosion.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Curb cuts have some erosion control measures, but are still prone to erosion.

*Immediate Action:* Modify curb cut construction with additional hardscape to control erosion.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Little or no provisions for erosion control at curb cut entries.

*Immediate Action:* Repair or replace curb cuts to control soil/mulch erosion.

### PERVIOUS PAVING SWEEPING

Good, Continue Maintenance Routine



CENTER FOR NEIGHBORHOOD TECH. (FLICKR)

*Condition:* Pervious paving joints are free of debris and sediment.

*Continued Action:* Maintain current pervious paving sweeping schedule.

Mediocre, Modify Maintenance Routine



MIKE BOUCHER (FLICKR)

*Condition:* Some pervious paving joints are beginning to fill with sediment and debris slowing infiltration.

*Immediate Action:* Remove areas of sedimentation. Adjust frequency of sweeping schedule.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Excessive build-up of sediment inhibits infiltration between pervious paver joints.

*Immediate Action:* Remove areas of sedimentation. May require interlocking pavers to be removed, cleaning the joints, and re-applied. Adjust frequency of sweeping schedule.

### SPLASH PADS FOR EROSION CONTROL

Good, Continue Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Splash pad at water flow point is adequately controlling erosion.

*Continued Action:* Splash pads adequately control erosions at water flow points.

Mediocre, Modify Maintenance Routine



URBAN RAIN DESIGN

*Condition:* Water flow point only uses piled rock as a splash point. Some signs of erosion/rock movement.

*Immediate Action:* Modify water flow points with additional hardscape/splash pad to control erosion.

Poor, Overhaul Maintenance Routine



URBAN RAIN DESIGN

*Condition:* No splash pad is present causing severe erosion at water flow point.

*Immediate Action:* Repair or replace water flow points with a splash pad to control soil/mulch erosion.

# 4.2 Maintenance Activity Schedules & Checklists

## Annual Landscape and Hardscape Maintenance Checklist

### Ongoing Processes

1. Maintain monthly documentation of irrigation checks and as-built plans of any changes or adjustments to the system.
2. If pesticides, herbicides, etc. are used, submit a pest management record as part of a monthly maintenance report.



### Observation

- Observe site for the following conditions and adjust as necessary:
  - ▶ Monitor mulch levels.
  - ▶ Check for proper irrigation coverage. Signs of improper coverage include standing water, irrigation run-off and dry spots within the landscape.
  - ▶ Check irrigation system for function and leaks. Report any evidence of damage or malfunction to the Owner.
  - ▶ Observe plant material for signs of stress, indicating excessive or insufficient watering.
  - ▶ Inspect site for any plants that are dead, damaged, diseased, stressed or missing. Remove dead and diseased plants.
  - ▶ Inspect site for proper plant coverage. If, by visual assessment, the planter is determined to have inadequate plant coverage, schedule the installation of additional plants.
  - ▶ Inspect site for any signs of disease or pest infestation where non-chemical treatments have failed. Develop a treatment plan with the Owner.
  - ▶ Inspect site for poor visibility, obstructed views and hiding spaces. Prune to maintain safety where necessary.
  - ▶ Inspect site for excessive sediment/trash build up, erosion issues, clogging of pervious paving, and issues with water retention levels.



### Mulch Layer Maintenance

- Add or redistribute bark mulch within planting areas where the mulch has been reduced to less than 3 inches deep. Place mulch that has been knocked or washed out of planters back and smooth into place.



### Trimming & Weeding

- Remove dead, broken, damaged or diseased branches of trees and shrubs.
- Remove suckers growing from the base of trees.
- Trim shrub branches and groundcovers back from all sidewalks, curbs and paved areas. Cut the edges of groundcovers at an angle for a more natural appearance and healthier plants.
- Trim any tree branches that interfere with public safety, including visibility clearances.
- Remove all visible weeds located in planted areas, sidewalks, gutters and pavement. Remove as much of the root system as possible. Dispose of weeds off-site.



### Fertilization

- Obtain a minimum of two separate agronomy reports.
- Apply granular fertilizers to planting areas, if required, per Agronomy Report to trees, shrubs, perennials and grasses. Be sure to make application prior to a moderate rainfall so the rain will wash the fertilizer in.



### Irrigation

- Adjust irrigation controller for current water needs of plants. Correct both frequency and duration of irrigation run times.
- Conduct a comprehensive irrigation system test by performing the following tasks:
  - ▶ Check irrigation system pressure.
  - ▶ Ensure all flush valve/cap locations are visible.
  - ▶ Ensure valve boxes are visible and can be opened.
  - ▶ Clean valve boxes of dirt and debris.
  - ▶ Inspect valves, filters and pressure regulators for damage or leaks. Check wire splices.
  - ▶ Flush out the irrigation system and check for proper operation of each valve zone. Flush laterals.
  - ▶ Inspect and clean filters. A hose can be attached to the flush cap to keep water out of the valve box. Replace damaged or torn filters.
  - ▶ Clean or replace plugged sprinkler nozzles.
  - ▶ Make sure plants have adequate numbers of drip emitters for their size, if applicable.
  - ▶ Replace batteries to irrigation controller and sensor, as applicable.
  - ▶ Test soil sensors per manufacturer's instructions.



### Structural Pruning

- Prune shrubs as needed to maintain their proper shape. Prune young trees for up to five years after planting to develop a strong branch structure.
- Reduce weight on heavy branches to pre-empt branch weakening. No more than 20% of live foliage should be removed or else cause unnecessary stress to a tree.



