Chapter 8: Operation and Maintenance

Introduction

This C.3 Regulated Projects Guide provides recommendations on how to meet the inspection and reporting requirements concerning O&M of regulated projects. Additional guidance and documents can be found in Appendices A (Plant List) F (Mosquito Controls) and G (Maintenance Plan Templates*).* ***For additional practical examples of maintenance inspections and guidance on maintenance activities for a variety of treatment designs and site conditions, refer to Chapter 6 of the GI Design Guide***.

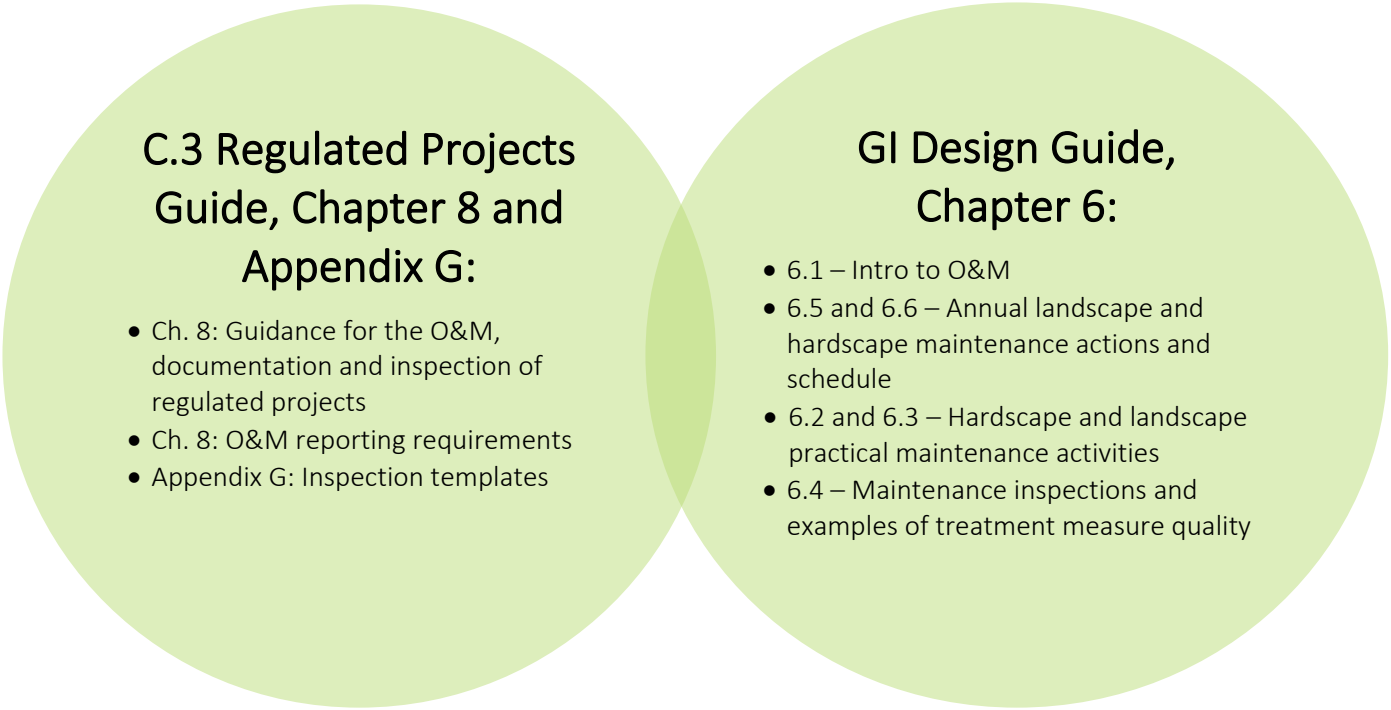

Figure 8-1: Chapter 8 and Appendix G details and cross-references to the GI Design Guide

Remember

Thresholds for determining whether Provision C.3 applies to a project (in which case the project is a "C.3 Regulated Project") are based on the amount of impervious surface that is created and/or replaced by a project, as described below.

- Since 2006, private or public parcel-based projects that create and/or replace ***10,000 or more square feet of impervious surface*** have been C.3 Regulated Projects.
- On ***December 1, 2011***, the threshold for requiring stormwater treatment was reduced from 10,000 to 5,000 square feet or more of impervious surface for the following project categories: uncovered parking areas (stand-alone or part of another use), restaurants, auto service facilities[11] and retail gasoline outlets.

In addition to these thresholds, there are size thresholds for implementing site design measures - but not stormwater treatment or hydromodification management measures - for the following smaller project types:

- Small projects that create and/or replace between 2,500 square feet and 10,000 square feet of impervious surface; and
- Detached single-family home projects that create and/or replace 2,500 square feet or more of impervious surface.

8.1 Summary of O&M Requirements

O&M is essential for assuring that stormwater control measures required for the project (e.g. pervious pavement, site design, stormwater treatment and hydromodification management (HM) measures) continue to function effectively and do not cause flooding, provide habitat for mosquitoes, or otherwise become a nuisance. The O&M requirements described in this chapter apply to ***pervious pavement, stormwater treatment measures, and HM measures*** included in the project; however, site design measures can also be included in the O&M requirements for a site. The O&M process can be organized into five phases, as described below:

- Determining ownership and O&M responsibility;
- Identifying O&M requirements when selecting control measures;
- Preparing the O&M plan and other documentation;
- Executing an O&M agreement or other O&M assurance; and
- Ongoing inspections and O&M activities.

Key Point

O&M requirements for treatment measures also apply to HM measures where and when they are implemented.

8.1.1 Responsibility for Maintenance

The responsibility for the O&M of stormwater control measures ***belongs to the project applicant and/or property owner*** unless other specific arrangements have been made. O&M responsibility for stormwater control measures should be considered at the earliest stages of project planning, typically at the pre-application meeting with municipal staff. The municipal stormwater permit also requires that the project applicant provide a signed statement accepting responsibility for O&M (or comply with another legally enforceable mechanism) until this responsibility is legally transferred, as well as ensuring access to municipal, Water Board, and San Mateo County Mosquito Abatement District staff to inspect the control measures.

