



Pest Prevention by Design - Landscapes

Authoritative guidelines for
designing out pests



SF Environment

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Online version

Pest Prevention By Design - Landscapes: Authoritative guidelines for designing out pests is the product of a two-year project led by the San Francisco Department of the Environment. The project's goal is to assemble design features and planning considerations that can prevent pest infestations - including weeds - in managed landscapes, and ultimately reduce both labor inputs and pesticide use. This resource is also available online at <https://airtable.com/shrPOKRSuYzxiKDlg>

The online version allows access to all of the details, including downloadable attachments, references, and links to various product examples. Use this version to get the most complete and up-to-date information.

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Pest Prevention by Design for Landscapes

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Disclaimer

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Background

A clever person solves a problem. A wise person avoids it.
- Albert Einstein.

Participants in the City & County of San Francisco's Integrated Pest Management Program had long been questioning the design decisions underlying the landscapes they manage. For example, who designed the irrigation system that resulted in overwatered turf in some areas, leading to weed invasions? Why were median strips installed with ornamental stone ground covers over geotextiles, resulting in weeds that could no longer be pulled by hand? What could be done about rodent burrows in tree wells?

With increasing attention focused on herbicide and rodenticide use in urban areas, the time was right to apply the pest prevention lens to managed landscapes. In 2018, the San Francisco Department of the Environment and the San Francisco Public Utilities Commission organized a series of meetings on the subject, including a wildly interactive "World Café" session, and proceeded to organize an informal workgroup of landscape managers, landscape architects, and IPM professionals to tackle the project. Our intention was to create a local, peer-reviewed resource that could introduce pest prevention into the vocabulary of landscape design, ultimately reducing the need for expensive and hazardous pest control measures.

The idea for this compilation began with its predecessor, Pest Prevention by Design: Authoritative guidelines for designing pests out of structures (2014). This initial compilation of pest preventive design elements was well received by the integrated pest management and green building communities. However, its scope covered only buildings, not landscapes.

As the workgroup conversations progressed, we discovered that landscape and building designs are different beasts. For one, there is fuzzier boundary between design and management elements. Unlike buildings, some of the most important elements of landscape designs are impermanent. For example, critical activities such as plant selection, phytosanitary measures and mulching are not one-time design decisions, but recurrent. Agreeing on a clear scope for this project became a central challenge, because this humble effort could not realistically address all management aspects of all landscapes. In the end, we chose to include the most important management decisions into separate chapters entitled "Maintenance Plan Design" and "Planting Design."

Preventing pests – whether they are weeds, rodents, insects, plant pathogens, or other organisms – is the foundation of any integrated pest management program. While many of the tactics listed in this volume are likely familiar to the reader, we have not found other publications that bring them all together into one set of tools.

Methods

The Department of the Environment contracted Michael Baefsky, a licensed arborist and well-known expert on landscape IPM, to assist with content and editing. The management team undertook a literature review on the subject including scientific literature, manuals, websites, and professional publications. A web-enabled database was developed to organize the resulting information. The Pest Prevention by Design for Landscapes Working Group met eight times in 2018-2019 to systematically filter out pest preventive elements that have a basis in scientific literature or industry experience. The results were summarized in two forms: A database/web site that serves as a living document, and a PDF document that provides a more user friendly format.

How to use these guidelines

This publication is intended for architects, engineers and builders who wish to take green building to the next level, but can be used by anyone who wishes to incorporate well-informed design choices into the design and retrofit of landscapes. To make best use of these guidelines, the user should understand what these guidelines are and are not.

Landscape emphasis. This resource focuses on managed landscapes. For pest preventive design elements in structures, please see the companion volume, *Pest Prevention by Design: Authoritative guidelines for designing pests out of structures* (2014) <https://sfenvironment.org/article/pest-prevention-by-design-guidelines>.

Guidelines, not standards. Best practices vary widely depending on the programming of the landscape, its location, prevailing pests, climate, levels of pest tolerance, and the relative importance of sometimes-competing goals such as construction cost or aesthetics. For this reason, we present these pest prevention tactics as guidelines, not rules or standards. In some cases, we have listed instances where a tactic is likely to conflict with other design goals.

Design and retrofit emphasis. These guidelines include features that be incorporated at either the design stage of a new landscape, or during a retrofit of existing landscapes. In many cases, the tactics can apply to either. Similarly, we specifically excluded management activities, such chemical and nonchemical pest treatments. We felt that these strategies are expertly addressed by other publications, and are predominantly in the realm of pest control professionals, not landscape designers.

Two versions, same information.

PDF version: We created a PDF version to provide a more user friendly format that can also be printed out. It is organized by chapters, but you may also conduct simple text searches for CSI numbers, pests, building types, and other variables. Updated PDFs will be created periodically; check the date of download.

Web version: The web version of this resource is an interlinked database that may be preferable for some users. It is organized by CSI number, but features a variety of filters that can be used with any variable. The web version will always be the most up to date, and offers some variables not found in the PDF version.

Click here for the online version:

<https://airtable.com/shrPOKRSuYzxiKDlg>



CHAPTER 1:

Maintenance Plan Development

Chapter Principles

An all-inclusive design process should involve maintenance managers. This ensures that the proper systems, tools, and infrastructure are in place to support pest management efforts.

- **Include maintenance in administrative systems and budgets**

Include maintenance staff in the design process to ensure better plant selection and adequate consideration of future maintenance needs, including administrative tools such as maintenance plans and pest management tracking systems.

- **Include maintenance and sanitation infrastructure in physical designs**

Plan for easy human and vehicle access, sanitation, and equipment cleaning and maintenance.

1.1 Design with maintenance in mind

APPLICABILITY:

DESIGN STAGE

PESTS AFFECTED:

Mice & Rats

Mammals - other

Weeds

CSI CODE

01 42 19 - Reference Standards

DETAILS

- 1) Design teams should include maintenance managers as well as designers and administrators.
- 2) Use past maintenance efforts as a baseline (see Maintenance Budget Impact Statement tactic).
- 3) Clearly define anticipated visibility issues: Pedestrians, vehicles, etc.
- 4) Incorporate plantings with lower maintenance requirements when possible, for example, substituting untrimmed native bushes for trimmed hedges.
- 5) Consider levels of maintenance that will be required in the future and adjust designs accordingly.



Photo by Daniel McCullough

EFFECT ON PEST

Incorporating maintenance limitations into the design process prevents pest problems caused by inadequate maintenance.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Incorporating maintenance factors into landscape design represents a shift in the design process, which is typically driven by aesthetics or functional factors. Changing processes involves cultural and procedural changes within organizations, which can require time and resources.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Military Museum Plant nursery Park Pipeline row
 Pumping plant Regional watershed Reservoir Restoration site River
 Roadside Rooftop garden Sewage treatment plant Sidewalk garden
 Trails Urban-wildland interface

REFERENCES

Design Trust for Public Space & City of NY - High Performance Landscape Guidelines (2010)

1.2 Budget for IPM

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

Birds Ants Insects - misc Mosquitoes Mice & Rats
Mammals - other Plant diseases Tree roots Weeds

DETAILS

Incorporate time and resources for IPM into all maintenance planning. This includes routine pest monitoring, record keeping and communicating pest control advisor(s)'s recommendations, and the flexibility to modify IPM approaches based on changing conditions.

IPM costs include labor and equipment fees associated with maintenance monitoring, as well as the costs of creating and maintaining record keeping systems such as mapping or database software. The IPM budget also incorporates audits of onsite garbage generation and other sanitation issues.

CSI CODE

01 30 00 - Administrative Requirements



Photo by StellrWeb

EFFECT ON PEST

Budgeting for costs associated with IPM monitoring and feedback based on landscape situations will ensure ongoing IPM implementation and more effective pest management overall.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Rooftop garden Sewage treatment plant
Sidewalk Sidewalk garden Sports turf Trails Tree well Turf grass
Unpaved road Urban-wildland interface Vacant Wildland

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

1.3 Create maintenance budget impact statement

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

Birds Ants Insects - misc Mosquitoes
Mice & Rats Mammals - other Plant diseases

DETAILS

Draft a maintenance budget impact statement as a cost estimate of staff, material and equipment needed to install and maintain new landscapes and to sustain them after they are established. Results may be used to modify the project if needed.

1) Maintenance impact statements should differentiate between programmatic elements and major material assemblies within the new landscape, which may have varying life expectancies or user wear. Impact statements should realistically anticipate levels of usage for each area or major element.

2) Specialty elements should be individually itemized or expressed on a linear foot, square foot, or acre basis to facilitate adjustments to proposed designs.

3) Provide data on space requirements for anticipated materials, equipment, staff, and staging areas required for regular maintenance.

4) When feasible, estimate future costs avoided by incorporating IPM programming, for example, by reducing frequency of landscape renovations.

5) Use the impact statement to form the basis of the comprehensive management plan for use after the completion of the project.

EFFECT ON PEST

Including adequate maintenance budgets prevents landscape degradation that leads to pest problems.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Preparing a maintenance budget impact statement requires time, which is an additional cost for the planning process.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Rooftop garden Sewage treatment plant
Sidewalk Sidewalk garden Sports turf Trails Tree well Turf grass
Unpaved road Urban-wildland interface Vacant Wildland

CSI CODE

01 30 00 - Administrative Requirements



Photo by Nik MacMillan

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

Design Trust for Public Space & City of NY - High Performance Landscape Guidelines (2010), San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

1.4 Develop an equipment maintenance plan

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

Birds Ants Insects - misc Mosquitoes Mice & Rats
Mammals - other Plant diseases Tree roots Weeds

DETAILS

Equipment maintenance plans (EMP) define the tasks or procedures and all associated information needed to properly maintain equipment.

It is generally best to develop an EMP for each type or class of equipment and then apply the identified maintenance to all the equipment that is of the same type or class. When you have the same type of equipment, but in different operating environments, you may want to develop separate EMPs for each of them and apply different frequencies, man-hours and special tools/materials to each. For example, particular tools such as hoes, mulching mowers, and chippers may be needed on specific sites. The availability of specialty tools can be verified via EMPs as well.

When outside contractors are required for maintenance, their contact information should also be included in the EMP.

EFFECT ON PEST

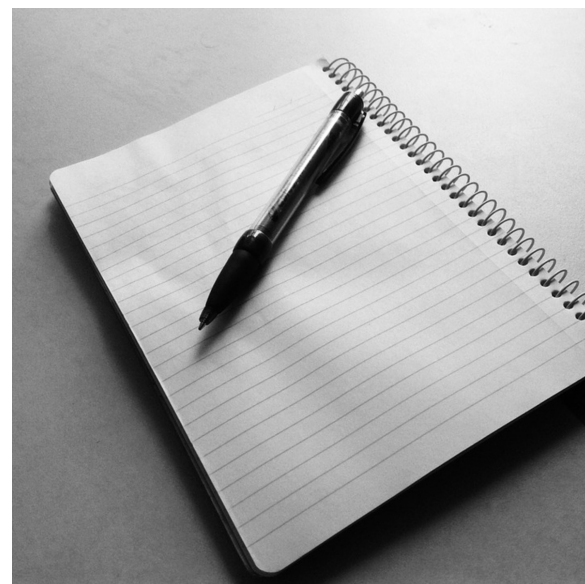
Pest management is often a time-sensitive activity, and tools must be available - and in good repair - when they are needed. Detailed planning for long-term maintenance minimizes pest problems caused by lack of tools. For equipment used for cutting vegetation, clean, sharpened blades are also important to obtain clean cuts with reduced chances of infection.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Preparation of an equipment maintenance statement will require time, adding cost to the planning process.

CSI CODE

01 93 13 - Facility Maintenance Procedures



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Rooftop garden Sewage treatment plant
Sidewalk Sidewalk garden Sports turf Trails Tree well Turf grass
Unpaved road Urban-wildland interface Vacant Wildland

REFERENCES

Life Cycle Engineering, Inc. - Developing Equipment Maintenance Plans White Paper (2011), San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

1.5 Develop an IPM data management system

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

Birds Ants Insects - misc Mosquitoes Mice & Rats
Mammals - other Plant diseases Tree roots Weeds

DETAILS

Design a data management/record keeping system to provide and maintain site-specific information about pest populations and treatments. Efficient IPM data storage and retrieval systems provide timely geographical and/or historical pest data that support quality decision making.

IPM data includes complaints, observations, pest identification, population estimates, locations and conditions, treatments, and time and materials used for monitoring and treating pest problems.

CSI CODE

01 93 13 - Facility Maintenance Procedures



Photo by Pestpac

EFFECT ON PEST

An IPM data storage and recovery system improves efficiency for practitioners and public access to that information. Easy access to historical pest and treatment data allows for more efficient preventative treatments and assists in analyzing trends in different locations and from different pests.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Time and materials costs are needed to develop, implement and maintain an IPM data management and retrieval system.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--|------------------------|
| Marin County Parks IPM Treatment Reports | Marin County |
| Santa Clara County Web-Based IPM Activities and Pesticide Use Reporting Database (IPM-PUR) | Santa Clara County |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Rooftop garden Sewage treatment plant
Sidewalk Sidewalk garden Sports turf Trails Tree well Turf grass
Unpaved road Urban-wildland interface Vacant Wildland

REFERENCES

Purdue U - Record Keeping (2014), U of Nevada, Cooperative Extension - IPM Record-Keeping Forms (2019), U of Nevada, Cooperative Extension - Principles of IPM (2019), San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

1.6 Plan for cleaning equipment

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

CSI CODE

PESTS AFFECTED:

Weeds

DETAILS

Institute a plan for thoroughly cleaning landscaping equipment to avoid spread of weed seeds, rhizomes or roots between sites. For larger equipment this may require constructing a cleaning station, ideally with provisions for filtering and recycling wash water.