### Plant Replacement & Addition

- Refer to as-built drawings to determine the species and size of plants to be installed. If drawings are not available, match additional plants to the species present within the planter area. Add or replace plants under the following circumstances:
  - ▶ Replace any dead or missing plants.
  - ▶ If the site is determined to lack proper plant coverage, add plants until a minimum coverage of 70% is achieved.
  - ▶ Replace ill-adapted plants with a species better adapted to a permanently altered environmental condition.

### Sediment & Trash Removal

- Remove sediment/trash from curb cuts and landscape areas on a monthly basis:
  - ▶ For streets, work with adjacent property owners to sweep the gutter line to help reduce the burden of sediment flowing into street facilities.
  - ▶ Observe areas prone to clogging due to sediment loading and suggest adding forebays, etc. to help ease the removal of sediment.

### Hardscape Maintenance

- Check hardscape areas such as curb cuts, weirs/checkdams, inlets for proper function and grading during the rainy season.
  - ▶ Replace/adjust hardscape features as needed.
- Clean pervious paving on at least an annual basis.
- Perform a pervious paving infiltration test on an annual basis.

# 4.3 Maintenance Activity Schedules & Checklists

## Monthly Landscape and Hardscape Maintenance Frequencies

Maintenance Task	Frequency Description
 Observation	Monthly
 Mulch Layer Maintenance	Monthly, as necessary
 Trimming & Weeding	Monthly, as necessary
 Fertilization: Obtain agronomy reports	Once yearly in early February
 Fertilization: Apply fertilizer, if required	Once yearly in late February, if required
 Irrigation: Adjust irrigation controller for seasonal water needs	Quarterly
 Irrigation: Conduct a comprehensive irrigation system test	Once yearly in early April
 Structural Pruning: Prune shrubs to maintain shape and trees to develop branch structures	Prune spring- and winter-flowering shrubs and trees in June; Prune summer- and fall-flowering shrubs and trees in December
 Structural Pruning: Reduce branch weight	Once yearly in early June, as necessary
 Plant Replacement & Addition	Twice yearly in April and October, as necessary

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Observation	<input type="checkbox"/>											
Mulch Layer Maintenance	<input type="checkbox"/>											
Trimming & Weeding	<input type="checkbox"/>											
Fertilization: Obtain agronomy reports		<input type="checkbox"/>										
Fertilization: Apply fertilizer, if required		<input type="checkbox"/>										
Irrigation: Adjust irrigation controller for seasonal water needs			<input type="checkbox"/>									
Irrigation: Conduct a comprehensive irrigation system test				<input type="checkbox"/>								
Structural Pruning: Prune shrubs to maintain shape and trees to develop branch structures						<input type="checkbox"/>						<input type="checkbox"/>
Structural Pruning: Reduce branch weight						<input type="checkbox"/>						
Plant Replacement & Addition				<input type="checkbox"/>						<input type="checkbox"/>		



# Chapter 5

## Design Changes to Ease Maintenance

- 5.1 *Getting the Water in and Ease of Sediment Removal*
- 5.2 *Top Plant Recommendations for Performance and Maintenance*
- 5.3 *Effective Site Grading and Mulch Placement*
- 5.4 *Optimum Placement of Stormwater Facilities to Ease Maintenance*
- 5.5 *Adjustable Overflow/Check Dams Design for Water Retention*

◀ *This rain garden at The Cove at Oyster Point collects stormwater from both building and parking lot surfaces.*  
Photo Credit: Urban Rain|Design

# 5.1 Design Changes to Ease Maintenance

## Getting the Water in and Ease of Sediment Removal



▲ Cobble placed at a curb cut entry does not allow for good erosion control or ease of water flow.



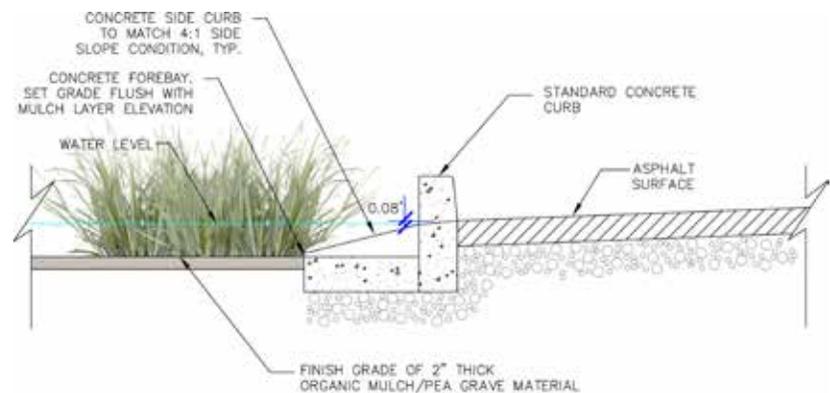
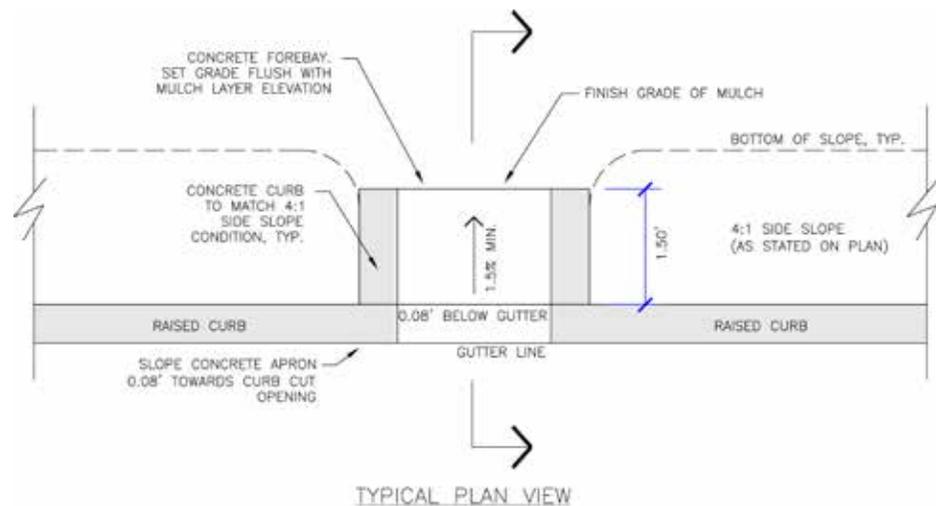
▲ This rain garden's curb cut is structured correctly and provides adequate drainage into the landscape.