Key Point

Unless specified otherwise, the responsibility for maintenance of stormwater control measures belongs to the project applicant and/or property owner.

8.1.2 Considerations When Selecting Treatment Measures

O&M Needs

When determining which types of control measures to incorporate into project plans, be mindful of how maintenance intensive they are. Review O&M requirements for LID systems and study the operation manual for any manufactured, proprietary system. Control measures must be maintained so that they continue to treat stormwater runoff effectively ***throughout the life of the project*** and do not provide habitat for mosquito breeding. Adequate funds must be allocated to support long-term maintenance. Some systems will hold standing water if they are not maintained correctly, and frequent maintenance may be needed to avoid health/vector concerns. Vault-based systems are hidden from sight and can have special confined-entry considerations which should be taken into account. A properly designed and established bioretention area, by contrast, may require little maintenance beyond what is required for normal

landscaped areas. However, the maintenance obligation will vary depending on the system design. The plant palette for bioretention systems is usually different from that used in non-stormwater types of landscapes and can require different maintenance practices. For example, some rushes, reeds, sedges and bunch grasses will be healthiest if they are not trimmed at all - they can be damaged if trimmed or sheared in the same way that some other plants are maintained.

The party responsible for maintenance will also be required to ***dispose of accumulated residuals properly.*** Residuals such as trash, filter media, and fine sediments collected from treatment measures may or may not be contaminated. At present, research generally indicates that residuals are not hazardous wastes and as such, after dewatering, property owners can generally dispose of residuals in the same way they would dispose of any uncontaminated soil.

A list of ***landfills in San Mateo County*** that accept sediment ("soil"), contaminated or otherwise, is available at https://www2.calrecycle.ca.gov/SWFacilities/Directory/. If there are proprietary treatment devices onsite, property owners may choose to contract with the treatment device manufacturer to maintain these treatment measures. Services typically provided include inspection, maintenance, handling and disposal of all residuals.

Mosquito Controls

When selecting and installing stormwater treatment devices, the various environmental, construction, and local factors that may influence mosquito breeding will need to be considered. Except for certain treatment measures designed to hold permanent pools of standing water, treatment measures should ***drain completely within five days*** to effectively suppress mosquito production. The Countywide Program's Vector Control Plan includes mosquito control design guidance and maintenance guidance for treatment measures. This guidance is included in Appendix F.

Warning

Except for treatment measures designed to hold permanent pools of standing water, treatment measures should drain completely within five days to suppress mosquito production.

Access to Municipal Staff

Remember

Make sure stormwater treatment measures and HM measures are readily accessible to inspectors.

The O&M agreement or other maintenance assurance for the project will need to guarantee access permission for staff from the local municipality, the San Mateo County Mosquito Abatement District, and the Water Board to enter the property to verify that maintenance is being conducted in accordance with the maintenance plan, throughout the life of the project. Stormwater control measures must be ***readily accessible to the inspectors***, and municipal staff should be contacted to determine whether easements will be needed. Stormwater control measures must also be accessible to equipment needed to maintain them. Maintenance needs vary by the type of control measure that is used. The maintenance requirements described in Section 8.2 should be reviewed to identify the accessibility needs for maintenance equipment. It is generally more difficult to provide adequate and safe access for maintenance of below-ground control measures than above-ground control measures.

8.1.3 O&M Documentation Required with Permit Application

As part of the building permit application, Regulated Project applicants typically need to prepare and submit the documents listed below. ***The local jurisdiction should be consulted*** for specific requirements.

- A legible conceptual plan of the site, clearly showing the locations of pervious pavement, stormwater treatment, and HM measures. The plan should specifically identify all pervious pavements systems that total 3,000 ft.² or more (excluding private-use patios for single-family homes, townhomes, or condominiums). Letter-sized plans are preferred; legal-sized plans may be accepted.
- A legal description of the property
- Detailed maintenance plan for pervious pavement, stormwater treatment, and HM measures, including inspection checklists, as appropriate.
- O&M information from the manufacturer for any proprietary control measures installed on the site.
- A standard O&M report form, to be attached to a maintenance agreement or other maintenance assurance.
- As-built cross section and plan view details of the stormwater control measures installed on the site.

Please note that requirements may vary from one jurisdiction to another. Some jurisdictions may not need to have the draft O&M agreement submitted until later in the construction phase, but all should have the O&M agreement or other maintenance assurance document(s) signed and notarized before any certificates (temporary or final) of occupancy are issued. Ask municipal staff if there are any additional requirements. Appendix G includes templates to assist project applicants in preparing their standard treatment measure O&M report form and maintenance plan. Guidance on preparing these documents is provided in Section 8.2.

Contact

The local jurisdiction should be contacted for inquiries about documents required for building permit applications.

8.1.4 Maintenance Agreement or Other Maintenance Assurance

Where a property owner is responsible for maintenance, the property owner of regulated projects is typically required to enter into a maintenance agreement with the municipality to ensure long-term maintenance of stormwater control measures. The agreement will usually be ***recorded against the property*** to run with the title of the land. The local jurisdiction should be contacted to obtain a copy of the standard maintenance agreement. The maintenance agreements require property owners to ensure that the control measures are being operated properly in perpetuity, regular maintenance inspections of all stormwater control measures are being conducted, necessary maintenance activities are completed, and – depending on the municipality – annual submittals of a Standard Treatment Operation and Maintenance Inspection Report form to the municipality are completed. Alternatively, some jurisdictions do not record O&M agreements and instead use Conditions of Approval and their municipal code to require property owners to operate and maintain stormwater control measures and provide access to municipal inspectors. Some municipalities may also require maintenance assurance through the means of a financial instrument

such as a bond or security deposit that is held for a period of time to ensure that maintenance obligations can be paid for if the property owner or developer is unable to perform that duty in the future.