Photo by Chris Geiger

EFFECT ON PEST

In situations where equipment is frequently transported between management sites, such as municipal parks, removing seeds and other plant material from the equipment can greatly reduce the spread of invasive weeds.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Additional time and resources may be required.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Golf course Lake Median strip Plant nursery Pipeline row
 Regional watershed Restoration site Roadside Reservoir
 Sidewalk garden Sports turf Trails Turf grass

REFERENCES

UC Statewide IPM Program - Sanitation (2019)

1.7 Plan for frequent refuse removal

APPLICABILITY:

INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

Birds Ants Insects - misc Mice & Rats

Mammals - other

DETAILS

Schedule site- and refuse stream-specific waste removal for each site.

Adapt and modify refuse removal schedules based on monitoring and with consideration for existing pest populations and their life stages, changing seasons and weather patterns, and expected refuse volume.

CSI CODE

01 93 13 - Facility Maintenance Procedures

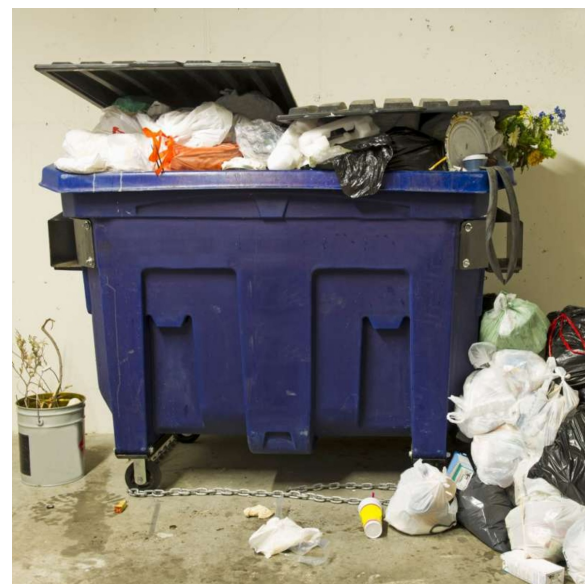


Photo by StockstudioX & Getty Images

EFFECT ON PEST

Removing refuse before it attracts pest populations will reduce pest activity in the vicinity of the garbage containers. Increased sanitation has the potential to reduce pest populations on the entire site.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Frequent garbage removal requires additional labor and budget for monitoring, planning and implementing.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Building perimeter Golf course Hospital Industrial Military Museum

Plant nursery Park Plaza Roadside Rooftop garden Trails

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), R.M. Timm et al. - How to Manage Pests - Rats (2011), E.C. Mussen & M.K. Rust - How to Manage Pests - Yellowjackets & Other Social Wasps (2012)



CHAPTER 2:

Soils and Water

Chapter Principles

Know your soil and water! Matching plant selections to soil and water factors can promote healthier vegetation and reduce pests and diseases. Soil erosion, compaction, drainage and nutrient levels can also worsen pest problems - including mosquitoes.

- **Use the site's soil and water factors to inform plant selection**

Analyze irrigation water and test soils to understand the site's constraints and the need for soil amendments. Select plant material that matches soil and water parameters, especially in terms of soil salinity, drainage requirements, hydrozones and water budgets.

- **Manage soils to reduce pest problems**

Minimize soil disturbance and compaction, which can promote weed growth and adversely affect plantings. Maintain proper drainage to reduce mosquito and plant disease incidence. Fertilize based on plant needs; too much or too little fertilizer can affect pest and disease incidence.

2.1 Planter drainage

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mosquitoes

DETAILS

Design planters to prevent the accumulation of drainage water, which can support mosquito populations. Design drainage water receptacles so that they do not retain water for long, for example, by incorporating drainage tubes. For retaining wall-type planters, include drainage holes below soil line. If accumulation of water cannot be prevented, then seal off openings to the drainage area using 1/16" or finer mesh.

EFFECT ON PEST

Drainage water in planters is a common habitat for certain mosquito species. Reducing any standing water will reduce mosquito populations.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Additional up-front expense to adapt planters.

APPLICABLE LANDSCAPE TYPES

Plant nursery Park Plaza Rooftop garden Sidewalk garden

CSI CODE



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

2.2 Prevent soil disturbance

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

Prevent soil disturbances prior to, during and following new landscape installation.

Conserve native topsoil by planning access routes, covering bare soil, limiting foot and vehicle traffic, and designating storage and parking areas. Plan walkway and roadway widths to accommodate anticipated maintenance vehicle widths and turning radii without damage to curbing or softscape areas.

EFFECT ON PEST

Preserving undisturbed soils enhances resistance to plant diseases and reduces the spread of weeds into areas vacated or not occupied by healthy growing plants.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Preventing or minimizing soil disturbances can increase the cost of installation by requiring more careful and time-consuming habits on a job site. Design options may be limited when grading is minimized.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Park Parking lot Pipeline row
Plaza Pumping plant Regional watershed Reservoir Restoration site
River Roadside Rooftop garden Sewage treatment plant
Sidewalk garden Sports turf Trails Tree well Turf grass Unpaved road
Urban-wildland interface Vacant Wildland

CSI CODE

31 01 00 - Maintenance of Earthwork

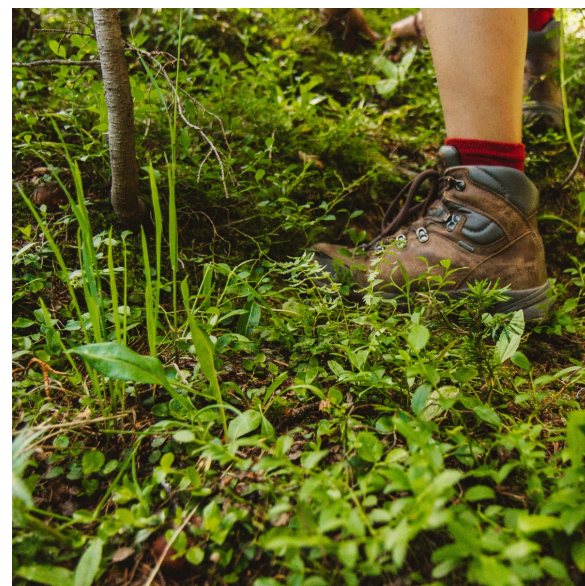


Photo by Holly Mandarich

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

D. Hanks & A. Lewandowski - Protecting Urban Soil Quality: Examples for Landscape Codes and Specifications (2003), Cal-IPC - Preventing the Spread of Invasive Plants (2012), C. Napper et al. - Soil Disturbance Field Guide (2009), P. Kotanen - Effects of Experimental Soil Disturbance on Revegetation By Natives and Exotics in Coastal California Meadows (1997)

2.3 Prevent soil compaction

APPLICABILITY:

DESIGN STAGE

PESTS AFFECTED:

Plant diseases

Weeds

DETAILS

Prevent soil compaction by developing site-specific guidelines based on existing soil types. Identify critical areas such as steep slopes, waterways, and vegetated buffers along streams, lakes, and wetlands. Consider how water will flow off of impervious surfaces (roofs, pavement), and where the water could be absorbed. Determine which trees and other healthy vegetation can be preserved. Test the soil to determine its existing depth and quality.

Based on these observations, make a soil management plan that divides the area into:

1. Protected zones where existing soil and vegetation will not be disturbed.
2. Zones that will be managed with minimal disturbance.
3. Zones where construction traffic will be allowed.
4. Space for stockpiling topsoil and imported amendments.

Make the first two zones as large as possible and fence them off from construction traffic. Ensure that some parts of the landscape are left free of traffic to ensure good water absorption and drainage.

Reducing compaction to 1400 kiloPascal (kPa) or less is considered a reasonable standard. The strength of a typical soil after construction may be 6000 kPa. The limit of root growth is defined as 3000 kPa, but roots are restricted at much lower levels.

EFFECT ON PEST

Preventing soil compaction reduces invasive exotic weed infestations and the development and spread of biotic (phytophthora, armillaria) and abiotic (oxygen depletion, water logging) diseases.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Preventing soil compaction on job sites may translate into a higher construction cost. Well designed and administered soil compaction prevention will cost time and materials for design, installation and maintenance during the life of the installation.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Sewage treatment plant Sidewalk
Sidewalk garden Sports turf Trails Tree well Turf grass
Urban-wildland interface Vacant Wildland

CSI CODE

32 04 90.33 - Topsoil Preservation



Photo by Paul Jarvis

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

D. Hanks & A. Lewandowski - Protecting Urban Soil Quality: Examples for Landscape Codes and Specifications (2003), A.L. Shober et al. - Soil Compaction in the Urban Landscape (2018), T.R. Randrup (1997), J. Lichter & P.A. Lindsey - The Use of Surface Treatments (1994)

2.4 Test soils before plant selection

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Tree roots Weeds Insects - misc

DETAILS

Analyze the physical, chemical, and biological qualities of soil prior to designing the landscape. Include evaluations of the soil texture, structure, percentage organic matter, major and minor chemical (nutrient) elements, salts and pH.

Generally, collecting from two sampling depths - such as 0-12" and 12-24" - is a good idea for new sites. Collect 10-15 subsamples from discrete areas of the site, and mix them together thoroughly in a clean 5 gallon bucket. Place the amount of sample required by the laboratory (8-16 ounces) into sampling bags provided by the laboratory. Consider sampling at different depths if, for example, soil color changes at 6", in which case take samples from 0-6" (above the color change), and 6-12" (below the color change).

CSI CODE

02 24 23 - Chemical Sampling and Analysis of ...



Photo by Michael Baefsky

EFFECT ON PEST

Designing a landscape that complements the site's soil characteristics aids plant selection, irrigation design, and soil preparation.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Conducting a soils analysis require additional time and money.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-----------------------------------|------------------------|
| AMS 3/14" Basic Soil Sampling Kit | AMS |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial Lake Median strip Military Museum Plant nursery Park Parking lot Pipeline row Plaza Pumping plant Regional watershed Reservoir Restoration site River Roadside Rooftop garden Sewage treatment plant Sidewalk garden Sports turf Trails Turf grass Wildland

REFERENCES

R. Smith - Selected Plant and Soil Laboratories in N. and Central CA (2018), Brookside Labs, Inc. - How to Take A Soil Sample (2009), CA Code of Regs - Model Water Efficient Landscape Ordinance (2009), R. Kourik - Understanding Roots... (2015), J. Urban - Up By Roots (2008), P.J. & T.A. Craul - Soil Design... (1992), P.J. Craul - Urban Soils... (1999)

2.5 Water analysis

APPLICABILITY:

DESIGN STAGE

PESTS AFFECTED:

Insects - misc

Plant diseases

DETAILS

Begin by locating a lab that analyzes irrigation water and collecting one or more water samples that represent the irrigation water.

Analyze for pH, boron, chloride, sodium, total dissolved salts, salinity, and bicarbonates. Use lab interpretation of levels to screen plants based on their tolerance to these factors.

CSI CODE

02 24 13.43 - Water Assessment



Photo by Hans Reniers

EFFECT ON PEST

Designing irrigation and selecting a plant palette based on water analysis reduces abiotic plant diseases. It also reduces population spikes of sucking arthropods such as aphids, spider mites and whiteflies that increase when irrigated with high nitrogen recycled water.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Water analysis costs money, takes time and modifies the plant palette. A landscape that tolerates the water conditions on a site may not be the landscape that was originally conceived, and its aesthetic may require some adjustments and explanations to client or stakeholder.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Park Parking lot Plaza
 Pumping plant Regional watershed Reservoir Roadside Rooftop garden
 Sewage treatment plant Sidewalk garden Sports turf Trails Turf grass
 Urban-wildland interface Vacant Wildland

REFERENCES

G.D. Denny & G. Hansen - Right Plant, Right Place (2018), R. Smith - Selected Plant and Soil Laboratories in N. and Central CA (2018), WaterReuse Foundation - Salinity Mgmt Guide (2007)

2.6 Base soil amendments on soil testing

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Plant diseases Tree roots Weeds Insects - misc

DETAILS

Soil analysis can assist in planning what to plant, and will also give critical information on the need for amendments. Healthy woody ornamentals usually do not require fertilization, and drought stressed plants should never be fertilized. A small amount of nutrient stress may be beneficial to increase root growth.

However, in some cases amendments may be beneficial in correcting deficiencies, particularly with regard to organic matter and texture. To determine the need for soil amendments, first check peer-reviewed scientific guidelines to assess plant nutrient needs. Pay particular attention to salts, pH, boron and magnesium levels.

EFFECT ON PEST

Designing a landscape that complements the site's soil characteristics aids plant selection, irrigation design, and soil preparation. Soil amendments - particularly organic matter - may promote plant health and disease/pest resistance. Too much fertilizer, however, can promote the growth of certain sucking insects and weaken plants, especially young ones.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Conducting a soils analysis and considering fertilization needs require additional time and money.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial Lake Median strip Military Museum Plant nursery Park Parking lot Pipeline row Plaza Pumping plant Regional watershed Reservoir Restoration site River Roadside Rooftop garden Sewage treatment plant Sidewalk garden Sports turf Trails Turf grass Wildland

CSI CODE

02 24 23 - Chemical Sampling and Analysis of ...