▲ Tapered concrete side walls conform to curb cuts with 45-degree chamfered edges.

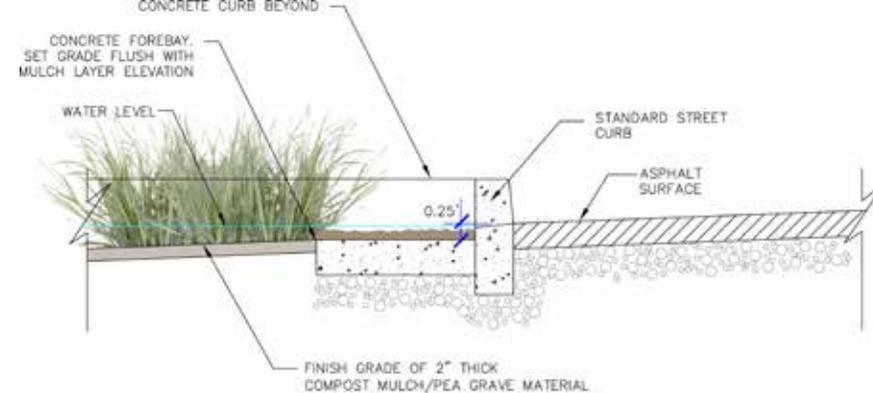
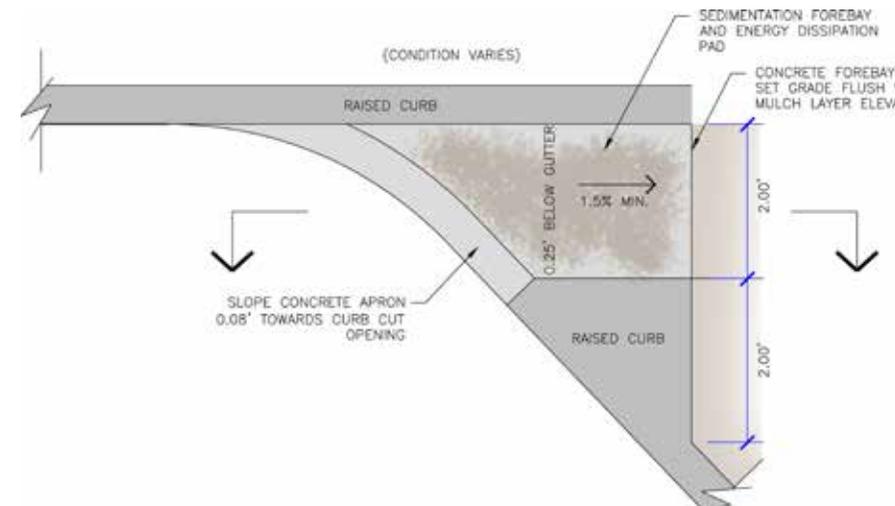
### Typical Curb Cut Design with Side Slopes

Where a vegetated stormwater systems have curb cuts along a side slope condition, it is best to retain the side slope grade on both sides of the curb cut to prevent erosion and more efficiently direct runoff from the curb cut into the landscape area. It is also important for the curb cut to allow for a small recessed concrete pad for easy sediment removal. See detail sketches below.



### Typical Stormwater Curb Extension Curb Cut

Since stormwater curb extensions primarily receive stormwater runoff from a single-entry curb cut, it is important to have a well thought out grading design to allow water to flow into the landscape and at the same time provide a dedicated forebay to capture sediment and small trash. See detail sketches below.



▲ This stormwater curb extension has no concrete forebay. Sediment builds up and blocks runoff from entering.



▲ This stormwater curb extension has a concrete forebay that captures sediment that is removed regularly.



▲ While this is a good concrete pad, the elevation needs to be lowered at least 2 inches to allow for sediment capture.

# 5.2 Design Changes to Ease Maintenance

## Top Plant Recommendations for Performance and Maintenance

### Top Plant Recommendations for Easier Maintenance and Better Performance

The following list of plants is divided in three categories: trees, plants suited for growth on the side slopes of stormwater facilities, and plants that withstand inundation at the basin of the facility. This list includes key plants that are observed to be some of the best candidates for planting within stormwater facilities. This is only a small listing of possible plant choices. A more extensive plant list exists within Appendix A of *C.3 Stormwater Technical Guidance*, a document produced as part of the San Mateo Countywide Water Pollution Prevention Program. The document can be found at [www.flowstobay.org](http://www.flowstobay.org).