For ***residential properties*** where the stormwater control measures are located within a common area that will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the project's conditions, covenants and restrictions (CC&Rs). Printed educational materials regarding on-site stormwater controls are typically required to be included with the first, and any subsequent, deed transfer. The educational materials typically:

- Explain the post-construction stormwater controls requirements;
- Provide information on what stormwater controls are present;
- Describe the need for maintenance;
- Explain how necessary maintenance can be performed; and
- For the initial deed transfer, describe the assistance that the project applicant can provide.

If stormwater control measures are proposed to be located in a ***public area*** for transfer to the municipality, these control measures must meet the design guidelines specified in Chapter 6 and will remain the property owner's responsibility for maintenance until the control measures are accepted for transfer.

8.1.5 Ongoing Inspections and Maintenance

After the maintenance agreement is executed, or the municipality approves other maintenance assurance such as CC&Rs, the party responsible for maintenance begins to implement the maintenance plan. Inspection reports are submitted to the municipality as required by the maintenance agreement or other maintenance assurance.

The municipality, Water Board, and San Mateo County Mosquito Abatement District may conduct ***operation and maintenance verification inspections*** to make sure that stormwater control measures are being maintained. In the event adequate maintenance is not conducted, the municipality will either take an enforcement action against the responsible party or take necessary steps to restore the control measures to good working order. The property owner will be responsible for reimbursing the municipality for expenditures associated with restoring the control measures to good working order.

Warning

The municipality, Water Board and San Mateo County Mosquito Abatement District staff may conduct O&M verification inspections to make sure that stormwater control measures are maintained.

8.2 Preparing Maintenance-Related Documents

This section provides instructions for preparing the following documents that are typically required as parts of the building permit application, if the project is a regulated project and includes pervious pavement (3,000 sq. ft. or more), stormwater treatment measures and/or HM measures:

- A standard control measure O&M report form
- A maintenance plan, including a schedule of maintenance activities.

8.2.1 Standard Treatment Measure O&M Report Form

The municipality may require the property owner, or other responsible party, to submit an annual report summarizing the maintenance and inspections of control measures included in the project. To standardize and simplify the reporting process, the property owner submits a "Standard Treatment Measure O&M Report Form" with the building permit application, and the municipality includes the report form as an Exhibit to the maintenance agreement. After the agreement is executed, the property owner, or other responsible party, uses this form to prepare the annual report, which is typically submitted by December 31 of each calendar year or annually before the rainy season begins on October 1st. When submitting the completed report form each year, the responsible party will typically be required to attach the inspection forms that were completed during that calendar year.

To assist with preparation of the Standard Treatment Measure O&M Report Form, a template is included in Appendix G. ***The local jurisdiction should be consulted*** for an electronic version of the template. When using the template to prepare the report form, project-specific information should be inserted where indicated by highlighted prompts such as the following: [[== insert name of property owner/responsible party ==]]

8.2.2 Maintenance Plan

The maintenance plan must be sufficiently detailed to demonstrate to the municipality that pervious pavement, stormwater treatment measures, and/or HM measures will receive ***adequate inspections and maintenance*** to continue functioning as designed over the life of the project. A maintenance plan typically includes the following elements:

- Contact information for the property owner or other responsible party.
- Project address and, if required, the Assessor's Parcel Number and directions to the site.
- Identification of the number, type and location of all pervious pavement (3,000 sq. ft. or more), stormwater control, and/or HM measures on the site.
- A list of specific, routine maintenance tasks that will be conducted, the intervals at which they are conducted (e.g. "Inspect control measure once a month, using the attached checklist"), required practices (e.g. Bay-Friendly practices), and prohibited practices such as the use of pesticides or chemical fertilizers.
- An inspection checklist, specific to the control measure(s) included in the project, which indicates the items that will be reviewed during regular maintenance inspections. Completed inspection

forms may be required as part of the annual Stormwater Control Measure O&M Report, described in Section 8.2.1.

The following materials are available to assist with preparing the maintenance plan:

- Maintenance plan templates included in Appendix G.
- A list of common maintenance concerns for frequently used stormwater control measures (see the following pages).

When using a template to prepare the report form, project-specific information should be inserted where indicated by prompts such as: [[== insert name of property owner/responsible party ==]]. The templates include sample inspection checklists for some control measures. If the project includes different control measures, then the template will need to be customized. To prepare the maintenance plan, the ***control measure-specific maintenance information*** provided in Sections 8.3 and 8.4 should be referred to.

Key Point

Refer to the control measure-specific maintenance information to prepare the maintenance plan.

8.3 General Landscape Maintenance Activities

8.3.1 General Guidance

Overview of Landscaped Treatment Measure Maintenance Activities

Frequency of site visits and required maintenance practices will vary depending upon the stormwater measure and plant selection. Maintenance shall include watering, cultivation, weeding and pruning as necessary to maintain optimum growth conditions and, as appropriate to the specific stormwater measure, to keep the planted areas neat and attractive in appearance. In all instances, controlling weeds and unwanted growth with chemical applications is prohibited.

The contractor installing the treatment measure should be familiar with the design and function of the specific stormwater measure(s) to ensure that the plantings are maintained appropriately and do not interfere with the efficient runoff drainage and filtration.

Ongoing management of invasive weed species will be required in all applications. Monthly hand weeding will allow the naturalized vegetation to take hold, and will ultimately be less costly than less frequent, and more intensive clearing. Regular application of composted mulch (also known as aged mulch) or other mulch material that will resist floating with surface runoff, will also help control weed growth. "Micro-bark" and "gorilla hair" mulches are not recommended.

Erosion Control

With landscapes that are not fully established, maintenance staff will need to monitor and evaluate potential for erosion and sediment accumulation in the runoff, which will influence irrigation scheduling, and determine the need for additional erosion control measures. Soil can be protected from erosion by a number of methods including:

- Keep the soil covered with vegetation to the greatest extent possible;
- Slow water runoff by using compost berms, blankets or socks along slopes;
- Cover bare soil with a minimum of 3-inch layer of mulch;
- Minimize the use of leaf blowers in planting beds and on turf;
- On slopes, use composted arbor mulch that is not prone to washing into storms drains; and
- Store leaf litter as additional mulch in planting beds as appropriate.