Photo by Better Homes & Gardens

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

Cornell University Cooperative Extension (2011), R. Kourik - Understanding Roots... (2015), J. Urban - Up By Roots (2008), P.J. & T.A. Craul - Soil Design... (1992), P.J. Craul - Urban Soils... (1999)

2.7 Drainage to prevent mosquitoes

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED: Mosquitoes

DETAILS

Assess drainage; there should never be standing water on a site for more than 72 hours. For dry systems that are designed to drain completely following a storm event and remain dry, pay attention to groundwater depth. Select a BMP that allows water to flow by gravity through the structure, with adequate slopes to drain fully and prevent standing water. The design slope should take into consideration buildup of sediment between maintenance periods. Incorporate features that prevent or reduce the possibility of clogged discharge orifices (e.g., debris screens).

The use of weep holes is not recommended due to rapid clogging. Compaction during grading may also be needed to avoid slumping and settling. Avoid the use of loose riprap or concrete depressions that may hold standing water. Avoid barriers, diversions, or flow spreaders that may retain standing water.

Stormwater ponds and constructed, modified, or restored wetlands that receive runoff and provide stormwater treatment nearly all produce mosquitoes to some degree. For these structures ensure that funds are allocated to support long-term site maintenance as well as routine monitoring and management of mosquitoes by a qualified agency.

EFFECT ON PEST

Adequate drainage of water minimizes mosquito breeding, nuisances and health risks.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Ensuring drainage to prevent mosquito habitat in the landscape requires time, tools and materials. Retrofitting is more challenging if existing landscapes are only partially modified.

APPLICABLE LANDSCAPE TYPES

Baylands Golf course Creek Hospital Industrial Lake Military
Museum Plant nursery Park Pipeline row Pumping plant
Regional watershed Reservoir Restoration site River Roadside
Rooftop garden Sewage treatment plant Sidewalk garden Sports turf
Trails Tree well Turf grass Unpaved road Urban-wildland interface
Vacant Wildland

CSI CODE

02600 Drainage and Containment

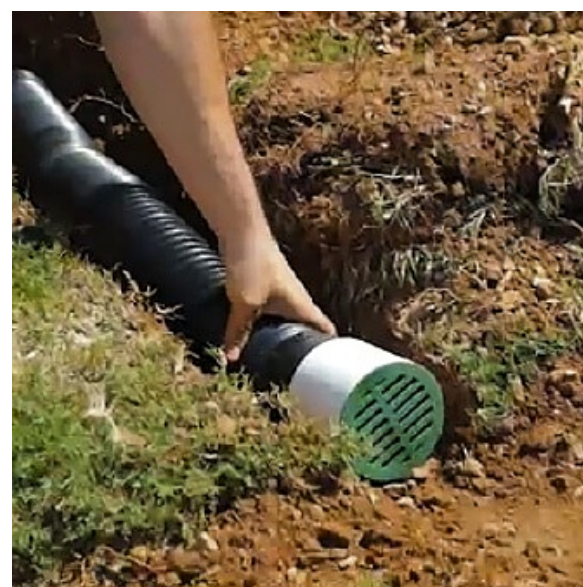


Photo by Adams Landscape Supply

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), M.E. Metzger - Managing Mosquitoes in Stormwater Treatment Devices (2004), P.R. Rector et al. - Rain Gardens and Mosquitoes (2012)



Photo by Jake Voit,
Courtesy of ReScape California

CHAPTER 3: Planting Design

Chapter Principles

Take care in choosing what plants to plant and where to plant them, in order to minimize weeds, plant diseases, and insect pests.

- **Design with the whole area in mind**

When designing plantings, evaluate the larger landscape context with regard to nearby rodent infestations and harborage, rodent food and water sources, established paths, and likely points of entry.

- **Prioritize plant diversity**

Diverse plantings can hedge your bets against major pest and disease infestations. Plant diversity also supports a wider range of beneficial insects, which may help control insect pests. Native plants are often the species best adapted for survival, and also support local pollinators and ecosystems.

- **Beware of introducing invasive plants**

Because non-native, invasive species are often introduced as ornamentals, landscape designers have a special responsibility to carefully consider the long-term impacts of each plant they select. Invasive species often have a competitive advantage because their native herbivores are not present. That means they can quickly become serious weeds.

- **Choose pest-resistant plants**

When specific pests or diseases are known to occur on or in the region of a planting site, selecting resistant plants or plant varieties can promote a more resilient landscape.

3.1 Choose resistant plants

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Insects - misc Mammals - other Plant diseases

DETAILS

Use plants recommended for local climates by scientific research institutions, such as universities and cooperative extension.

Resistant plants are able to tolerate, biologically resist or otherwise avoid pest damage. When specific pests are known to occur on or in the region of the site, then known resistant species and/or varieties should be selected.

EFFECT ON PEST

Using pest-resistant plants eliminates the need for other pest management activities.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Documented pest resistant plants may not be as aesthetically pleasing or desirable as susceptible species. It can be more difficult to locate and purchase pest resistant plants.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Park Parking lot Pipeline row
Plaza Pumping plant Regional watershed Reservoir Restoration site
River Roadside Rooftop garden Sewage treatment plant Sidewalk
Sidewalk garden Sports turf Trails Turf grass Unpaved road
Urban-wildland interface Vacant Wildland

CSI CODE

01 45 13 - Source Quality Code Procedures

32 93 00 - Plants

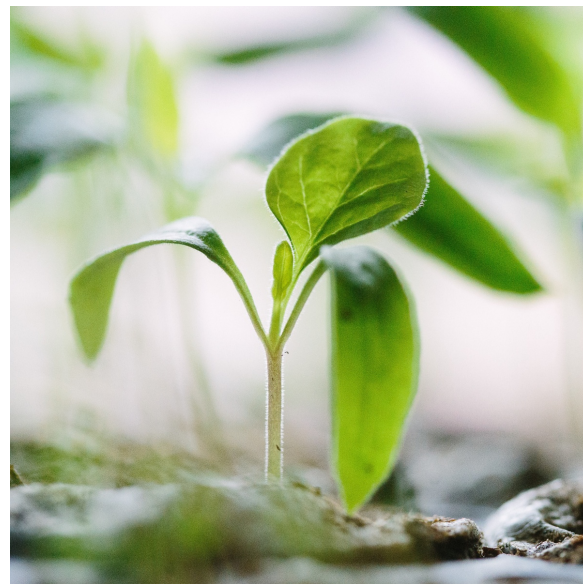


Photo by Francesco Gallarotti

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

G.D. Denny & G. Hansen - Right Plant, Right Place (2018), S. Dreistadt - Pests of Landscape Trees... (2016)

3.2 Minimize cracks between pavers

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

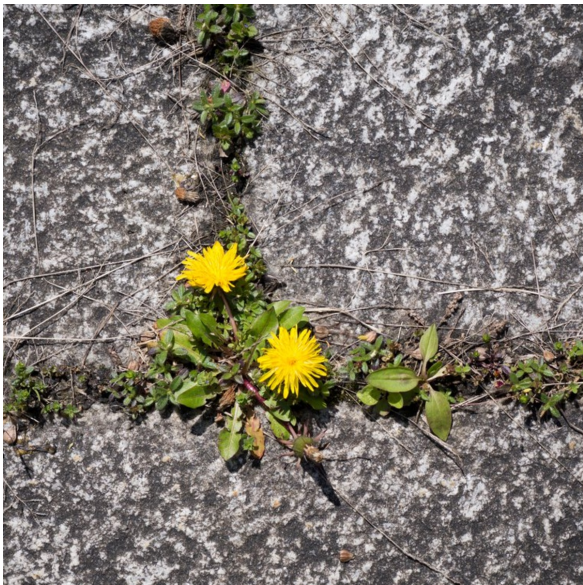
PESTS AFFECTED: Weeds

DETAILS

Install paving with narrow joints (2-5mm) in between. Use fine-grained (0/2 mm) joint-filling sand or silica caulking to prevent weeds.

CSI CODE

01 93 13 - Facility Maintenance Procedures



EFFECT ON PEST

Fewer weeds in between pavers can be achieved by using Minimal Weed Paving systems.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Preventing pavement weeds by using narrow gap pavers and coarse sand or silica caulking involves additional costs of installation and maintenance, beyond standard pavement products and methods.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|---------------------------------|------------------------|
| Sodium Silicate Pavement Sealer | |

APPLICABLE LANDSCAPE TYPES

- Building perimeter
- Golf course
- Hospital
- Industrial
- Median strip
- Military
- Museum
- Park
- Parking lot
- Reservoir
- Restoration site
- Roadside

REFERENCES

A. Muller & M. Fink - Studies on allelochemical and mineral compounds for sustainable weed control in a pavement filler from brick recycling material (2017), B. De Cauwer et al. - Integrating preventative and curative non-chemical weed control strategies (2014)

3.3 Rodent-proof planter boxes

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mice & Rats Mammals - other

DETAILS

Planter boxes that are designed or maintained without gaps that would allow rodent access prevent infestations.

Products made of welded steel do not have gaps and are not amenable to rodent gnawing. Prevent gaps of 1/4" that allow mice entrance, and/or 1/2" that allow rat entrance by using products such as concrete, galvanized sheet metal, brick and hardware cloth.

CSI CODE

32 31 56 - Wildlife Deterrent Fence



Photo by Revolution Landscape

EFFECT ON PEST

Rodent-proof planter boxes prevent rodent infestations from below or the sides.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Rodent-proof containers are more expensive than those that are not. Alternatively, retrofitting existing planter boxes to become rodent-proof adds time and materials costs.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|----------------------------------|---|
| Double galvanized wire mesh roll | Gopherslimited.com |
| Corten Steel Planter Box | Veradek Metallic Series Corten Steel Planter Box |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Plant nursery
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sidewalk garden
- Sports turf
- Trails
- Tree well
- Turf grass
- Unpaved road
- Urban-wildland interface
- Vacant
- Wildland

REFERENCES

EXtension - Rodent Exclusion Methods (2013), San Francisco Dept. of Public Health - Director's Rules and Regulations For Prevention and Control of Rodents and other Vectors (2007)

3.4 Use participatory design approach

APPLICABILITY:

DESIGN STAGE

PESTS AFFECTED:

Birds Ants Insects - misc Mosquitoes Mice & Rats
Mammals - other Plant diseases Tree roots Weeds

DETAILS

Form an integrated design team that includes professionals knowledgeable in maintenance.

Develop a collaborative communication process that allows the viewpoints and perspectives of all members to be fully considered in the decision-making process. Designate a team facilitator to be responsible for overseeing and ensuring a collaborative communication process.

Identify project sustainability principles and performance goals.

CSI CODE

01 42 19 - Reference Standards



Photo by You X Ventures

EFFECT ON PEST

Incorporating maintenance considerations into landscape designs reduces any future pest problems that might arise from inadequate maintenance staffing or resources.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Designing with maintenance in mind takes more time and costs more at the design stage due to the added complexity and multiplicity of factors needing review.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Plant nursery Park Parking lot
Pipeline row Plaza Pumping plant Regional watershed Reservoir
Restoration site River Roadside Rooftop garden Sewage treatment plant
Sidewalk Sidewalk garden Sports turf Trails Tree well Turf grass
Unpaved road Urban-wildland interface Vacant Wildland

REFERENCES

D. de la Pena et al. - Design as Democracy... (2017), J. Green - Participatory Design Must Evolve (2018), CA Dept. of Real Estate - Operating Cost Manual for Homeowner Assn's (2016), Design Trust for Public Space & City of NY - High Performance Landscape Guidelines (2010), San Francisco Dept. of the Envir. - World Cafe Meeting (2018), U.S. Green Business Council - SITES v2 Rating System For Sust. Land Design... (2014)

3.5 Emphasize native and insectary plantings

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Insects - misc

DETAILS

Many beneficial insects use pollen and nectar as a food source. Increasing the availability of "insectary plants" can therefore help support existing biological controls of insect pests. Ideally, select plants with staggered bloom periods to provide pollen and nectar year-round. Native species are generally best suited to supporting local insect populations and ecosystems.

In California, for example, insectary plants suitable for hedgerows include black sage (*Salvia mellifera*), California buckwheat (*Eriogonum fasciculatum*), California lilac (*Ceanothus* spp.), white sage (*Salvia apiana*), willows (*Salix* spp.), goldenrods (*Euthamia occidentalis*, *Solidago californica*), heliotrope (*Heliotropium curassavicum*), yarrow (*Achillea millefolium*), sweet alyssum (*Lobularia maritima*), and coriander (*Coriandrum sativum*).

EFFECT ON PEST

Insectary plantings reduce insect pests indirectly by helping support populations of insect parasitoids and predators. Native species are generally best adapted to local climates, resulting in improved plant health and fewer pest problems.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Care must be taken to avoid insectary plants that also carry plant pathogens or pest insects.