Scientific Name Common Name	Light Preference	Water Requirement	Size ↑ Height ↔ Width	CA Native	Notes
1 <b><i>Acer rubrum</i></b> Red Maple	☉ ☉ Sun to Partial Shade	💧 Medium	↑ 50' ↔ 40'	No	Good performer within the basin of stormwater facilities.
2 <b><i>Ginkgo biloba</i></b> Maidenhair Tree	☉ Full Sun	💧 Medium	↑ 60' ↔ 35'	No	Long-lived, can perform well with poor soils and wet conditions.
3 <b><i>Lagerstroemia indica</i></b> Crape Myrtle	☉ Full Sun	💧 Low	↑ 6-25' ↔ 6-20'	No	Good small tree that can perform in both dry and wet conditions.
4 <b><i>Nyssa sylvatica</i></b> Black Tupelo	☉ ☉ Sun to Partial Shade	💧 Medium	↑ 40' ↔ 25'	No	Can perform well within wet and dry conditions.
5 <b><i>Platanus acerifolia 'Columbia'</i></b> London Plane Tree	☉ Full Sun	💧 Medium	↑ >50' ↔ 35'	No	Long-lived, can perform well with poor soils and wet conditions.
6 <b><i>Quercus spp.</i></b> Oak	☉ Full Sun	Varies	Varies	Varies	When planted young, can perform well with wet and dry conditions.

7 <b><i>Bulbine frutescens</i></b> Stalked Bulbine	☉ ☉ Sun to Partial Shade	💧 Low	↑ 1'-2' ↔ 1'-2'	No	Very drought-tolerant, no trimming needed.
8 <b><i>Mimulus aurantiacus</i></b> Sticky Monkey Flower	☉ ☉ Sun to Partial Shade	💧 Low	↑ 3' ↔ 3'	Yes	Very drought-tolerant, no trimming needed.
9 <b><i>Muhlenbergia rigens</i></b> Deer Grass	☉ ☉ Sun to Partial Shade	💧 Low	↑ 4'-5' ↔ 4'-6'	Yes	Very drought-tolerant, light trimming once annually.
10 <b><i>Salvia chamaedryoides</i></b> Germander Sage	☉ Full Sun	💧 Low	↑ 1'-2' ↔ 3'-4'	No	Very drought-tolerant, no trimming needed.
11 <b><i>Teucrium chamaedrys</i></b> Wall Germander	☉ Full Sun	💧 Low	↑ 1'-2' ↔ 2'-3'	No	Very drought-tolerant, no trimming needed.

Scientific Name Common Name	Light Preference	Water Requirement	Size ↑ Height ↔ Width	CA Native	Notes
12 <b><i>Carex divulsa</i></b> Berkeley Sedge	☉ ☉ Sun to Partial Shade	💧 Low	↑ 1'-2' ↔ 1'-2'	Yes	Good sedge for shade. Hand brush out leaves annually.
13 <b><i>Carex flacca</i></b> Blue Sedge	☉ ☉ Sun to Partial Shade	💧 Medium	↑ 6"-1' ↔ 1'-1.5'	No	Good sedge for sun/part shade. Light trimming once annually.
14 <b><i>Chondropetalum tectorum</i></b> Small Cape Rush	☉ ☉ Sun to Partial Shade	💧 Low	↑ 2'-3' ↔ 2'-3'	No	Good sedge for sun/part shade. No trimming needed.
15 <b><i>Juncus inflexus 'Blue Dart'</i></b> Blue Dart Rush	☉ Full Sun	💧 Medium	↑ 1'-2' ↔ 1'-2'	No	Good sedge for full sun. No trimming needed.
16 <b><i>Juncus patens 'Elk Blue'</i></b> Elk Blue California Gray Rush	☉ Full Sun	💧 Low	↑ 1'-2' ↔ 1'-2'	Yes	Good sedge for full sun. Light trimming once annually.
17 <b><i>Lomandra longifolia</i></b> Dwarf Mat Rush	☉ ☉ Sun to Partial Shade	💧 Low	↑ 3'-0" ↔ 3'-0"	No	Good sedge for sun/part shade. Hand brush out leaves annually.

BASIN PLANTS



TREES



SIDE SLOPE PLANTS



BASIN PLANTS

# 5.3 Design Changes to Ease Maintenance

## Effective Site Grading and Mulch Placement



▲ This newly installed green infrastructure facility will have consistent problems with erosion control and plant health issues because of steep grading and side slope conditions.

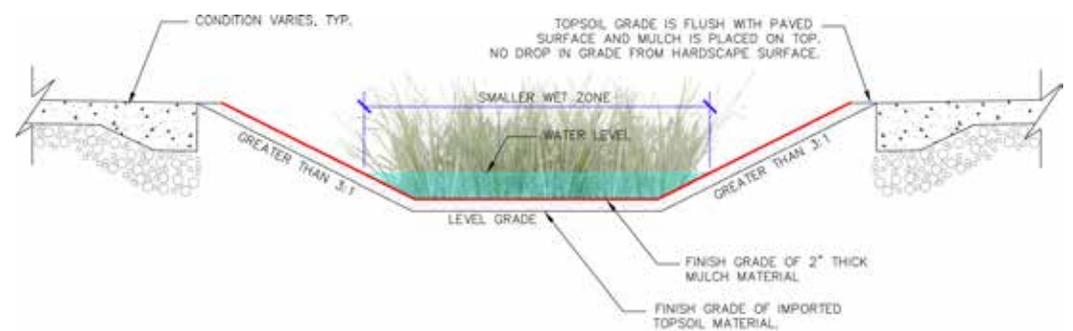


▲ This rain garden is graded very shallow to allow ponding of water, but it is not excessively deep or have steep side slopes. Ultimately this rain garden will perform better over time and will be easier to maintain.