Irrigation Systems

Where irrigation systems have been installed for temporary or permanent irrigation, maintain the irrigation system for optimum performance, per manufacturer's specifications. Inspect the entire system on an ongoing basis, including cleaning and adjusting all sprinkler and bubbler heads, drip emitters and valves for proper coverage. Monitor the irrigation system while operating to identify and correct problems with water runoff or standing water.

Monitor soil moisture within plant root zones using a soil probe or shovel and adjust irrigation schedules accordingly if a soil moisture sensor is not being utilized to signal the irrigation controller. If a Weather-Based Irrigation Controller (WBIC), otherwise known as a "Smart" Controller, is not utilized on the project,

irrigation should be scheduled using a water budget approach, basing irrigation frequency on evapotranspiration data (ET) to avoid over-irrigation of plant material. Adjust irrigation frequency within each hydrozone area a minimum of every four weeks to respond to expected adjustments in ET data.

If a standard turf mix is used in lieu of a no-mow variety, implement grasscycling, where appropriate to the stormwater treatment measure. Grass clippings should not be carried into drainage structures. Refer to "A Landscaper's Guide to Grasscycling" available from StopWaste.Org.

Bioretention and Other Vegetated Treatment Measures

In bioretention areas, undesirable and/or invasive plant species should be carefully monitored and controlled to reduce competition with the desired plantings and to assure the success of the revegetation activities. The establishment of undesirable and/or invasive species can be partially controlled during the establishment period by implementing the watering schedule of initial saturation followed by alternating periods of shallow inundation and dry soil. Manual methods of undesired plant removal should be conducted on the bottom, edge and side of the areas when they are not inundated.

Undesired plant removal should be conducted regularly the first two years to prevent the growth, flowering, and seed set of undesirable and/or invasive species. After the first two years, plant removal frequency will vary on a site-specific basis as determined by the type and seasonal growth cycle of the undesired species. In general, plant removal as often as once a month may be necessary to avoid more extensive and costly eradication in the future.

Long-term maintenance tasks will include continued control of undesirable and/or invasive plants, and control of erosion. Erosion could include gullies, rills and sheet erosion. Actions to control erosion should include redirecting or dissipating the water source. Recontouring and subsequent mulching and/or replanting may be required in bare areas. In the event of extensive die-off of the desired plant species, the bare areas should be replanted. Where the event that caused plant mortality was not a natural catastrophic occurrence, the site condition that resulted in the die-off should be investigated and remedial action to correct the problem should be undertaken prior to replanting.

For detailed treatment measure-specific guidance, see Section 8.4.

8.3.2 Bay-Friendly Landscaping and Integrated Pest Management

This section provides a summary of Bay-Friendly Landscaping and integrated pest management techniques, based on the Bay-Friendly Landscaping Guidelines at www.ReScapeCa.org.

Figure 8-2: The 8 Principles of Bay-Friendly Landscaping (Credit: ReScape California, rescapeca.org)

Bay-Friendly Landscaping

Bay-Friendly Landscaping is a whole systems approach to the design, construction and maintenance of the landscape in order to support the integrity of the San Francisco Bay watershed. Project sponsors are encouraged to use landscape professionals who are familiar with and committed to implementing Bay-Friendly Landscaping practices from the initial plant selection through the long-term maintenance of the site. This section summarizes Bay-Friendly Landscaping practices that may be implemented during design, construction, and maintenance of stormwater control measures, as well as information about how these practices can benefit water quality of the Bay and its tributaries.

Bay-Friendly Landscaping is based on eight principles of sustainable landscaping and features the following practices

1. Act Locally. Landscapes designed to be part of the larger ecosystem of the Bay Area can both protect the health, diversity and sustainability of this valuable resource while making the most of the natural processes of a well-functioning ecosystem. By selecting plants appropriate to the climate, exposure, soils, drainage and topography, plantings can be established more successfully with less consumption of resources and intensive maintenance. Landscape designers are also encouraged to use local, well-adapted plant communities as models and to consider the potential for fire when developing the plant palette for a project.
2. Reduce Waste. Reducing waste –and thus conserving landfill space and fossil fuel for hauling this material to the landfill - starts with not generating it in the first place. Plant trimmings pruning can be reduced by selecting plants that can grow to their natural size is the space allotted them, by

avoiding the use of sheared hedges as design elements and not specifying invasive species (go to www.cal-ipc.org). Prune selectively, and avoid excessive plant growth by applying water and fertilizer judiciously. The second step is to recognize the value of plant debris, and to keep this organic matter on the site, using it as a gardening resource for mulching and composting.

3. Nurture the Soil. Returning organic matter to the soil, in the form of plant debris, is the link between protecting the soil and protecting the watershed. Healthy soil that is rich in organic matter is full of life and can store water and actively cycle nutrients, regulate and partition water flow, neutralize pollutants, and resist pests. The following practices will encourage a complex soil community of microorganisms, worms, and other beneficial creatures. Base the landscape design on a soil analysis and understanding of soil texture, structure and drainage. The following practices are recommended during construction:

    - Protect topsoil in place or remove and store for re-spreading after grading;
    - Limit construction traffic to areas that will not be landscaped;
    - Control soil erosion;
    - Amend soils with compost before planting; and
    - Specify and maintain an adequate layer of organic mulch, taking into account water flow and designing to avoid the loss of mulch with runoff.

    Maintenance practices to benefit soils and the watershed include allowing grass clippings to remain on the lawn; feeding soils with naturally based products including compost and a water extract of mature compost, instead of synthetic, fast release fertilizers and avoiding pesticides.

4. Save Water. Amending the soil with compost and keeping it covered with composted mulch (or other mulch that resists floating) can increase soil permeability and water-holding capacity, reduce water loss through evaporation and decrease the need for irrigation. Planting appropriate, drought-tolerant California natives or Mediterranean plants also reduces water consumption for irrigation, as well as consumption of other resources for mowing, fertilizing, and spraying. Minimize the use of turf grasses that require regular watering and fertilizing to remain green, particularly on slopes or in narrow, irregular hard to water shapes. Arrange plants in "hydrozones" of low, medium or high-water demand. Onsite collection systems can allow the use of rainwater, or the reuse of "graywater" – uncontaminated wastewater from sinks, bathtubs, and washing machines. Specify, install and maintain high-efficiency irrigation systems, and train landscaping staff to manage irrigation according to need.