CSI CODE

32 93 00 - Plants

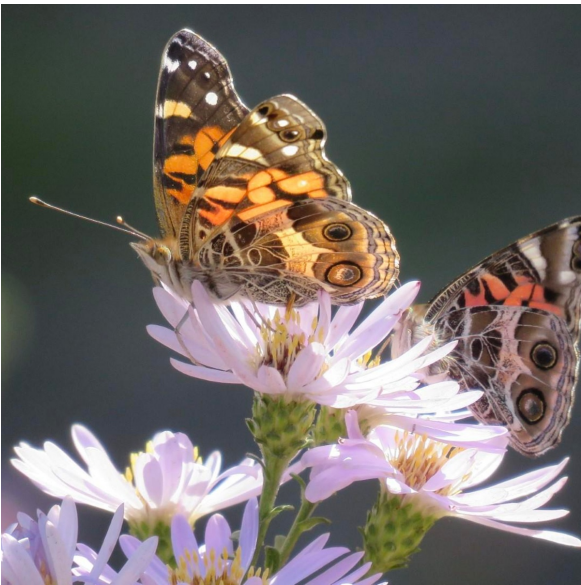


Photo by Liam O'Brien

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|----------------------------|----------------------------------|
| SF PlantFinder | City and County of San Francisco |
| Insect Habitat Plants | Rincon-Vitova Insectaries |
| Insectary Plant Seed Blend | Harmony Farm Supply & Nursery |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk garden
- Sports turf
- Trails
- Turf grass
- Urban-wildland interface
- Vacant
- Wildland

REFERENCES

R. Kourik - Flower-Bloom-Cycle Chart for Attracting Beneficial Insects (2019), San Francisco Dept. of the Envir. - World Cafe Meeting (2018), R.F. Long & J.H. Anderson - Establishing Hedgerows on Farms in California (2010), R.L. Bugg et al. - Flower Flies (Syrphidae) and Other Biological Control Agents for Aphids in Vegetable Crops (2008), UC Statewide IPM Program - Insectary Plants (2019)

3.6 Select plants not favored by rats

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mice & Rats

DETAILS

Choose plants with vase or upright growth forms, with more openness underneath. Deciduous shrubs and broadleaf evergreens are preferred. Plants that form impenetrable thickets are not.

Avoid known problem plants such as Algerian ivy (*Hedera canariensis*), ice plant (*Caprobrotus edulis*), arborvitae (*Platycladus orientalis* spp.), bamboo (*Bambusa* spp.), date palm (*Phoenix dactylifera*), English ivy (*Hedera helix*), Hall's honeysuckle (*Lonicera japonica halliana*), Himalayan blackberry (*Rubus armeniacus*), Italian cypress (*Cupressus sempervirens*), lirioppe (*Liriope muscari*), Lombardy poplar (*Populus nigra italica*), pachysandra (*Pachysandra* spp.), pampas grass (*Cortaderia selloana*), star jasmine (*Trachelospermum jasminoides*), tamarix juniper (*Juniperus sabina tamariscifolia*), and variegated Algerian ivy (*Hedera canariensis* variegata).

EFFECT ON PEST

Using rat-limiting plants reduces rat populations in their direct proximity.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Rat-limiting plants such as Algerian ivy and periwinkle can prevent soil erosion on steep slopes. Their elimination on steep slopes may increase soil erosion.

APPLICABLE LANDSCAPE TYPES

- Building perimeter
- Hospital
- Industrial
- Museum
- Plant nursery
- Pumping plant
- Rooftop garden
- Sewage treatment plant

CSI CODE

32 93 00 - Plants



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

Geiger & Cox - Pest Prevention by Design (2012), G.D. Denny & G. Hansen - Right Plant, Right Place (2018), San Francisco Dept. of the Envir. - World Cafe Meeting (2018), B.A. Colvin et al. - Rat Infestation of Urban Landscaping (1996), R.E. Marsh - Landscape Plants, Forest Trees, and Crops Most Resistant to Mammal Damage (1991), Santa Barbara Mosquito & Vector Mgmt District - Groundcovers Not Attractive to Rats

3.7 Select plants resistant to grazing animals

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Ants Insects - misc Mice & Rats Mammals - other

CSI CODE

32 93 00 - Plants

DETAILS

Use plants that have documented resistance to deer, insect and mite pests when those pests are known to occur in the area of a site.

Deer have seasonal and local preferences, and while references abound, use these as general guidelines, not guaranteed rules.

Insect and mite resistance is well documented, but species have local, regional, and statewide distributions, so make sure that scientific names are correlated for both the resistant host and the pest you are seeking to resist.



EFFECT ON PEST

Using animal-resistant plants eliminates the need for animal management.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Animal-resistant plants may not be as aesthetically pleasing or desirable as susceptible species. It can be more difficult to locate and purchase pest-resistant plants.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Park Parking lot Pipeline row
 Plaza Pumping plant Regional watershed Reservoir Restoration site
 River Roadside Rooftop garden Sewage treatment plant
 Sidewalk garden Sports turf Trails Turf grass Unpaved road
 Urban-wildland interface Vacant Wildland

REFERENCES

S.V. Swain et al. - Pitch Moth (2013), G.D. Denny & G. Hansen - Right Plant, Right Place (2018), R.M. Timm - Deer-Resistant Plants (2013), UC Statewide IPM Program - Susceptibility of Fuchsia; Relative Susceptibility of Pines (2019), C.S. Koehler & W.W. Moore - Resistance of... (1983), A.L. Antonelli & R.L. Campbell - Root Weevil Control... (1984), UC Master Gardeners (Sonoma) - Deer Resistant Plants (2019)

3.8 Consider microclimate during plant selection

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Insects - misc Plant diseases Weeds

DETAILS

Evaluate site microclimates created by topography, soil, water, wind and structures. Match plant characteristics with soils, air temperature, humidity, solar and terrestrial radiation, wind and rain patterns on a site-by-site basis.

Use local plant databases such as SF PlantFinder, WUCOLS IV, and Sunset Western Garden Book, and fine-tune for microclimates.

CSI CODE

32 93 00 - Plants



Photo by Cameron Venti

EFFECT ON PEST

Micro-climate adapted plants are healthier and more pest resistant than non-adapted plants.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Selecting micro-climate adapted plants adds an additional layer of necessary evaluations and screening for the plant palette, which add to the design costs.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|----------------|----------------------------------|
| SF PlantFinder | City and County of San Francisco |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Park Parking lot Pipeline row
 Plaza Pumping plant Regional watershed Reservoir Restoration site
 River Roadside Rooftop garden Sewage treatment plant
 Sidewalk garden Sports turf Trails Turf grass Urban-wildland interface
 Vacant Wildland

REFERENCES

G.D. Denny & G. Hansen - Right Plant, Right Place (2018), R.D. Brown - Design with Microclimate (2010), L.R. Costello and K.S. Jones - WUCOLS IV: Water Use Classification of Landscape Species (2014), K.N. Brenzel - The New Sunset Western Garden Book (2012), SF Plant Finder (2017), Cal-IPC - Preventing the Spread of Invasive Plants (2012)

3.9 Select weed-competitive plants

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Select plants with known capacity to outcompete weed species of regional concern. This applies to any plantings but is especially important for groundcovers and turfgrass selection. Consider adaptations to soils, water, sun, shade, weather and (if applicable) intended use to identify the optimal species or variety for a given situation.

CSI CODE

32 93 00 - Plants



EFFECT ON PEST

Using weed-competitive plants increases desired landscape benefits, improves desired plant health and reduces weed control efforts.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Plants that are strong competitors are invasive themselves and may become weeds in certain settings. Adding an additional layer of plant material to the landscape increases installation costs and requires additional irrigation, at least initially.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk garden
- Sports turf
- Trails
- Turf grass
- Urban-wildland interface
- Vacant
- Wildland

REFERENCES

A.M. Haravandi et al. - Turfgrass Selection for the Home Landscape (2011), C.A. Wilen et al. - Integrated Weed Management: Turfgrass (2016), Cal-IPC - Preventing the Spread of Invasive Plants (2012)

3.10 Employ temporary plantings

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED: Insects - misc Weeds

DETAILS

Install temporary plantings - known in agriculture as cover crops - around new perennial plantings to reduce weed infestation and increase soil health. Commonly used in restoration projects (see hydroseeding).



Photo by Loren Gu

EFFECT ON PEST

Temporary plantings can outcompete weeds and prevent weed seed growth.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|---|--|
| Cover Crop Chart: Common Cover Crops for California | Natural Resources Conservation Service |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Temporary plantings require labor, tools and materials to install and maintain. They may also require labor and tools to remove, dispose of or incorporate into the soil.

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk garden
- Trails
- Urban-wildland interface
- Vacant
- Wildland

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), B. Hartzler and M. Anderson - Impact of cover crops on weed management, blog post (2019), M. Schonbeck - Plant and Manage Cover Crops for Maximum Weed Suppression (2011), C. Ingels et al. - Selecting the right cover crop gives multiple benefits (1994)

3.11 Hydrozone plantings

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

Hydrozoning begins with evaluating soils, sun and shade. Plants can be classified according to their water needs using the Water Use Classification of Landscape Species (WUCOLS) or SF Plantfinder (these tools also include other filters, such as pollinator habitat and California native species).

Group plantings according to their water needs to decrease the chances of over- or under-watering, and to simplify irrigation installations.

EFFECT ON PEST

Hydrozoning prevents plant diseases associated with overwatering, including root, root crown and trunk rots, leaf spot diseases, and leaf and twig blights. Hydrozoning can also prevent insect pests associated with underwatering, such as greenhouse thrips (*Heliothrips haemorrhoidalis*) and two spotted spider mites (*Tetranychus urticae*), and can also minimize attacks of bark beetles (*Scolytinae* subfamily) on woody plants.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Hydrozoning limits and complicates the plant palette available for design. Some plant combinations that are desired for aesthetic reasons will not be acceptable when hydrozoning. This may increase the time needed during the design process.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
Lake Median strip Military Museum Park Parking lot Pipeline row
Plaza Pumping plant Regional watershed Reservoir Restoration site
River Roadside Rooftop garden Sewage treatment plant
Sidewalk garden Trails Wildland

CSI CODE

32 93 00 - Plants



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--|--|
| SF PlantFinder | City and County of San Francisco |
| WUCOLS IV Water use classifications of landscape species | Univ. of California |
| WELO Water Budget Based Landscape Design Tool | Created by the Urban Farmer Store, San Francisco, CA |

REFERENCES

CA Code of Regs - Model Water Efficient Landscape Ordinance (2009), L.R. Costello and K.S. Jones - WUCOLS IV: Water Use Classification of Landscape Species (2014), Extension.org - Grouping plants into hydrozones (2015)

3.12 Select disease-resistant species and varieties

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Plant diseases

CSI CODE

32 93 00 - Plants

DETAILS

Use plants resistant to regional plant diseases, as recommended by research institutions.

Research-based lists exist for many plant diseases including powdery mildew, fireblight, sudden oak death, phytophthora root and crown rot, verticillium wilt, Dutch elm disease and others. Start with a disease compendium, such as the listings by UC Riverside (<http://ipm.ucanr.edu/PMG/diseases/diseaseslist.html>); scroll through list of plant diseases and check plants to verify that they are resistant to local diseases. Local gardeners' associations can also be helpful resources.



Photo by Bill Sevier

EFFECT ON PEST

Selecting disease-resistant plants eliminates the need for additional plant disease management.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Disease-resistant plants may not be as aesthetically pleasing or desirable as susceptible species. It can be more difficult to locate and purchase pest-resistant plants.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Park Parking lot Pipeline row
 Plaza Pumping plant Regional watershed Reservoir Restoration site
 River Roadside Rooftop garden Sewage treatment plant
 Sidewalk garden Sports turf Trails Turf grass Unpaved road
 Urban-wildland interface Vacant Wildland

REFERENCES

B. Sevier - Master Gardener: Disease-resistant plants are beneficial... (2016), S. Dreistadt - Pests of Landscape Trees... (2016), N. Pataky - Choose Disease Resistance (2003), J.W. Pscheidt & C.M. Ocamb - Plants Resistant or Susceptible to Armillaria Root Rot (2019), San Diego Master Gardeners Assn. - Good Bets for Hedges to Replace Dying Oleanders (2010), UC Statewide IPM Program-All Plant Disease (2019)

3.13 Verify plant health prior to acceptance

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Plant diseases Ants Insects - misc Weeds

CSI CODE

32 93 00 - Plants

DETAILS

Select specimens in the nursery and check delivered specimens before planting by looking for signs and symptoms of plant disease and insect pests. If a plant looks unhealthy, reject it.

Brush away mulch or soil burying plant root-crown regions and check for discoloration, decay and other problems. Look for discolored or oozing bark on main limbs and trunks of woody plants or stems of herbaceous plants. Also look for webbing on the undersides of leaves caused by spider mites or white stippling caused by thrips.

Reject any plants with signs or symptoms of plant diseases or pests.



Photo by NC State Extension

EFFECT ON PEST

Selecting for disease- and pest-free plants reduces introduction of plant diseases and insect pests.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Plant Problem Diagnostic Tool | UC IPM |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

It takes time and trained staff to inspect plants for disease problems. This examination may delay timely installation and maintenance of new plantings.