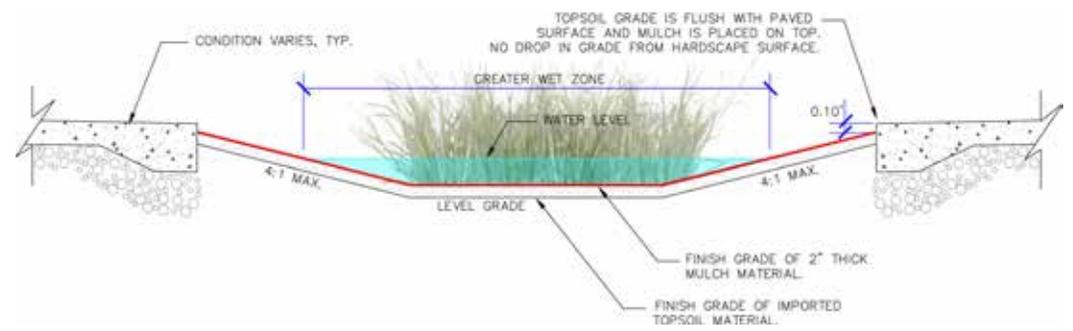
### Effective Site Grading

Many stormwater facilities built in San Mateo County are designed to be too deep and with very steep side slopes. These types of conditions have permanent operation and maintenance consequences including erosion issues, plant desiccation, and difficulty to physically access plant material. For future projects, it is best to design facilities with gradual side slopes and shallow depth facilities to help limit erosion, better mimic natural landscape conditions, and promote more flat space for water contact. See below for grading comparisons.

#### Undesirable Grading Scenario: Steep Slopes/Deep Facility



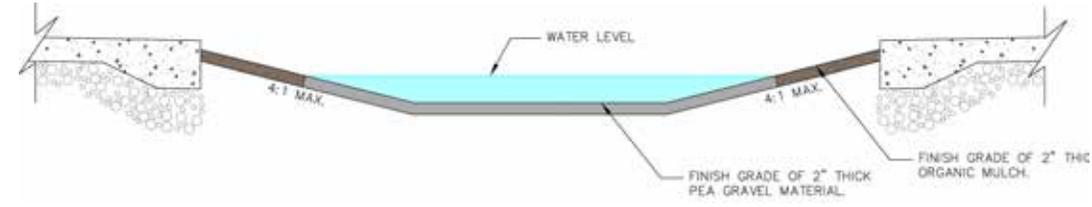
#### Optimum Grading Scenario: Gentle Slopes/Shallow Facility



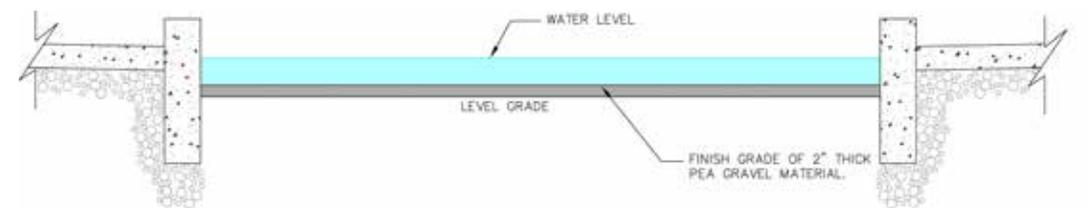
### Proper Mulch Placement

Mulching plant material is a critical maintenance activity that helps keep plants and soil healthy. Care needs to be taken to both the choice of mulch material and placement of the mulch. Organic mulch is best placed in areas that do not have contact with ponding or moving water to limit mulch movement. Pea gravel or small rock is a better choice where water is ponding or being conveyed through the landscape. See below for different conditions based on facilities having side slopes, no side slopes, or a hybrid facility.

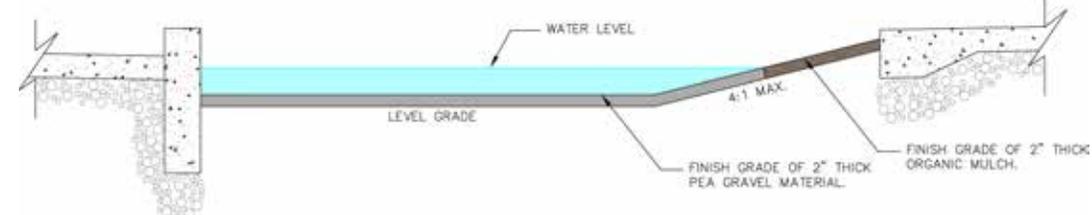
#### Mulch Placement with Side Slope Condition



#### Mulch Placement with Planter Level-Grade Condition



#### Mulch Placement with Hybrid Condition



▲ The basin portion of this rain garden is mulched with pea gravel and the side slopes are covered with organic mulch.



▲ This flat planter-style landscape is completely mulched with small rock to control erosion with water flow.



▲ This stormwater curb extension has a hybrid of both rock at the flow line and organic mulch along the side slopes.

# 5.4 Design Changes to Ease Maintenance

## Effective Placement of Pervious Paving



▲ Stormwater runoff and sediment from impervious area is flowing onto and constantly clogging the joint spaces of concrete interlocking pervious pavers.

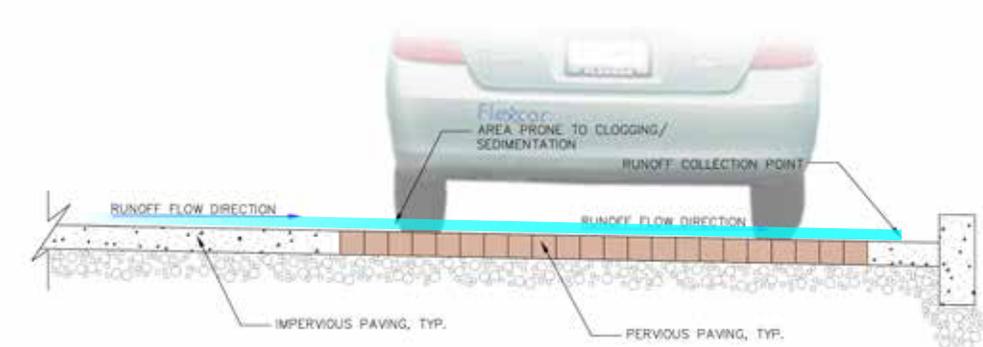


▲ This application of pervious pavers only has direct rainfall to manage. There is no impervious area runoff directed to it.