5. Conserve Energy. Conventional landscapes are very fossil fuel consumptive. Selecting plantings that do not require regular mowing or pruning, fertilizing and watering can help reduce this demand and restore our landscapes to those that are more productive than consumptive. Tree plantings can be used to moderate building temperatures, and to shade paved areas and air conditioners. Trees can also intercept significant amounts of rainfall each year and thus help control stormwater runoff. Specify as large a tree as possible but be sure that it will be allowed to grow to its natural shape and size in the allotted space. Outdoor lighting should be designed to use less energy and minimize "light pollution." Choose and maintain energy-efficient landscaping equipment to conserve fuel. Specifying local products and suppliers reduces the energy needed to transport products and supports local economies.

6. Protect Water and Air Quality. Bay-Friendly landscaping can help protect water quality by increasing on-site infiltration and reducing runoff, reducing pollutants in runoff, and increasing the soil's ability

to remove pollutants from runoff. It can help protect air quality by reducing fossil fuel consumption, recycling plant debris onsite, and planting trees to remove carbon dioxide and absorb air pollutants. Many of the practices described previously, such as minimizing high input decorative lawns, keeping soil covered with mulch and planting trees play a critical role in protecting water and air quality. An additional very important component of Bay-Friendly landscaping is reducing the use of pesticides through integrated pest management, which is described in a separate section, below.

7. Create and Protect Wildlife Habitat. Although we tend to rely on parks and open space to preserve wildlife habitat, developed landscapes can also provide food, water, shelter and nesting sites for birds, butterflies, beneficial insects, and other creatures. This can be accomplished by providing a diverse landscape that includes annuals, biennials and perennials of many different sizes, shapes, colors and textures; by choosing California natives first; providing appropriate water and shelter for wildlife; eliminating the use of pesticides; and planning sites to conserve or restore natural areas and wildlife corridors.

8. Sequester Carbon. As the amount of carbon dioxide in the atmosphere reaches new highs, solutions to the climate change crisis must come from every sector. Through photosynthesis, plants draw carbon dioxide out of the air. They use some of that carbon for growth and exude some of it through their roots to feed soil organisms. This process stabilizes the carbon in the soil, where it can reside for centuries. Applying compost to improve soil and plant health jump starts the conversion of atmospheric carbon to soil carbon. Compost increases the stored soil carbon by increasing the soil's water-holding capacity and improving conditions for beneficial soil microorganisms. This leads to greater plant growth and more stable carbon in the soil.

Integrated Pest Management

All creeks in the San Francisco Bay Area exceed water quality toxicity limits, primarily due to pesticides entering urban runoff. Water quality agencies recommend using integrated pest management (IPM) practices for maintaining stormwater control measures. IPM is a holistic approach to mitigating insects, plant diseases, weeds, and other pests. Projects that require a landscaping plan as part of a development project application are required to use IPM, as indicated in each agency's source control measures list, which is based on the countywide Model IPM Policy. Avoiding pesticides and quick release synthetic fertilizers are particularly important when maintaining stormwater treatment measures, to protect water quality.

IPM involves the use of many strategies for first preventing, and then controlling, but not eliminating, pests. It places a priority on fostering a healthy environment in which plants have the strength to resist diseases and insect infestations, and out-compete weeds. Using IPM requires an understanding of the life cycles of pests and beneficial organisms, as well as regular monitoring of their populations. When pest problems are identified, IPM considers all viable solutions and uses a combination of strategies to control pests, rather than relying on pesticides alone. The least toxic pesticides are used only as a last resort. IPM features the following practices:

Prevent Pest Problems. Fostering a healthy soil and selecting appropriate plant communities for the site helps reduce the susceptibility to disease and other pests. Landscape designs should include a diversity of species that are well-suited to the site; specify resistant varieties and native species, including plants that attract beneficial insects; place plants a proper distance from buildings; avoid over-planting; and include compost in the soil specifications. Cultural methods of avoiding pests during construction and maintenance include the following:

- Selecting plant material that is free from disease and insects;
- Planting at the right depth;
- Watering thoroughly but not over-watering;
- Keeping mulch on the soil surface at all times, keeping it away from root crowns;
- Using slow release fertilizer, if necessary, and not over-fertilizing;
- Pruning judiciously;
- Eliminating noxious weeds before they go to seed or spread;
- Cleaning equipment after use on infected plants;
- Inspecting and removing invasive plant parts or seeds from clothing, tools and vehicle before leaving an infected site; and
- Cleaning up fruit and plant material that is infected with insects or diseases.

Watch for and Monitor Problems. Landscaping firms should provide their staff with the time and resources to learn to identify both pest and beneficial organisms, and train property owners to monitor and record pest problems. Plants should be checked often for vigor and signs of pests. Clarify which problems are the result of pests and not other environmental problems. Evaluate the results of any treatments, and check regularly with the Bio-Integral Resource Center (www.birc.org) or UC Davis (www.ipm.ucdavis.edu) for up-to-date resources and information.

Education is Key. Many property owners have unrealistic standards for pest control and need to learn how landscapes can tolerate a certain level of pests without resulting in significant, or even noticeable, damage. Landscape professionals should educate their clients and refer them to www.ourwaterourworld.org for fact sheets and information on alternative pest control strategies.

Use Physical and Mechanical Controls. If pests are identified as the source of unacceptable levels of damage, physical barriers or mechanical techniques are the first line of control. This can include the carefully timed and conducted pruning of infested plant material or removal of whole plants, spraying aphids with a strong jet of water, using pheromone or sticky traps to keep ants and other insects away or hand-picking large adult insect pests and larvae as they appear

Use Biological Controls. Living organisms can also be used to keep pest populations under control. The most important biological controls appear naturally and will be abundant in a landscape that is not heavily treated with pesticides. Encourage beneficial insects by planting a wide range of plants that flower throughout the year (a list is provided in the Bay-Friendly Landscaping Guidelines), and introduce natural predators. Buy all biological controls from a reputable source, and do not use pesticides except as a last resort.