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial Lake Median strip Military Museum Plant nursery Park Parking lot Pipeline row Plaza Pumping plant River Roadside Rooftop garden Sewage treatment plant Sidewalk Sidewalk garden Trails Turf grass

REFERENCES

T.S. Schubert et al. - Basic Concepts of Plant Disease and How to Collect a Sample for Disease Diagnosis (1999), UC Statewide IPM Program - Sanitation (2019), Sudden Oak Death Guidelines

3.14 Consider mosquito habitat in selecting plants

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mosquitoes

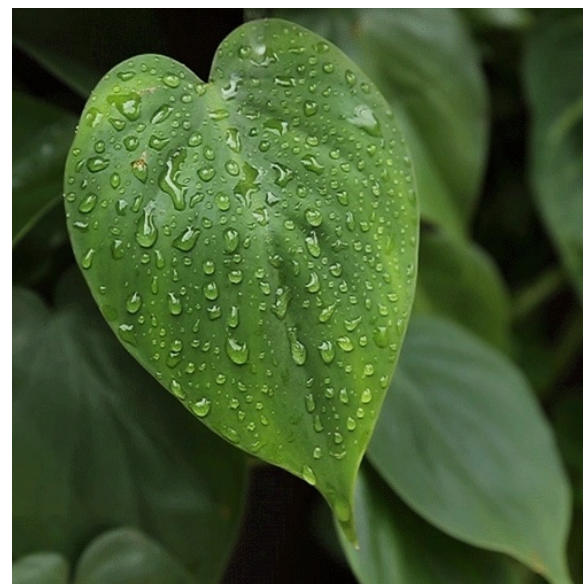
DETAILS

To avoid creating water pockets that could harbor mosquitos, carefully assess plant material for its potential to trap water in leaves and stems. Particularly relevant in high rainfall and high humidity areas, or where overhead irrigation is widespread.

Avoid using tank-type plants that form water reservoirs where their leaves meet, such as pineapple and others of the Bromeliaceae (bromeliad) family, and many ornamental plants.

CSI CODE

32 93 00 - Plants



EFFECT ON PEST

Avoiding plants that trap water in their leaves reduces mosquito populations.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Avoiding plants that shed water reduces the plant palette, which can limit the aesthetics of a site.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Plant nursery Park
 Pipeline row Plaza Pumping plant Regional watershed Reservoir
 Restoration site River Roadside Rooftop garden Sewage treatment plant
 Sidewalk garden Sports turf Trails Turf grass Unpaved road
 Urban-wildland interface Wildland Vacant

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), J.H. Frank and L.P. Lounibos - Insects and allies associated with bromeliads (2009), J.H. Frank - Bromeliads and Mosquitoes (1990)

3.15 Match plantings with soils

APPLICABILITY:

DESIGN STAGE

PESTS AFFECTED:

Plant diseases

Tree roots

Weeds

Insects - misc

DETAILS

Analyze soil texture, structure and chemistry to guide complementary selection of plants, installation methods and irrigation.

For example, in weakly structured sandy soils, use plants that thrive with good drainage, tolerate low pH and low nutrient levels, and do not require good anchorage, matching the design with an irrigation system that is appropriate to the plants' water use needs.

In contrast, in strongly structured clayey soils, use plants that thrive in poor drainage, tolerate high pH and elevated plant nutrients, and do require good anchorage.

CSI CODE

32 93 00 - Plants



Photo by Patricia Zumsteg

EFFECT ON PEST

Soils analysis-based landscape design minimizes plant diseases such as root rot and weed proliferation due to poor plant establishment.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Considering soil influences on plants and water in order to select plantings appropriately takes time and adds cost. It also limits the plant palette, which may require modifying aesthetic expectations.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|----------------|----------------------------------|
| SF PlantFinder | City and County of San Francisco |

APPLICABLE LANDSCAPE TYPES

Baylands

Building perimeter

Creek

Golf course

Hospital

Industrial

Lake

Median strip

Military

Museum

Park

Parking lot

Plaza

Pumping plant

Regional watershed

Reservoir

Restoration site

River

Roadside

Sewage treatment plant

Sidewalk garden

Trails

REFERENCES

CA Native Plants Soc. - Calscape (2019), CA Soil Resource Lab - Soil Web App (2019), B. Wilson - Native Plant Habitats of CA (2018), WaterReuse Fdn. - Assessing chem. of soil; physical charac.'s of soil (2007), WaterReuse Fdn. - Salt-tolerant plants (2007), UC ANR - Trees & Shrubs... (2009), SF Plant Finder (2017), USDA - Serpentine Soils... (2019), P.J. & T.A. Craul - Soil Design... (1992), P.J. Craul - Urban Soils... (1999)

3.16 Include access space for plantings

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

- Birds
- Ants
- Insects - misc
- Mice & Rats
- Mammals - other
- Plant diseases
- Tree roots
- Weeds

DETAILS

Leave room between plants and to access all sides of plant. Allow a minimum of three feet from structures and adequate space to walk, turn, crouch and work between plants that are not interconnected as hedges. Leave room for inspecting and treating soil, irrigation, root crown regions, and trunks.

CSI CODE

32 91 13.26 - Planting Beds



MacClaren Park photo by ReScape California

EFFECT ON PEST

Allowing adequate space between plants facilitates effective pest monitoring and rapid response to pest problems.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Allowing space between plants reduces maintenance costs when it is easy to walk around and maintain the plant. Increased open spaces however have more weed pressure and require preventative mulching to minimize new infestations.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Plant nursery
- Sidewalk garden
- Trails
- Unpaved road
- Urban-wildland interface
- Vacant
- Wildland

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

3.17 Use dense plantings to reduce weeds

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Weeds Insects - misc Plant diseases

DETAILS

In planting plans that emphasize short-term coverage, place plants densely together to increase their survivability and competitiveness with weeds.

Use plant sizes and spacings that will reduce open area between new plants.

CSI CODE

32 90 00 - Planting



EFFECT ON PEST

Quick shading of soil -the result of dense plantings- reduces weed germination and growth.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

More plants are needed to plant densely, which increases planting costs. Irrigation needs are higher to maintain dense plantings versus widely-spaced installations.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|---------------------|--|
| Planting calculator | Coastal Restoration Trust of New Zealand |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Lake
 Median strip Military Museum Park Parking lot Pipeline row Plaza
 Pumping plant Restoration site Regional watershed Reservoir River
 Roadside Rooftop garden Sewage treatment plant Sidewalk garden
 Sports turf Trails Turf grass Unpaved road Urban-wildland interface
 Vacant Wildland

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), M. Benjamin - The Effects of Maize Planting Density and Weeding Regimes on Light and Water Use (2014), M.A. Tollenaar et al. - Effect of Crop Density (1994)

3.18 Hydroseed restoration sites with natives

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED: Weeds

DETAILS

On the ground, survey the area of a restoration project. Identify indigenous species that reproduce by seed and can compete with weeds in the area of the site.

Collect or purchase locally native seed mix, combine with products that improve germination such as glues and mulches, and specify dilution and seeding rate. Time hydroseeding to take advantage of natural precipitation.

CSI CODE

32 90 00 - Planting



Photo by South Florida Water Mgmt. District

EFFECT ON PEST

Done properly, hydroseeding will allow desirable plants to outcompete many weed species.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

None noted.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

- Urban-wildland interface
- Restoration site
- Baylands
- Park
- Pipeline row
- Reservoir
- Roadside

REFERENCES

E. Gornish & Julea Shaw - Restoration Manual for Annual Grassland Systems in CA (2017)

3.19 Observe plant-structure setbacks

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

Prevent pest access to plants by designing plantings that will not grow within three feet of structures.

CSI CODE

32 92 00 - Planting



Photo by Michael Baefsky

EFFECT ON PEST

Plant setbacks from structures reduces incursions by rodents by making access more difficult for rats, mice and ants. It also ensures visibility for IPM monitoring.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Installing plants at least three feet from structures exposes structural foundations visually. Hard building edges are not as softened visually when plants are not installed up to the structures. The open space that is maintained provides weed habitat and requires ongoing maintenance.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Trails
- Sidewalk garden
- Wildland
- Vacant
- Urban-wildland interface

REFERENCES

M.K. Rust & D.H. Choe - How to Manage Pests: Ants (2012), S.M. Vantassel et al. - Rodent-proof construction (2009), R. Timm et al. - Rat Mgmt Guidelines (2011), R.O. Baker et al. - Rodent-proof construction and exclusion methods (1994)

3.20 Weed-suppressive groundcovers

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Select groundcover plants with proven weed-suppression capacity. Plants should be compatible with specific site environments and unlikely to become weeds.

Check weed status of your selections in the Cal-IPC Inventory, <https://www.cal-ipc.org/plants/inventory/> and look for a "Don't Plant A Pest" brochure for your area, which includes groundcover suggestions that are not likely to become weeds in your region.

CSI CODE

32 93 13 - Ground Covers



Photo by californialawnalternatives.com

EFFECT ON PEST

Low-growing plants shade out and reduce weed populations.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Time is needed to check regional lists and ensure that plants selected are not considered weeds. This restricts the plant palette and designer choices in terms of aesthetics. May result in client, customer or stakeholder dissatisfaction due to aesthetic expectations.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Median strip Military Museum Plant nursery Park Parking lot
 Pipeline row Plaza Pumping plant River Roadside Rooftop garden
 Sewage treatment plant Sidewalk Sidewalk garden Trails Turf grass

REFERENCES

Cal-IPC - Invasive Ground Covers of the Bay Area, Cal-IPC - Inventory, M. Wynne - SF Plant Finder (2017), California Native Plant Society - California Groundcovers (2019), B. Wilson - Less than a foot high ground cover plants that are native to California (2013), Cal-IPC - Preventing the Spread of Invasive Plants (2012)

3.21 Check seed labels

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

For direct seeding of ecological restoration areas or of turfgrass, check seed labels to ensure quality and minimize the potential for introducing unwanted weeds.

Seed purchased should have a label that includes the following:

- Purity: Most seed should be no less than 75% pure and preferably over 85% pure.
- Weed seed content: The tag should state NO invasive plants are present. If possible, certified weed-free seed should be used.
- Quality: Purchase high quality seeds with critical information provided on the label, such as percentage germination and germination test date. See Cal-IPC - Preventing the Spread of Invasive Plants (2012) for recommended seed label information.

For sensitive restoration sites, consider requiring seed testing by a certified seed laboratory according to Association of Seed Technologists and Analysts (AOSTA) standards (which include a statewide invasive plant list).

EFFECT ON PEST

Selecting seeds that have been evaluated for quality minimizes spread of unspecified invasive species, and reduces the need for herbicide or other controls.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

APPLICABLE LANDSCAPE TYPES

Golf course Plant nursery Restoration site Turf grass

CSI CODE

01 45 13 - Source Quality Code Procedures



Photo by forageseeds.com

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|---|---|
| Sample seed specifications - Alameda County | San Francisco Public Utilities Commission |

REFERENCES

Cal-IPC - Inventory, CDFA - Know What You Sow - Important information about the California Seed Law and Seed Quality (2019), J.M. Englert - A Simplified Guide to Understanding Seed Labels (2007), M. Houck - Plant Materials Technical Note No. 11 Understanding Seeding Rates, Recommended Planting Rates, and Pure Live Seed (2009), Cal-IPC - Preventing the Spread of Invasive Plants (2012)

3.22 Consider desire lines in landscape designs

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Anticipate and design paths with desire lines in mind. Desire lines are the shortest and easiest distances between two points, and reflect the most common pedestrian movements through a landscape. Not providing appropriate paths may result in trampling of plants as pedestrians seek shortcuts.

CSI CODE

32 91 00 - Planting Preparation



Photo by Max Robitzsch

EFFECT ON PEST

Incorporating desire lines minimizes soil compaction caused by unplanned foot traffic, which may damage plantings and favor weeds incursions.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Incorporating desire lines may reduce desired aesthetics. It may require time and materials to stabilize the new paths, repair or repurpose the old paths, and harmonize the change.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial
 Lake Military Museum Park Plaza Pumping plant
 Regional watershed Reservoir River Roadside Rooftop garden
 Sewage treatment plant Sidewalk Sidewalk garden Trails Tree well
 Urban-wildland interface Vacant

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), T. Hulme - What Can We Learn from Shortcuts? TED Talk (2016), K. Kohlstedt - Least Resistance: How Desire Paths Can Lead to Better Design (2016), IPM Access - Mowing Strips & Underlayment (1999)



CHAPTER 4:

Physical Barriers

Chapter Principles

Physical barriers, fabrics, and mulches of various kinds can prevent weeds, insects and mammals from becoming pests in the first place.

- **Restrict pest infestations using physical barriers**

Installing physical barriers between or under landscape features helps contain plantings, prevent weeds and block burrowing rodents. Barriers are also important in some situations for preventing mosquito breeding.

- **Consider mulch as a soil covering, but choose carefully**

There are many kinds of mulches for different purposes. Organic mulches have the advantage of improving soil fertility and cooling the soil, but may not be appropriate near structures in high termite pressure areas. Inorganic mulches may be more appropriate on pathways or near buildings, but can complicate weed control.

4.1 Favor single fences over double fences

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED:

DETAILS

Double fences can create inaccessible spaces that are ideal rodent habitat and passageways. In addition, weeds (especially vines) between double fences may be beyond the reach of control efforts. Single fencing permits greater access for monitoring and control.



Photo by Randy Fath

EFFECT ON PEST

Improves the ability to detect and manage pest populations, particularly rodents and small mammals such as raccoons and opossums.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

None noted.

APPLICABLE LANDSCAPE TYPES

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

4.2 Mulch tree wells

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

For trees surrounded by turf or pavement, design tree wells around the base and use mulch to protect the soil surface, allow water infiltration, and inhibit weeds. Mulch depth will vary depending on material, but 3 inches is generally needed to prevent weed growth.