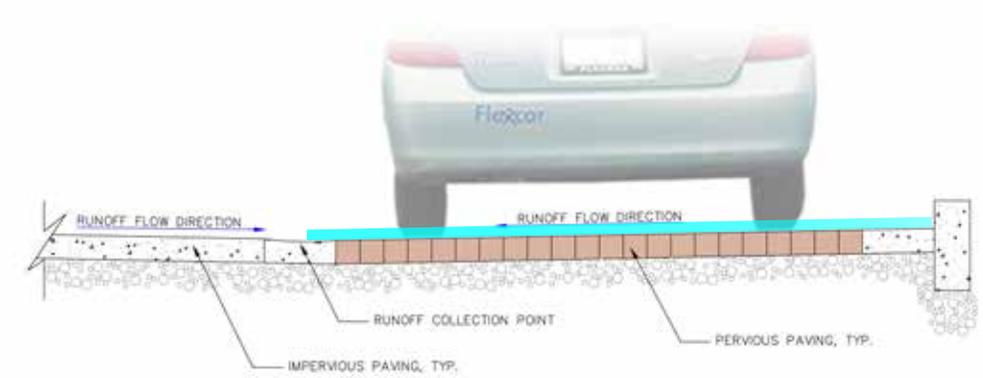
### Effective Placement of Pervious Paving

Pervious paving works the best and is easiest to maintain if it only receives direct rainfall on it rather than run-on from adjacent impervious area. When impervious area runs onto pervious paving it carries sediment loads that clog the pores of the paving or the joints between the pavers depending on the type of pervious paving. If pervious paving is used, try to direct runoff away from the pervious surfaces to help reduce sediment transport. See sketches below.

### Undesirable Pervious Paving Placement: Impervious Area Run-on



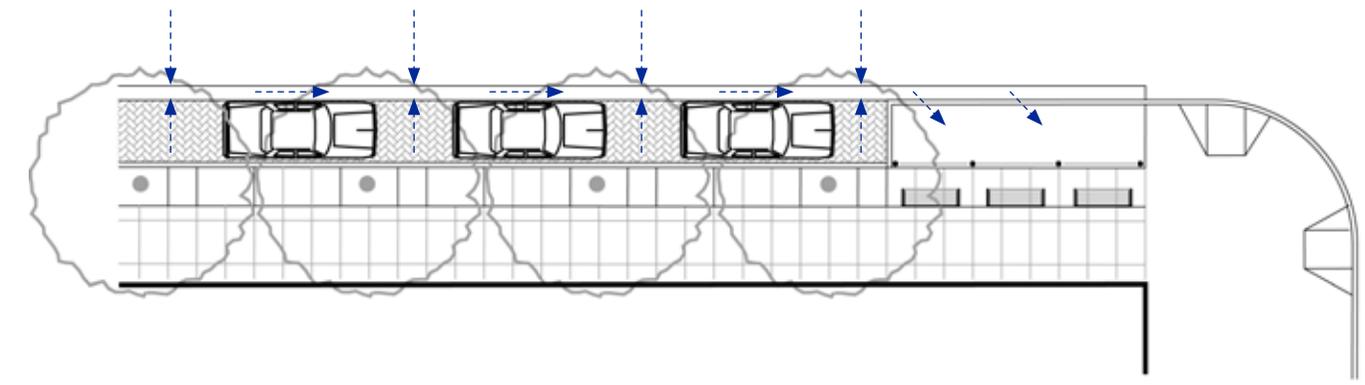
### Optimum Grading Scenario: No Impervious Area Run-on



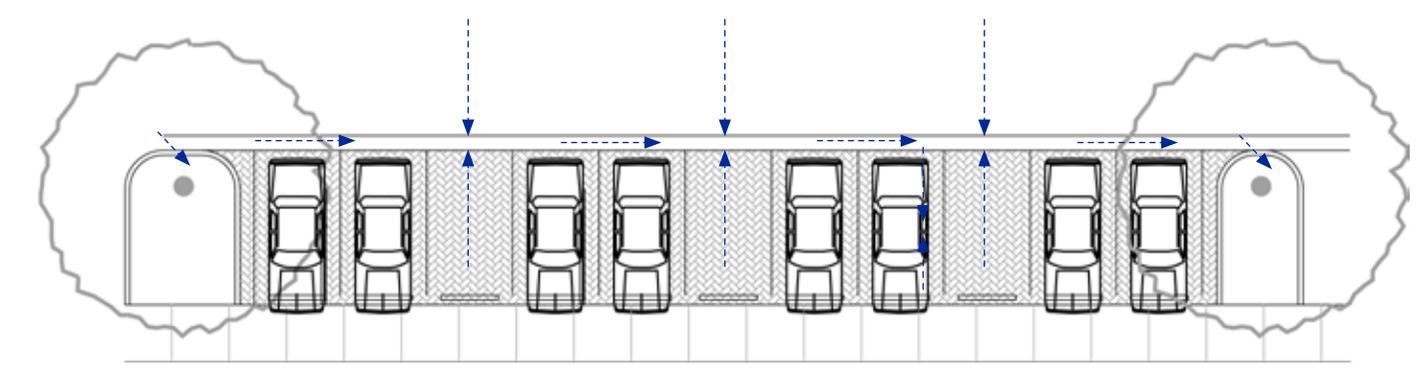
### Optimal Pervious Paving Placement/Grading Scenarios

The design sketches below illustrate a street condition and a parking lot condition where pervious paving is placed in parking stalls, but the majority of impervious area runoff is directed away from the pervious paving.