Least Toxic Pesticides are a Last Resort. The least toxic and least persistent pesticide is used only when monitoring indicates that preventative and non-chemical methods are not keeping pests below acceptable levels. Pesticides are not used on a calendar basis. When used, their efficiency is maximized by understanding the pest and beneficial life cycles, by careful timing and targeted application.

8.4 Specific Maintenance Activities by Treatment Measure

8.4.1 Bioretention Areas (Chapter 6.1) – Common Maintenance Concerns

The primary maintenance requirement for bioretention areas is the regular inspection and repair or replacement of the control measure's components. Generally, the level of effort is similar to the routine, periodic maintenance of any landscaped area. It is recommended that certain maintenance tasks be conducted monthly or quarterly as required, annually before the rainy season, annually after the rainy season, and after large storm events.

Depending on the control measure needs, monthly or quarterly inspections should be conducted as follows:

- Inspect bioretention surface area, inlets and outlets for obstructions and trash; clear any obstructions and remove weeds and trash.
- Inspect bioretention areas for standing water. Presence of algae growth in ponded water is a good indicator of problems. In general, if standing water does not drain within 1 day, there may be a problem with the system. First check the cleanout riser (if there is one) and clean out any underdrains for clogging material. Other causes of standing water can include clogged outlets, faulty irrigation systems, and/or improperly specified or installed biotreatment soil media, mulch, or plant material. If needed, remove problematic materials and replace with approved biotreatment soil media, mulch, new plants and/or other components as needed. Compaction of native soil can also be a cause of standing water; in which case the whole system may need to be reconstructed. If mosquito larvae are observed, contact the San Mateo County Mosquito Abatement District through their on-line service request at www.smcmvcd.org/online-service-request or call the District at (650) 344-8592. Larvae will breed more quickly in warmer seasons.

Before and after the rainy season, an evaluation of the whole control system should be conducted, including the following activities:

- Prune and weed the bioretention area and remove trash. Remove and replace any dead plants.
- Inspect the vegetation to ensure that it is healthy and dense enough to provide filtering and protection from erosion. Do not use pesticides or other chemical applications to treat diseased plants, control weeds or remove unwanted growth.
- Inspect inlets for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment.
- Check the irrigation system to ensure that plants are receiving the correct amount of water. Repair or replace any improperly functioning equipment.
- Use compost and other natural soil amendments and fertilizers. Do not use synthetic fertilizers, especially if the system uses an underdrain.
- Inspect the energy dissipater at the inlet to ensure it is functioning adequately, and that there is no scour of the surface mulch. Remove any accumulation of sediment.

- Inspect and, if needed, replace wood or rock mulch depending on the site conditions. It is recommended that composted arbor mulch be applied once a year to maintain a 3" depth. Mulch should be added when erosion is evident or when the bioretention area begins to look unattractive. The entire area may need mulch replacement every two to three years, although spot mulching may be sufficient when there are random void areas. Rock mulch can be raked up or manually collected and redistributed after maintenance is performed.

After large storm events, the system should be inspected for:

- Erosion of biotreatment soil media, loss of mulch, standing water, structural failure, clogged overflows, weeds, trash and dead plants. If using rock mulch, check for 3" of coverage.

Figure 8-3: Bioretention Area in Daly City (Credit: SMCWPPP)

For more guidance on how to conduct these maintenance tasks, see visual aids provided in Section 6.4 of the GI Design Guide. Specifically for bioretention areas, see detailed examples of: mulch application, hand weeding, plant coverage and health, visual safety, grass trimming, irrigation schedule and irrigation components condition, sediment load management, trash removal, and erosion control.

8.4.2 Flow-Through Planters (Chapter 6.2) – Common Maintenance Concerns

Maintenance objectives include maintaining healthy vegetation at an appropriate size; avoiding clogging; and ensuring the structural integrity of the planter and the proper functioning of inlets, outlets, and the high-flow bypass. It is recommended that certain maintenance tasks be conducted monthly, annually before the rainy season, annually after the rainy season, and after large storm events.

Depending on the system needs, monthly inspections should be conducted as follows:

- Inspect the planter surface area, inlets and outlets for obstructions and trash; clear any obstructions and remove trash.

- Inspect the planter for standing water. Presence of algae growth in ponded water is a good indicator of problems. First check the cleanout riser and clear any underdrains of obstructions or clogging material. In general, if standing water does not drain within 1 day, there may be a problem with biotreatment soil media, mulch, outlets, cleanouts, underdrains, irrigation systems and/or plant material. If needed, remove problematic materials and replace with approved biotreatment soil media, mulch and new plants or appropriate materials. If mosquito larvae are observed, contact the San Mateo County Mosquito Abatement District through their on-line service request at www.smcmvcd.org/online-service-request or call the District at (650) 344-8592. Larvae will breed more quickly in warmer seasons.
- Check for eroded or settled biotreatment soil media. Level soil with rake and remove/replant vegetation as necessary.

Before and after the rainy season, a complete evaluation of the system should be conducted:

- Ensure that vegetation is healthy and dense enough to provide filtering and protect soils from erosion. Prune and weed as necessary. Replace dead plants. Remove excessive growth of plants that are too close together to allow water flow and/or causing other issues. Remove trash and sediment. Do not use pesticides or other chemical applications to treat diseased plants, control weeds or remove unwanted growth.
- Use compost and other natural soil amendments and fertilizers. Do not use synthetic fertilizers, especially if the system uses an underdrain.
- Inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping. Use the cleanout riser to clear underdrains of obstructions or clogging material.
- Inspect the energy dissipater at the inlet to ensure it is functioning adequately, and that there is no scour of the surface mulch. Remove any accumulation of sediment.
- Inspect mulch and, if needed, install new wood or rock mulch depending on site conditions. It is recommended that composted arbor mulch be applied once a year to maintain a 3” depth. Rock mulch can be raked up or manually collected and redistributed after maintenance is performed.