Keep mulch away from the bases of tree and shrub trunks. Do not pile it up against the trunk. Check mulch depth quarterly and replenish as necessary to maintain weed suppressive depth.

CSI CODE

32 91 13.16 - Mulching



Photo by Chris Geiger

EFFECT ON PEST

Mulching tree wells reduces competition from weeds and other plants.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Mulch and Top Soil Calculator | Home Depot |
| Tree Weed Mat | Bosmere |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Maintaining mulch in tree wells is challenging since it may interfere with other maintenance activities if other plantings are nearby. It is difficult to keep mulch away from tree trunks, where it can contribute to root crown rot diseases.

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Sewage treatment plant
- Urban-wildland interface
- Vacant

REFERENCES

The Morton Arboretum - Mulching Trees and Shrubs (2019)

4.3 Use leaf mulch created onsite

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Apply leaf mulch from on-site sources to reduce labor and dump fees.

Use up to twice the depth of leaf mulch as would normally be applied as wood chip mulch because leaf mulch decomposes more rapidly than wood chips and also blows around unless wetted and/or mulched on top of/with other products.

CSI CODE

32 91 13.16 - Mulching



Photo by Dan LeFebvre

EFFECT ON PEST

Mulch from fallen leaves reduces weed seed germination and improves soil quality, which improves plant health and pest resistance.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Fallen leaf mulch may blow around and create an aesthetic mess, unless covered with wood chips or watered. Some fallen leaves may also harbor plant disease organisms (such as, sudden oak death on CA bay laurel (*Umbellularia californica*) and entomosporium leaf spot on evergreen pear (*Pyrus kawakamii*)), and should not be used as mulch in the landscape.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Mulch and Top Soil Calculator | Home Depot |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Sewage treatment plant
- Sidewalk garden
- Wildland
- Vacant
- Urban-wildland interface

REFERENCES

A. Budelman - The performance of selected leaf mulches in temperature reduction and moisture conservation in the upper soil stratum (1989)

4.4 Use heavier mulch for windy, steep areas

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Use physically heavy mulches in windy areas or on steep slopes to minimize losing material.

Green mulch that has a high water content can be used for this purpose, and must be supplemented as it dries out. Larger, 2-3", organic mulch wood chips are available, and less drift prone than smaller particles. Bark mulches that may not be physically heavy but tend to bind together, such as redwood bark mulch, may also fulfill the needed function.

River rocks and other rock mulches that are rated as 1.5" and greater are less likely to fly away than pebbles and finer gravel mulches.

CSI CODE

32 91 13.16 - Mulching



Photo by Paul Green

EFFECT ON PEST

Heavy mulches stay in place longer, which makes weed suppression with this mulch less expensive on steep or windy sites.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Heavy mulch is less expensive to maintain than other mulches, though possibly more expensive to purchase and/or transport and install on windy or steeply sloping sites.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Mulch and Top Soil Calculator | Home Depot |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial Lake Median strip Military Museum Park Parking lot Pipeline row Plaza Pumping plant Regional watershed Reservoir Restoration site River Roadside Rooftop garden Sewage treatment plant Sports turf Tree well Turf grass

REFERENCES

Caltrans, Erosion control toolbox., G. Witheridge - Erosion and Sediment Control – A Field Guide for Construction Site Managers (2010), L. Chalker-Scott - Impact of Mulches on Landscape Plants and the Environment (2007), Cal-IPC - Preventing the Spread of Invasive Plants (2012), Stop Waste - Bay-Friendly Landscaping Guide (2011)

4.5 Use gravel mulch for limited situations

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Ants Insects - misc Mice & Rats Weeds

DETAILS

Using gravel mulch may be most appropriate around structures where ant, termite and rodent populations are problematic. In other areas, gravel mulch (along or with weed barrier fabrics) can be difficult to maintain. See related tactic on inorganic mulches next to structures.

Install gravel mulch deep enough to thoroughly block light and reduce weed germination, improve drainage, and conserve moisture.

CSI CODE

32 91 13.16 - Mulching



EFFECT ON PEST

Gravel mulch reduces weeds and attracts fewer ants, termites and rodents than organic mulches.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Gravel mulch is difficult to use with hoes and other manual tools. It is also hard on weed trimmer lines. In the long term it will intermix with soil and affect soil characteristics. While gravel mulch will inhibit seed germination and weed growth, once weeds become established it is more difficult pull them manually. In hot areas, plant roots do not grow into or directly next to the gravel due to heat and dryness.

APPLICABLE LANDSCAPE TYPES

Building perimeter Golf course Hospital Industrial Median strip
Military Museum Park Parking lot Plaza Pumping plant
Rooftop garden Sewage treatment plant Sidewalk garden Tree well

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Mulch and Top Soil Calculator | Home Depot |

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), K.K. Jordan & S.C. Jones - Invertebrate diversity in newly established mulch habitats in a Midwestern Urban Landscape (2007), C.E. Long et al. - Effect of Organic and Inorganic Landscape Mulches (2001)

4.6 Use wood chip mulch correctly

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Ants Plant diseases

DETAILS

Apply wood chip mulch directly to soil surfaces or on top of cardboard, paper or weed fabric. Apply 3-6 inches; coarser wood chips require thicker application. Coarse mulches allow better water and air penetration than fine mulches and typically last longer. Replenish mulch when it has decreased in volume by half or more.

Combine wood chip mulch with gypsum to suppress *Phytophthora cinnamomi*, the causal agent of phytophthora root and crown rot. Use cedar mulch to reduce Argentine ant (*Linepithema humile*) in the landscape.

CSI CODE

32 91 13.16 - Mulching



Photo by Maddy Baker

EFFECT ON PEST

Wood chip mulch reduces weed seed germination, root rot disease and Argentine ant populations.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Wood chip mulch can become habitat for ants, termites, cockroaches, mice and rats. It breaks down and must be replenished to provide effective weed control. It absorbs water and may require more irrigation than bare soil.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Mulch and Top Soil Calculator | Home Depot |

APPLICABLE LANDSCAPE TYPES

Baylands Building perimeter Creek Golf course Hospital Industrial Lake Median strip Military Museum Park Parking lot Pipeline row Plaza Pumping plant Regional watershed Reservoir Restoration site River Roadside Rooftop garden Sewage treatment plant Sidewalk garden Tree well Unpaved road Urban-wildland interface Vacant

REFERENCES

D. Jodaugienė et al. - The impact of different types of organic mulches... (2006), T.K. Broschat - Effects of Mulch Type & Fertilizer Placement... (2007), L. Chalker-Scott - Wood chip mulch... (2007), H.E. Meissner & J. Silverman - Effect of Aromatic Cedar Mulch... (2003), J. Downer - Can Fresh Wood Chip Amendments Suppress Root Pathogens? (2019), A. Eskalen & B.A. Faber - Pest Mgmt - Phytophthora... (2016)

4.7 Use inorganic mulch near structures

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Ants Insects - misc Mice & Rats Weeds

DETAILS

Select inorganic mulches (gravel or shredded rubber) for building perimeters in order to decrease chances of rodent, termite and ant infestations, enhance aesthetics, provide adequate drainage away from structures, and enable foot traffic necessary to the maintenance of the structure and plantings.

Specify a minimum 12" strip of this mulch applied at a depth of 1-3", depending on the material. Remove weeds regularly to avoid the establishment of deep-rooted perennials.

CSI CODE

32 91 13.16 - Mulching



Photo by Michael Baefsky

EFFECT ON PEST

Using inorganic mulch near structures reduces termite and ant infestations, and eliminates harborage for rats and mice. Mulch coverings also reduce weed germination on bare soil.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

While these mulches will inhibit seed germination and weed growth, once weeds become established it is more difficult pull them manually. Because water infiltrates more easily through gravel, designers must be attentive to drainage issues to avoid water impacts on foundations. Rubber from shredded tires may release zinc and other chemicals into soil.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Building perimeter Hospital Industrial Museum Plant nursery Plaza
Pumping plant Rooftop garden Sewage treatment plant

REFERENCES

UC Statewide IPM Program - Mulches (2019), San Francisco Dept. of the Envir. - World Cafe Meeting, Pest Prevention by Design for Landscapes (2018)

4.8 Apply gravel mulch on geotextile weed fabric

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

Gravel mulch on top of geotextile weed fabric can reduce water puddles in nursery settings while inhibiting weed growth. It is also useful underneath hardscapes such as decomposed granite paths and bocce ball courts, or dry creek beds. While the weed barriers do not decompose and therefore do not need replacement as often as organic mulch systems, there are many other situations where its usefulness is limited due to difficulties in using physical weed controls.

CSI CODE

32 91 13.16 - Mulching



EFFECT ON PEST

Gravel mulch on top of weed fabric reduces puddling, weeds and disease organisms.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Gravel on top of weed fabric creates soil layering, which limits plant growth. Weed seeds accumulate in the layer above the fabric where they germinate when mulch depth does not completely eliminate light. Flaming, hoeing and mowing are also difficult if not impossible to use efficiently with synthetic fabric and gravel mulch. Pulling established weeds is difficult or impossible, possibly resulting in the need for herbicides.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Sewage treatment plant
- Urban-wildland interface
- Vacant

REFERENCES

C.A. Wilen et al. - Weed Management in Landscapes (2018)

4.9 Sheet mulch

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Weeds

DETAILS

Use sheet mulching in new plant installations, for short term (1-2 years) control of weeds in mulched areas, or for lawn conversions.

Fine grade the soil surface and remove obvious weeds and weed seeds. Install biodegradable weed barrier - frequently corrugated cardboard - on top of the bare soil surface. Install plants through the biodegradable weed barrier by cutting or tearing through the material. Install appropriate mulch on top of biodegradable mulch at depth and with desired materials.

CSI CODE

32 91 13.16 - Mulching



Photo by Cagwin & Dorward Landscape

EFFECT ON PEST

Sheet mulching reduces weed seed germination, thus reducing competition for plantings. It eventually contributes to plant health and pest resistance when it decomposes further as part of soil organic matter. Unlike inorganic weed fabrics, there are no fabric shreds remaining in the soil to interfere with future management.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Sheet mulching provides short-term weed suppression and increased soil fertility, but some robust perennial species may still penetrate the mulch layer. If weeds are not controlled, the higher fertility will boost weed growth. A recent study (Chalker, 2019) found reduced biological activity in soil covered with cardboard.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|---|---|
| Sheet mulch calculator | Lawn to Garden website (created by StopWaste.org) |
| Corrugated cardboard rolls for sheet mulching | Cogent Solutions & Supplies |
| WeedGard Plus | Sunshine Paper Company |

APPLICABLE LANDSCAPE TYPES

Golf course Hospital Median strip Industrial Military Museum
 Plant nursery Park Parking lot Pipeline row Pumping plant
 Regional watershed Reservoir Restoration site Roadside
 Sidewalk garden Sports turf

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), ReScape California - Sheetmulching (2019), Marin Municipal Water District - Sheet Mulching Guide (2019), Lawn to Garden sheet mulch guide, UC Statewide IPM Program - How to Manage Pests: Sheet Mulching (2019)

4.10 Install underground root barriers

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED: Tree roots Weeds

DETAILS

Design and install barriers in between hardscapes and invasive plants that spread through roots, surface growing stems (stolons), underground stems (rhizomes), and plants with aggressive, rapidly spreading root systems that are known to damage hardscapes. Use root barriers also between those rapid-spreading plants and other plantings.

CSI CODE

32 94 13 - Landscape Edging



EFFECT ON PEST

Underground root barriers reduce and delay physical damage caused by roots to hardscapes, delay the unintentional spread of some weedy perennials, and reduce future management needs.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Standard plastic root barriers increase slip-trip hazards as they must extend above ground to prevent aggressive roots from spreading. They can tear and break down above ground, providing pathways for root invasions. As a result, root barriers need to be monitored regularly and additional root control tactics, such as root pruning, may be required.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|------------------------|------------------------|
| Root and Water Barrier | Home Depot |
| Root Barrier | DeepRoot |

APPLICABLE LANDSCAPE TYPES

- Building perimeter
- Creek
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sidewalk garden
- Trails
- Tree well
- Unpaved road
- Vacant

REFERENCES

J.M. DiTomaso & G.B. Kyser - Pest Notes: Woody Weed Invaders (2017), R. Hoyt - Root Barriers Prevent Costly Damage (2001), J.A. Wagar & P.A. Barker - Effectiveness of three barrier materials (1993)

4.11 Use edging at boundaries

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED: Tree roots Weeds

DETAILS

The purpose of edging is to restrict weed growth and invasion into adjacent areas, and sometimes to contain mulch.

Install vertical edging such as concrete, wood, steel or composite products between planted areas, or between plantings and hardscapes.

CSI CODE

32 94 13 - Landscape Edging



EFFECT ON PEST

Edging reduces weed infestations. It can eliminate the need for herbicide or mechanical controls along various boundaries within a planted landscape.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-----------------------------|---|
| Earth Edge - 8' rubber roll | Valley View Industries |
| Steel Edging | Col-Met attached image © 2017 www.deavita.com |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Edging can create additional removal and replacement work when landscape is modified. Steel edging materials tend to resist degradation, but often sink and disappear or become covered in irrigated, mulched landscapes. Wooden bender boards may biodegrade, requiring ongoing replacement. Synthetic or hybrid edging products may crack, break, bend or shatter, depending on their quality, UV exposure, irrigation and soil.