### Street Condition: Pervious Paving in Parking Stalls



### Parking Lot Condition: Pervious Paving in Parking Stalls



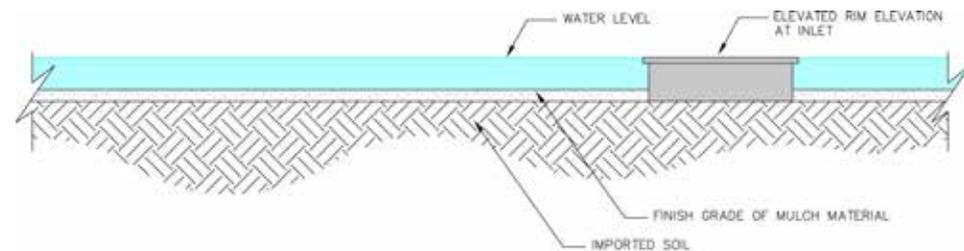
# 5.5 Design Changes to Ease Maintenance

## Adjustable Overflow/Check Dams Design for Water Retention

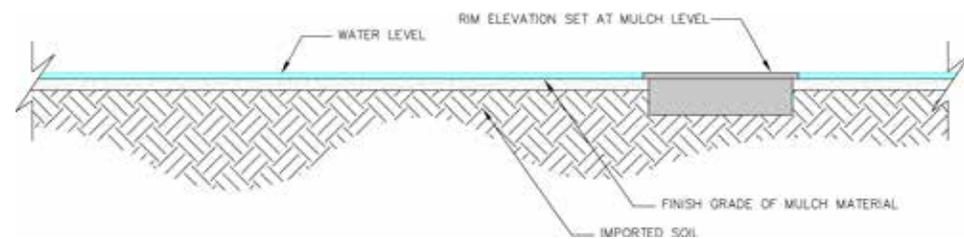
### Undesirable Inlet Placement

Many projects in San Mateo County have overflow inlets rim fixed at predetermined elevations that are either too high or too low for optimum stormwater retention. Having a fixed retention depth is taking a chance that infiltration/retention of water will work as planned and leaves no ability to adjust for changing conditions for the future. The illustrations below show the common conditions of retaining too much or too little water due to a fixed inlet rim elevation.

#### Undesirable Inlet Placement: Fixed Elevated Position



#### Undesirable Inlet Placement: Fixed Flush Position



▲ This storm inlet's rim is placed at a fixed height of 8 inches. If this rain garden does not infiltrate at a reasonable rate, it is prone to the effects of prolonged standing water.

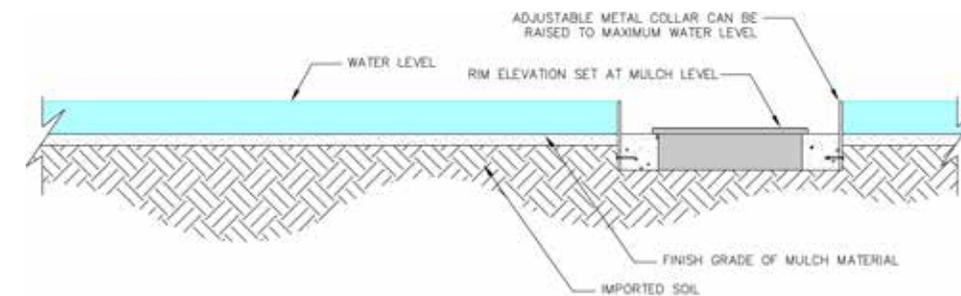


▲ Conversely, this stormwater curb extensions inlet rim is fixed at the finish grade of rock mulch leaving little opportunity for water retention.

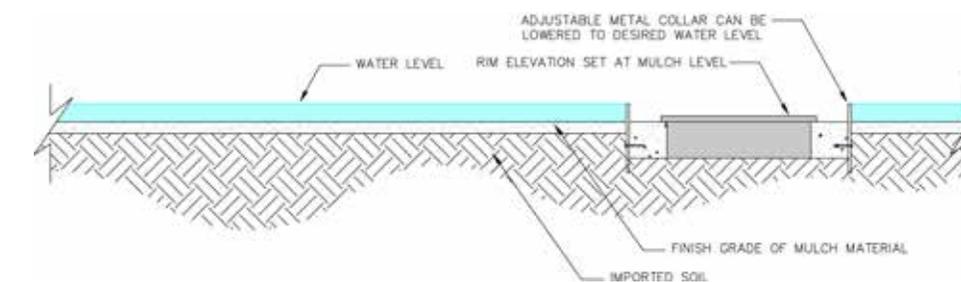
### Optimum Flexible Inlet/Weir/Checkdam Placement

To allow for better performance and flexibility of water retention levels, it is optimal to incorporate adjustable check dams and weirs. These structures can be made from metal, plastic, or even certain wood and are adjustable to raise or lower water levels throughout the landscape or immediately prior to the inlet. Place the inlet structure flush with the mulch grade and use the adjustable weir to dictate the optimum water retention level. The scenario below illustrates how an adjustable weir at an inlet can be raised or lowered for better water level control.

#### Raised Metal Weir for Maximum Water Retention



#### Lowered Metal Weir for Minimal Water Retention



▲ This stormwater planter has several metal weirs placed along the flow path of water to encourage infiltration.



▲ This HDPE weir surrounds an inlet that is flush with the soil grade. The weir dictates the water level.



▲ Simply surrounding an existing flush inlet with raised bricks that use epoxy to seal gaps creates a simple raised weir effect and retains additional runoff.