After large storm events, the system should be inspected for:

- Erosion of biotreatment soil media, loss of mulch, trash, standing water, and structural integrity of walls, flow spreaders, energy dissipaters, curb cuts, outlets and flow splitters for cracks and breaks. If using rock mulch, check for 3” of coverage.

Figure 8-4: Flow through planter in Emeryville (Credit: EOA, Inc.)

For more guidance on how to conduct these maintenance tasks, see visual aids provided in Section 6.4 of the GI Design Guide. Specifically for bioretention areas, see detailed examples of: mulch application, hand weeding, plant coverage and health, visual safety, grass trimming, irrigation schedule and irrigation components condition, sediment load management, trash removal, and erosion control.

8.4.3 Tree Well Filters (Chapter 6.3) – Common Maintenance Concerns

The following maintenance requirements are typical:

- Conduct a biannual (twice yearly) evaluation of the health of trees and any ground cover. Remove any dead, dying, or missing vegetation.
- Do not use pesticides or other chemical applications to control weeds or unwanted growth.
- Use compost and other natural soil amendments and fertilizers instead of synthetic fertilizers, especially if the system uses an underdrain.
- Maintain vegetation and the irrigation system. Prune and weed as needed to keep the tree well filter neat and orderly in appearance. Clean up fallen leaves or debris.
- Before the wet season begins, check that the media is at the appropriate depth. Remove any accumulations of sediment, litter, and debris. Confirm that the tree well filter is not clogging and will drain per design specifications. Till or replace the media as necessary.
- Inspect tree well filter periodically, and after storms, to ensure that it has not clogged.
- Periodically inspect the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.

For more guidance on how to conduct these maintenance tasks, see visual aids provided in Section 6.3 and 6.4 of the GI Design Guide. Specifically for tree filters, see detailed examples of: mulch application, hand weeding, tree health and pruning, irrigation schedule and irrigation components condition, sediment load management, trash removal, and erosion control.

Figure 8-5: Tree well filter
(Source: University of New Hampshire, 2012)

8.4.4 Infiltration Trenches (Chapter 6.4) – Common Maintenance Concerns

The primary maintenance objective is to prevent clogging, which may lead to trench failure. Typical inspection and maintenance tasks are as follows:

- Inspect infiltration trench after large storm events and remove any accumulated debris or material.
- Check the observation well 2 to 3 days after storms to confirm drainage.
- Repair any erosion at inflow or overflow structures.
- Conduct a thorough inspection annually, including monitoring of the observation well to confirm that the trench is draining within the specified time.
- If inspection indicates that the trench is partially or completely clogged, it should be restored to its design condition.
- Mow and trim vegetation around the trench as needed to maintain a neat and orderly appearance.
- Do not use pesticides or other chemical applications to control weeds or unwanted growth of vegetation near the trench.
- Routinely remove trash, grass clippings and other debris along the trench perimeter and dispose of these materials properly. Trees or other large vegetation should be prevented from growing adjacent to the trench to prevent damage to the trench.

Figure 8-6: Infiltration Trench (Credit: CASQA)

For more guidance on how to conduct these maintenance tasks, see visual aids provided in Section 6.4 of the GI Design Guide.

8.4.5 Extended Detention Basins (Chapter 6.5) – Common Maintenance Concerns

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

Figure 8-7: Extended Detention Basin, Palo Alto

- Harvest vegetation annually, during the summer.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and mosquito control reasons.
- Do not use pesticides or other chemical applications to control weeds or unwanted growth.
- Conduct a biannual (twice yearly) evaluation of the health of the vegetation and remove and replace any dead or dying plants.
- Conduct semi-annual inspection as follows:
    - Inspect the outlet, embankments, dikes, berms, and side slopes for structural integrity and signs of erosion.

  - Examine outlets and overflow structures and remove any trash or debris plugging the outlets. Identify and minimize any sources of sediment and debris. Check rocks or other erosion control and replace, if necessary.
  - Check inlets to make sure piping is intact and not plugged. Remove accumulated sediment and debris near the inlet.
  - Inspect for standing water and correct any problems that prevent the extended detention basin from draining as designed.
  - If mosquito larvae are observed, contact the San Mateo County Mosquito Abatement District at (650) 344-8592.
  - Check for slope stability and the presence of rodent burrows. Fill in any holes detected in the side slopes.
  - Confirm that any fences around the facility are secure.
- Maintenance activities at the bottom of the basin should not be performed with heavy equipment, which would compact the soil and limit infiltration.
- Remove sediment from the forebay as needed.
- Remove accumulated sediment within the basin area and regrade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume.
- Remove accumulated trash and debris from the extended detention basin at the middle and end of the wet season (January and April), or as needed.

8.4.6 Pervious Pavement (Chapters 6.6 and 6.7) – Common Maintenance Concerns

Types of pervious pavement include pervious concrete, porous asphalt, pervious pavers, permeable pavers, and reinforced grid paving. All pervious pavement can become clogged with sediment over time if routine maintenance is not performed. Sources of sediment include vehicles and eroding soil, leaves, and mulch from adjacent landscaped areas. Regular surface cleaning will help maintain a high surface permeability and keep out vegetation.

Routine maintenance (two to four times annually):

- Prevent soil from washing or blowing onto the pavement. Do not store sand, soil, mulch or other landscaping materials on pervious pavement surfaces.
- Conduct preventative surface cleaning, using commercially available regenerative air or vacuum sweepers, to remove sediment and debris.

Inspection (two to four times annually):

- Check for sediment and debris accumulation on pervious pavement.
- Check for standing water on the pavement surface within 30 minutes after a storm event if possible. Standing water indicates that restorative cleaning may be required.
- Inspect pervious pavement for any signs of pavement failure.

- Inspect underdrain outlets and cleanouts annually, preferably before the wet season. Remove accumulated trash/debris.