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Plant nursery
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sidewalk garden
- Trails
- Turf grass

REFERENCES

M. Gilmer & G. Schmidt - Landscape Edging Options (2019)

4.12 Install mowstrips

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Tree roots Weeds

DETAILS

Install mowstrips along fence lines or along the boundaries between landscaped areas and turf or groundcovers. This element allows for mowing up to the fence or barrier and eliminates fenceline and edge weeds.

CSI CODE

32 94 13 - Landscape Edging



Photo by Jerry Naumann

EFFECT ON PEST

Mowstrips reduce weed infestations. They can eliminate the need for herbicide or mechanical controls along various boundaries within a planted landscape.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Mowstrips can create additional removal and replacement work when landscape is modified or repaired. They can also sink and/or biodegrade, depending on the material used.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|------------------------|
| Weedseal Fence & Border Guard | Bruckman Rubber Co. |
| Mowstrip - Fence Weed Barrier | YourFenceStore.com |
| Earth Edge - 8' rubber roll | Valley View Industries |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Plant nursery
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sidewalk garden
- Trails
- Turf grass

REFERENCES

IPM Access - Mowing Strips & Underlayment (1999), City of Fremont - Concrete Mow Band Detail (2011), City of Dallas - Concrete mow strip detail (2006-2019), M. Gilmer & G. Schmidt - Landscape Edging Options (2019)

4.13 Install underlaying wire barriers for rodents

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mice & Rats Mammals - other

DETAILS

Use corrosion-resistant wire mesh barriers to exclude or limit movement of rodents into parts of the landscape.

Generally, horizontal wire mesh barriers reduce rat habitat in heavily infested urban areas. In addition, wire barriers prevent gophers, rats, and mice from damaging plants by preventing their feeding, burrowing and mounding activities

CSI CODE

32 31 56 - Wildlife Deterrent Fence



Photo by Xcluder

EFFECT ON PEST

Part of an integrated approach to rat management in heavily urbanized landscapes, for example, by eliminating the possibility of rat burrows in tree wells. Underlaying wire barriers may also reduce gopher mounding in sports fields, thereby reducing tripping hazards.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Underlaying wire barriers interfere with irrigation repair, weed control, aerification, replacement plantings and other maintenance activities. They are difficult to work around when replacement planting is needed.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|------------------------|------------------------|
| Rodent Proofing Mesh | The Mesh Company |
| Gopher deterrent fence | Louis E. Page |
| Rat Mesh | TWP Mesh |

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Plant nursery
- Park
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Sewage treatment plant
- Sidewalk garden
- Sports turf
- Trails
- Turf grass
- Unpaved road

REFERENCES

UC Statewide IPM Program - How to Manage Pests: Gophers (2019), Gophers Limited - How to Install Wire Mesh Rolls and Baskets Under Lawns and Plants (2019), San Francisco Dept. of the Envir. - Landscape Pest Prevention by Design Working Group Member (2019), R. Baldwin - Pocket Gophers (2009)

4.14 Install wire baskets for gophers

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Mammals - other

DETAILS

For a limited number of highly managed landscape situations, gopher baskets may help protect plantings. However, this tactic is not generally recommended (see Tradeoffs).

Install individual plants in wire baskets where gopher populations are a problem. Prior to planting remove containerized plants from their containers and sharply cut any dead, dying, kinked or girdling roots off the plant. Place plant in the largest affordable gopher basket or create the largest possible basket from light gauge steel galvanized wire mesh. Over-excavate planting hole two to three times the size of the containerized plant. Install gopher basket, then install container plant in basket, maintaining as much distance between plant roots and basket as is possible. Before roots grow into and through the basket, cut basket up and remove as much of the basket as possible.

EFFECT ON PEST

Wire baskets prevent gopher damage to plants, although they can still access aboveground portions.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Gopher baskets can stunt, girdle and kill plants when the plants grow and roots begin penetrating the wire mesh. Replacement with larger baskets is difficult or impossible once the plant is established.

APPLICABLE LANDSCAPE TYPES

- Baylands
- Building perimeter
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Median strip
- Military
- Museum
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- Restoration site
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk garden
- Trails
- Urban-wildland interface

CSI CODE

32 31 56 - Wildlife Deterrent Fence



Photo by gopherbasket.com

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|----------------|---------------------------------|
| Gopher Baskets | Diggers Product Development LLC |

REFERENCES

T. Salmon et al. - An evaluation of fencing (1990), San Francisco Dept. of the Envir. - Landscape Pest Prevention by Design Working Group Member (2019), R. Baldwin - Pocket Gophers (2009)

4.15 Make void spaces accessible

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED: Mice & Rats Mammals - other Weeds

DETAILS

Design easy access to empty spaces underneath and around statues, planters, boardwalks, sheds and concrete structures. For example, wooden boardwalks can provide protected spaces for rat burrows, and water accumulations under planters can harbor mosquito populations.

Plan for inspection, cleaning and other pest management activities of these spaces, or completely seal off them off from pest access.

CSI CODE

01 42 19 - Reference Standards



Photo by Deshelia Mixon

EFFECT ON PEST

Easy access to void spaces makes monitoring and control efforts possible.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Designing out void spaces in landscapes requires time to analyze them and generate solutions.

APPLICABLE LANDSCAPE TYPES

- Building perimeter
- Golf course
- Hospital
- Industrial
- Military
- Museum
- Plant nursery
- Park
- Pipeline row
- Pumping plant
- Reservoir
- Restoration site
- Rooftop garden
- Sewage treatment plant
- Sidewalk garden

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018)

4.16 Consider geotextile weed fabric

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED: Weeds

DETAILS

Install geotextiles beneath planting areas, benches, tables, bocce ball courts, pathways, dry creeks, or other hardscape elements to reduce or eliminate weed infestations. Use geotextiles mainly for long-term weed control around stable landscape elements, and not in areas that must be replanted, such as in annual flower beds.

Place landscape fabric under mulch for greater weed control than mulch used alone. Ensure that fabric is fully covered to prevent degradation by UV light . For best weed control, use a coarse-textured mulch with pieces of about 1/4 to 3/4 inch in size. There are differences in weed-controlling ability among the geotextiles: fabrics that are thin, lightweight, or have an open mesh allow for greater weed penetration than more closely woven or nonwoven (spunbonded) fabrics. If weeds grow into or through the geotextile, remove them when they are small to prevent them from creating holes in the fabric.



EFFECT ON PEST

Underground barriers reduce weed populations by reducing weed seed germination from the soil surface, and blocking penetration of roots and stems along and below the soil surface. Some established perennial plants, however, may still penetrate the fabric.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|-------------------------------|---------------------------------|
| Non-Woven Landscape Fabric | AM Leonard Horticultural Supply |
| Woven Landscape Fabric | AM Leonard Horticultural Supply |
| Tygar Landscape Fabric | The DeWitt Company |
| Commercial Grade Weed Barrier | Home Depot |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Weed fabric may reduce water and air penetration to soil. Cultivation, digging, flaming and new plant installation are restricted and more time consuming. If weeds penetrate fabric, physical removal is more difficult due to entanglements of roots with the cloth, sometimes necessitating herbicide use. Mulch applied on top of weed fabrics may slide off, particularly on slopes or when larger bark mulches are applied.

REFERENCES

Caltrans - Roadside Mgmt Toolbox: Weed Control Mat (2017), C.A. Wilen et al. - Weed Mgmt in Landscapes (2018), IPM Access - Mowing Strips & Underlayment (1999)

APPLICABLE LANDSCAPE TYPES

- Building perimeter
- Golf course
- Hospital
- Industrial
- Median strip
- Military
- Museum
- Plant nursery
- Park
- Parking lot
- Pipeline row
- Plaza
- Pumping plant
- Reservoir
- Restoration site
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sidewalk garden
- Trails

4.17 Seal drainage system against mosquitoes

APPLICABILITY: DESIGN STAGE

PESTS AFFECTED:

DETAILS

Specify that all drains, drainage devices, and stormwater treatment devices incorporate mosquito-free design.

For systems with sumps, vaults, or basins that hold permanent or semipermanent standing water, completely seal structures using screen that is 1/16 inch or less. Covers should be tight fitting with maximum allowable gaps or holes of 1/16 inch to exclude entry of adult mosquitoes, or use well sealed gaskets. Unsealed inlets and outlets should be submerged completely to reduce the available surface area of water for mosquito egg-laying (female mosquitoes can fly through pipes) or use flapper or pinch valves, collapsible tubes and "brush curtains".

All stormwater treatment devices should be easily and safely accessible without the need for special requirements (e.g., OSHA requirements for "confined space"). This allows vector control personnel to effectively monitor and, if necessary, abate vectors. If utilizing covers, the design should include spring-loaded or lightweight access hatches that can be opened easily for inspection.

EFFECT ON PEST

Denying adult mosquitoes access to standing water prevents egg-laying and reduces mosquito populations.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Sealing off devices requires some extra time and cost, especially as a retrofit.

CSI CODE

02600 Drainage and Containment



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--|-------------------------|
| Mozzie Stoppa Mosquito Insect Flap Valve | Rain Harvesting Pty Ltd |

APPLICABLE LANDSCAPE TYPES

- Golf course
- Hospital
- Industrial
- Military
- Museum
- Plant nursery
- Park
- Plaza
- Pumping plant
- Sidewalk garden
- Sports turf
- Turf grass
- Parking lot
- Sewage treatment plant

REFERENCES

Greater LA County Vector Control District - DIY Mosquito Exclusion - Yard Drains (2018), M.E. Metzger - Managing Mosquitoes in Stormwater Treatment Devices (2004)



CHAPTER 5:

Sanitation

Chapter Principles

Plan ways to exclude pests and diseases from landscapes, and minimize refuse as a food source.

- **Screen seeds and nursery stock before planting**

Simple inspections and purchasing requirements before plantings can reduce pest management later on.

- **Minimize refuse as a pest food source**

Pest-proofing refuse containers and planning for adequate signage and refuse removal removes a big food source for rodents and birds.

- **Prevent the import of new pests and diseases**

Installing sanitation stations and emphasizing onsite mulch production can minimize plant disease occurrence.

5.1 Conduct pre-planting pest inspections

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED:

Ants Insects - misc Plant diseases Weeds

DETAILS

Prior to accepting new plants from nursery and installing them, inspect them for pests (weeds, pathogens, arthropods) and reject if infested.



Photo by Andrej Lišakov

EFFECT ON PEST

Pre-planting pest inspections minimize introduction of pests.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Additional time and scrutiny is required to pre-inspect planting stock.

APPLICABLE LANDSCAPE TYPES

Median strip Plant nursery Park Rooftop garden Sidewalk garden
Tree well

REFERENCES

Iowa State University Extension (2013)

5.2 Install pest-proof refuse containers

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED: Mice & Rats Mammals - other

DETAILS

Use pest proof containers with tightly closing and sealing lids. Self closing and self sealing are additionally advantageous. Cracks and holes should be sealed as hermetically as possible to prevent attracting and feeding rodents as well as other pests.



Photo by Rick Obst

EFFECT ON PEST

Pest-proof refuse containers eliminate feeding stations and reduce activity to the spill zones of these stations. This reduces risk from pest borne diseases.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--|------------------------|
| The Rubbermaid® Commercial BRUTE® Trash Can Dome Lid | Target |
| BearSaver Cart Garage | BearSaver |
| Bearicuda Varmint Vault | Bearicuda Bins |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Rodent-proof refuse containers may be more expensive than others. Closed containers may result in garbage being thrown on the ground in areas where open trash containers are the norm.

APPLICABLE LANDSCAPE TYPES

- Baylands
- Creek
- Golf course
- Hospital
- Industrial
- Lake
- Military
- Museum
- Plant nursery
- Park
- Parking lot
- Plaza
- Pumping plant
- Regional watershed
- Reservoir
- River
- Roadside
- Rooftop garden
- Sewage treatment plant
- Sidewalk
- Sports turf
- Trails
- Unpaved road
- Urban-wildland interface
- Vacant

REFERENCES

R.O. Baker et al. - Rodent-proof construction and exclusion methods (1994), B.A. Colvin et al. - Norway Rat Infestation of Urban Landscaping (1996)

5.3 Improve rodent-proofing of dumpsters

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

CSI CODE

PESTS AFFECTED:

Birds Insects - misc Mice & Rats Mammals - other

DETAILS

Rodent-proof containers reduce presence of rodent populations in the areas directly surrounding these containers. Dumpsters with large holes and loose or open lids attract rodents and increase their activities in the vicinity of dumpsters. The problem of open lids can sometimes be addressed through implementing workplace policies or trainings that require lids to be closed at all times, or through the use of locks.



Photo by Kevin Butz

EFFECT ON PEST

Rodent-proof dumpsters discourage rodent haborage, decreasing their activity in those areas.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|------------------------------|------------------------|
| Varmint Vault | Bearicuda |
| Guardian Bearproof dumpsters | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Rodent-proof dumpsters may be more expensive than non-rodent proof dumpsters.