# Appendixes

## Appendix A Appendix A.1

*Sample Maintenance Plan Forms  
Rain Gardens*

## Appendix B

*Additional Resources*

# Maintenance Plan

## Rain Gardens

Project Address: \_\_\_\_\_

Date of Maintenance Visit: \_\_\_\_\_



◀ Rain gardens function as soil and plant-based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes. These facilities normally consist of a ponding area, mulch layer, vegetation and biotreatment soil mix. Photo Credit: Urban Rain Design

Property Owner

Owner's Phone No.

Designated Contact

Contact's Phone No.

Designated Contact Mailing Address

Project Name

Project Address

Project Cross Streets

Assessor's Parcel No.

Date of Maintenance Visit

Quantity/Description of Rain Garden(s) Location(s) within Property

### Routine Maintenance Activities

The principal maintenance objective is to prevent sediment buildup and clogging, which reduces pollutant removal efficiency and may lead to bioretention area failure. Routine maintenance activities, and the frequency at which they will be conducted are shown below.

MAINTENANCE TASK	FREQUENCY OF TASK
 <p>Observe site for the following conditions and adjust as necessary:</p> <ul style="list-style-type: none"> <li>▶ Monitor mulch depth levels.</li> <li>▶ Check for proper irrigation coverage. Signs of improper coverage include standing water, irrigation run-off and dry spots within the landscape.</li> <li>▶ Check irrigation system for function and leaks. Report any evidence of damage or malfunction to the Owner.</li> <li>▶ Observe plant material for signs of stress, indicating excessive or insufficient watering.</li> <li>▶ Inspect site for any plants that are dead, damaged, diseased, stressed or missing. Remove dead and diseased plants.</li> <li>▶ Inspect site for proper plant coverage. If, by visual assessment, the planter is determined to have inadequate plant coverage, schedule the installation of additional plants.</li> <li>▶ Inspect site for any signs of disease or pest infestation where non-chemical treatments have failed. Develop a treatment plan with the Owner.</li> <li>▶ Inspect site for poor visibility, obstructed views and hiding spaces. Prune to maintain safety where necessary.</li> </ul>	<p>Monthly</p>

# Maintenance Plan

## Rain Gardens

Project Address: \_\_\_\_\_

Date of Maintenance Visit: \_\_\_\_\_

MAINTENANCE TASK	FREQUENCY OF TASK
 Add or redistribute bark mulch within planting areas where the mulch has been reduced to less than 3 inches deep. Place mulch that has been knocked or washed out of planters back and smooth into place.	Monthly, as necessary.
 Remove dead, broken, damaged or diseased branches of trees and shrubs.	Monthly, as necessary.
Remove suckers growing from the base of trees.	Monthly, as necessary.
Trim shrub branches and groundcovers back from all sidewalks, curbs and paved areas. Cut the edges of groundcovers at an angle for a more natural appearance and healthier plants.	Monthly, as necessary.
Trim any tree branches that interfere with public safety, including visibility clearances.	Monthly, as necessary.
Remove all visible weeds located in planted areas, sidewalks, gutters and pavement. Remove as much of the root system as possible. Dispose of weeds off-site.	Monthly, as necessary.
Obtain a minimum of two separate agronomy reports.	Once yearly in early February.
 Apply granular fertilizers to planting areas, if required, per Agronomy Report to trees, shrubs, perennials and grasses. Be sure to make application prior to a moderate rainfall so the rain will wash the fertilizer in.	Once yearly in late February, if required.
 Adjust irrigation controller for current water needs of plants. Correct both frequency and duration of irrigation run times.	Quarterly
 Conduct a comprehensive irrigation system test by performing the following tasks: <ul style="list-style-type: none"><li>▶ Check irrigation system pressure.</li><li>▶ Ensure all flush valve/cap locations are visible.</li><li>▶ Ensure valve boxes are visible and can be opened.</li><li>▶ Clean valve boxes of dirt and debris.</li><li>▶ Inspect valves, filters and pressure regulators for damage or leaks. Check wire splices.</li><li>▶ Flush out the irrigation system and check for proper operation of each valve zone. Flush laterals.</li><li>▶ Inspect and clean filters. A hose can be attached to the flush cap to keep water out of the valve box. Replace damaged or torn filters.</li><li>▶ Clean or replace plugged sprinkler nozzles.</li><li>▶ Make sure plants have adequate numbers of drip emitters for their size, if applicable.</li><li>▶ Replace batteries to irrigation controller and sensor, as applicable.</li><li>▶ Test soil sensors per manufacturer's instructions.</li></ul>	Once yearly in early April.

# Maintenance Plan

## Rain Gardens

Project Address: \_\_\_\_\_

Date of Maintenance Visit: \_\_\_\_\_

### MAINTENANCE TASK



Prune shrubs as needed to maintain their proper shape. Prune young trees for up to five years after planting to develop a strong branch structure.



Reduce weight on heavy branches to preempt branch weakening. No more than 20% of live foliage should be removed or else cause unnecessary stress to a tree.



Refer to as-built drawings to determine the species and size of plants to be installed. If drawings are not available, match additional plants to the species present within the planter area. Add or replace plants under the following circumstances:

- ▶ Replace any dead or missing plants.
- ▶ If the site is determined to lack proper plant coverage, add plants until a minimum coverage of 70% is achieved.
- ▶ Replace ill-adapted plants with a species better adapted to a permanently altered environmental condition.

### FREQUENCY OF TASK

Prune spring- and winter-flowering shrubs and trees in June; Prune summer- and fall-flowering shrubs and trees in December.

Once yearly in early June, as necessary.

Twice yearly in April and October, as necessary.

### MAINTENANCE NOTES

### DATE