As needed maintenance:

- Remove weeds from pervious pavement as needed. Do not use pesticides or other chemical applications to control weeds or unwanted growth near pavement or between pavers. Vegetation in reinforced grid paving (such as turf block) should be mowed as needed.
- Repair any surface deformations or broken pavers. Replace missing joint filler in permeable pavers.
- If routine cleaning does not maintain the permeability, then restorative surface cleaning with a vacuum sweeper and/or reconstruction of part of the pervious surface may be required. Adjust the vacuum sweeper suction to a level that does not remove portions of the pervious pavement base layer or joint filler.

Figure 8-8: Permeable pavers in Berkeley (Credit: EOA Inc.)

- Power washing with simultaneous vacuuming also can be used to restore surface permeability to highly clogged areas of pervious concrete, porous asphalt, pervious pavers or permeable pavers, but is not recommended for reinforced grid paving.
- Replenish aggregate in permeable paver joints or grids as needed after restorative surface cleaning.

For more guidance on how to conduct these maintenance tasks, **see Section 6.2 of the GI Design Guide and Section 6.4 for the visual aids provided**. Specifically for pervious pavement, see detailed examples of: sediment load management, trash removal, and pervious pavement sweeping.

8.4.7 Rainwater Harvesting (Chapter 6.9) – Common Maintenance Concerns

- Conduct annual inspections of all components, including pumps, valves, tanks, and backflow prevention systems, and verify operation.

- Inspect and clean filters and screens every three months and replace when necessary.
- Inspect and verify that disinfection, filters, and other water quality treatment devices are operational, in accordance with manufacturer's recommendations or local jurisdiction requirements.
- If rainwater is provided for indoor use, conduct annual water quality testing per the requirements of the local jurisdiction.
- Inspect and clear debris from rainwater gutters, roof surfaces, downspouts, roof washers, and first-flush devices every six months, or as needed, to prevent clogging. Remove tree branches and vegetation overhanging roof surfaces to reduce amount of debris.
- Maintenance requirements specific to cisterns:
    - Flush cisterns annually to remove sediment. Flushed water should drain to landscaping or to the sanitary sewer.
    - For buried structures, vacuum removal of sediment is required.
- Maintenance requirements specific to rain barrels:
    - Regularly inspect the gutters and gutter guards, downspouts, spigots, and rain barrels, and clean or replace parts as needed.
    - Inspect screens and seals prior to the wet season to make sure debris is not collecting on the surface and that there are not holes allowing mosquitoes to enter the rain barrel. Inspect screens more frequently if there are trees that drop debris on the roof.

Figure 8-9: Rainwater Harvesting Cistern in Oakland at Mills College (Credit EOA, Inc.)

    - Clean the inside of the rain barrel once a year (preferably at the end of the dry season when the rain barrel has been fully drained) to prevent buildup of debris. If debris cannot

be removed by rinsing, use vinegar or another non-toxic cleaner. Use a large scrub brush on a long stick, and avoid actually entering the rain barrel. Drain washwater to landscaping.

8.4.8 Media Filters (Chapter 6.10) – Common Maintenance Concerns

Clogging is the primary maintenance concern for media filters, although mosquito control is also an issue. Typical maintenance requirements are as follows:

- During the wet season, inspect periodically for standing water, sediment, trash and debris, and to identify potential problems.
- Remove accumulated trash and debris during routine inspections.
- Replace filter media as needed.
- Complete any other maintenance activities recommended by the manufacturer.

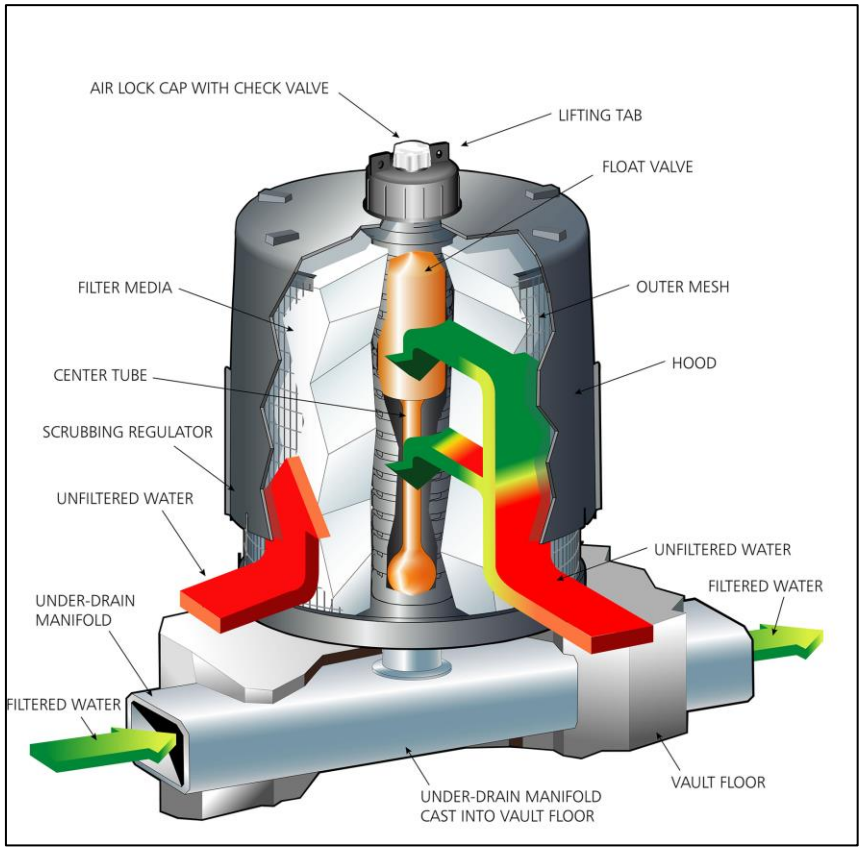

Figure 8-10: Example of a media filter cartridge (Type C, as described in Section 6.10), which is typically used as part of an array (Credit: www.stormwaterinc.com). This drawing is shown for general information only; its use is not an endorsement of any proprietary product.