APPLICABLE LANDSCAPE TYPES

Baylands Creek Golf course Hospital Industrial Lake Military Museum Plant nursery Park Parking lot Plaza Pumping plant Regional watershed Reservoir River Sewage treatment plant

REFERENCES

L. Agurto - San Francisco Dept. of the Envir. Technical Advisory Committee (2018), R.M. Timm - Norway Rats (1994), R. Corrigan - Dumpsters (2018)

5.4 Plan for production of bark or chip mulch onsite

APPLICABILITY: INCLUDE IN MAINTENANCE PLAN

CSI CODE

PESTS AFFECTED: Weeds Plant diseases

DETAILS

Using mulch created on-site can prevent the introduction of new weed or disease pests and save energy. Take care not to use plant material from diseased trees to make onsite mulch.



Photo by Steve Kuchera

EFFECT ON PEST

On-site mulch minimizes the spread of pests and introduction of weeds into landscapes.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

May require initial investment in chippers or other equipment.

APPLICABLE LANDSCAPE TYPES

REFERENCES

ReScape California - Bay Friendly Landscape Guidelines (2013)

5.5 Sanitize items in contact with soil

APPLICABILITY: INCLUDE IN MAINTENANCE PLAN

PESTS AFFECTED:

DETAILS

Thoroughly clean landscaping equipment to avoid spread of weed seeds, rhizomes or roots between sites. First, remove soil from the item. Then, treat the item in one of the following ways.

- 1. Treat with 70-90% ethyl or isopropyl alcohol: spray to thoroughly wet the surface and allow to air dry before use.
- 2. Treat with freshly diluted bleach solution - 0.525% sodium hypochlorite - for a minimum of one minute. Bleach treatment is not advised for steel or other materials that could be damaged by bleach.
- 3. Treat with quaternary ammonium disinfectant. Use according to manufacturer recommendations.

If treated surfaces are wetted with water, the sanitizing solution will become diluted. Apply enough sanitizer to completely displace water films, and then allow the required contact time. Observe all appropriate safety precautions to prevent contact with eyes or skin when using these solutions.

EFFECT ON PEST

Sanitizing items in contact with soil prevents the spread of plant diseases.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Additional time and resources may be required.

APPLICABLE LANDSCAPE TYPES

CSI CODE

01 93 13 - Facility Maintenance Procedures



RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

REFERENCES

Guidelines to Minimize Phytophthora Contamination in Restoration Projects

5.6 Install a sanitation station

APPLICABILITY: BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED: Plant diseases Weeds

DETAILS

Design and plan for sanitation systems that can be used prior to and after using certain landscaped areas. This is particularly applicable to habitat remediation projects, botanical gardens, or other specialized projects where invasive plant diseases are a threat.

Water, brushes and soap may be used to scrub and remove organic materials such as plants and mulch off gear and surfaces. Disinfectants can be used after organic material has been thoroughly removed to kill pathogens. Surfaces should be allowed to remain wet after disinfection for at least the time specified on the product label (sometimes called "dwell time"). Recycling or keeping rinsate water contained will prevent pest spread in the vicinity of the sanitation station.

CSI CODE

01 52 19 - Sanitary Facilities



Photo by Bree Candiloro

EFFECT ON PEST

Sanitation stations minimize the spread of weeds and pathogens.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

It takes time to clean off before and after working in a sensitive area. Creating a clean-off station costs time and materials; even simple mobile systems require at least a water source, a brush and disinfectant.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--|------------------------|
| Boot Blaster™ Wet Shoe & Boot Cleaner | ESCA |
| HACCP SmartStep™ Boot Scrubber with Handle | Nelson Jameson |
| Greelyman Boot Cleaner | Greely |

APPLICABLE LANDSCAPE TYPES

Baylands Plant nursery Park Restoration site Sports turf Golf course
Regional watershed Trails Urban-wildland interface

REFERENCES

K. Taylor et al. (2017), Cal-IPC - Preventing the Spread of Invasive Plants (2012)

5.7 Provide sufficient refuse receptacles

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Birds Insects - misc Mice & Rats Mammals - other

CSI CODE

32 33 23 - Site Trash and Litter Receptacles

DETAILS

1. Estimate how much total waste will be generated on the site. Break the total estimate down into recycling streams and geographical areas.
2. Determine constraints for frequency of refuse collection. How often can refuse be collected, given budget and staffing limitations?
3. Choose container type(s) and size(s) appropriate for the setting. If feasible and appropriate, use pest-resistant containers (see tactic on this subject).
4. Calculate how many containers are needed based on the total volume of the containers and the number of collections planned.
5. Monitor and modify as situations change.



Photo by Recology

EFFECT ON PEST

Having the right number of garbage receptacles on a site minimizes overflow that causes the receptacles to become pest magnets.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

Providing adequate numbers of waste receptacles requires some calculations prior to stocking a site, which adds time and cost of moving and/or purchasing additional receptacles. Monitoring and modifying the number of receptacles also costs time and money. In addition, the size of receptacles must be balanced with the frequency of collection.

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Golf course Museum Park Parking lot Plaza Rooftop garden

REFERENCES

San Francisco Dept. of the Envir. - World Cafe Meeting (2018), S. Vine - How Many Recycling Containers Do I Need? (2018), Zender Environmental Research Group - How To Calculate How Many Waste Containers You Will Need For Your Community. (2008)

5.8 Post refuse management signage

APPLICABILITY:

BOTH DESIGN & RETROFIT STAGES

PESTS AFFECTED:

Birds

Ants

Insects - misc

Mice & Rats

Mammals - other

DETAILS

Disposing food waste correctly reduces food sources for ants, cockroaches, mice, rats, ground squirrels, pigeons, crows, and other scavengers.

Use existing garbage containers more effectively by incorporating explanatory signage in visible locations as part of landscape design.

CSI CODE

32 33 23 - Site Trash and Litter Receptacles



EFFECT ON PEST

Garbage management signage improves the effective implementation of a sanitation strategy, and reduces pest populations that are attracted to garbage.

TRADEOFFS WITH OTHER DESIGN OBJECTIVES

RELATED TOOLS AND PRODUCTS

| Product | Manufacturer or Source |
|--------------|------------------------|
| None listed. | |

APPLICABLE LANDSCAPE TYPES

Baylands

Building perimeter

Creek

Golf course

Hospital

Industrial

Lake

Military

Museum

Plant nursery

Park

Parking lot

Plaza

Pumping plant

Regional watershed

River

Rooftop garden

Sidewalk garden

Trails

Urban-wildland interface

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Appendix of Tools

1.5 Develop an IPM data management system

- Marin County Parks IPM Treatment Reports, <https://www.marincountyparks.org/projectsplans/ipm/ipm-landscape-treatment-reports>
- Santa Clara County Web-Based IPM Activities and Pesticide Use Reporting Database (IPM-PUR), <https://www.sccgov.org/sites/ipm/program-implementation/Pages/management-tools.aspx>

2.4 Test soils before plant selection

- AMS 3/14" Basic Soil Sampling Kit, <https://www.ams-samplers.com/3-1-4-basic-soil-sampling-kit.html>

3.2 Minimize cracks between pavers

- Sodium Silicate Pavement Sealer

3.3 Rodent-proof planter boxes

- Double galvanized wire mesh roll; Gopherslimited.com, https://gopherslimited.com/img_2071/
- Corten Steel Planter Box; Veradek Metallic Series Corten Steel Planter Box, <https://www.wayfair.com/outdoor/pdp/veradek-metallic-series-corten-steel-planter-box-vrdk1019.html>

3.5 Emphasize native and insectary plantings

- SF PlantFinder; City and County of San Francisco, <http://sfplantfinder.org/about.html>
- Insect Habitat Plants; Rincon-Vitova Insectaries, <http://rinconvitova.com/material.htm#Insect%20Habitat%20Plants>

3.8 Consider microclimate during plant selection

- SF PlantFinder; City and County of San Francisco, <http://sfplantfinder.org/about.html>

3.10 Employ temporary plantings

- Cover Crop Chart: Common Cover Crops for California; Natural Resources Conservation Service, https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/capmctn13333.pdf

3.11 Hydrozone plantings

- SF PlantFinder; City and County of San Francisco, <http://sfplantfinder.org/about.html>
- WUCOLS IV Water use classifications of landscape species; Univ. of California, <https://ucanr.edu/sites/WUCOLS/>
- WELO Water Budget Based Landscape Design Tool; Created by the Urban Farmer Store, San Francisco, CA, <https://www.urbanfarmerstore.com/welo-water-budget-based-landscape-design-tool/>

3.13 Verify plant health prior to acceptance

- Plant Problem Diagnostic Tool; UC IPM, <https://www2.ipm.ucanr.edu/diagnostics/>

3.15 Match plantings with soils

- SF PlantFinder; City and County of San Francisco, <http://sfplantfinder.org/about.html>

3.17 Use dense plantings to reduce weeds

- Planting calculator; Coastal Restoration Trust of New Zealand, <https://www.coastalrestorationtrust.org.nz/resources/planting-calculator/>

Appendix of Tools

3.21 Check seed labels

- Sample seed specifications - Alameda County; San Francisco Public Utilities Commission

4.2 Mulch tree wells

- Mulch and Top Soil Calculator; Home Depot, <https://mulch-calculator.homedepot.com>
- Tree Weed Mat; Bosmere, https://www.amazon.com/Bosmere-Tree-Protection-Weed-3-Pack/dp/B00AMIM2PG?ref_=bl_dp_s_web_3019518011

4.3 Use leaf mulch created onsite

- Mulch and Top Soil Calculator; Home Depot, <https://mulch-calculator.homedepot.com>

4.4 Use heavier mulch for windy, steep areas

- Mulch and Top Soil Calculator; Home Depot, <https://mulch-calculator.homedepot.com>

4.5 Use gravel mulch for limited situations

- Mulch and Top Soil Calculator; Home Depot, <https://mulch-calculator.homedepot.com>

4.9 Sheet mulch

- Sheet mulch calculator; Lawn to Garden website (created by StopWaste.org), <http://lawntogarden.org/materials-calculator>
- Corrugated cardboard rolls for sheet mulching; Cogent Solutions & Supplies, <https://www.cogentsupplies.com/Product/S-F-Corrugated-18x250-B-Flute-Natural-25rls-plt-FDS-101100018>
- WeedGard Plus; Sunshine Paper Company, <http://www.weedguardplus.com/>

4.10 Install underground root barriers

- Root and Water Barrier; Home Depot, <https://www.homedepot.com/p/24-in-D-x-120-in-L-Polyethylene-Dual-Purpose-Root-and-Water-Barrier-Rolls-CR2410/304635196>
- Root Barrier; DeepRoot, <https://www.deeproot.com/products/root-barrier.html>

4.11 Use edging at boundaries

- Earth Edge - 8' rubber roll; Valley View Industries, <http://www.valleyviewind.com/8-rubber-roll/>
- Steel Edging; Col-Met, <https://www.colmet.com/Landscape-Edging>

4.12 Install mowstrips

- Weedseal Fence & Border Guard; Bruckman Rubber Co., <https://www.bruckmanrubber.com/parts-and-products/direct-to-customer/weedseal/fence-and-border-guard/>
- Mowstrip - Fence Weed Barrier; YourFenceStore.com, <https://www.yourfencestore.com/mowstrip/mow-strip-fence-weed-barrier.htm>
- Earth Edge - 8' rubber roll; Valley View Industries, <http://www.valleyviewind.com/8-rubber-roll/>

4.13 Install underlaying wire barriers for rodents

- Rodent Proofing Mesh; The Mesh Company, <https://www.themeshcompany.com/products/rodent-proofing-woven-wire-mesh.html>

Appendix of Tools

4.14 Install wire baskets for gophers

- Gopher Baskets; Diggers Product Development LLC, <https://gopherbasket.com>

4.16 Consider geotextile weed fabric

- Non-Woven Landscape Fabric; AM Leonard Horticultural Supply, <https://www.amleo.com/landscape-fabric-4oz-non-woven-4ft-x-360ft/p/NW4-436/?kc=amlshop19n&mkwid=NriTuUMp&pcrid=%7Bcreative%7D>
- Woven Landscape Fabric; AM Leonard Horticultural Supply, <https://www.amleo.com/landscape-fabric-woven-5oz-6ft-x-250ft/p/625S5/?kc=amlshop19n&mkwid=NriTuUMp&pcrid=%7Bcreative%7D>
- Typar Landscape Fabric; The DeWitt Company, <http://www.typargeosynthetics.com/products/geotextiles/landscape-fabric.html>
- Commercial Grade Weed Barrier; Home Depot, <https://www.homedepot.com/p/Southwest-Boulder-Stone-6-ft-x-300-ft-of-20-Year-Guarantee-Heavy-Duty-Commercial-Grade-Weed-Barrier-02-0030/305146977>
- Mozzie Stoppa Mosquito Insect Flap Valve; Rain Harvesting Pty Ltd, <https://bit.ly/373f9Y3>

5.2 Install pest-proof refuse containers

- The Rubbermaid® Commercial BRUTE® Trash Can Dome Lid; Target, <https://www.target.com/p/rubbermaid-174-trash-can-lid/-/A-17459875>
- BearSaver Cart Garage; BearSaver, <https://bearsaver.com/collections/bear-resistant-cart-garage>

5.3 Improve rodent-proofing of dumpsters

- Varmint Vault; Bearicuda, https://www.bearicuda.com/enclosures/ratproof_trashcan_enclosure.php
- Guardian Bearproof dumpsters; <https://www.bearicuda.com/enclosures/bearproof-cubicyard.php>

5.6 Install a sanitation station

- Boot Blaster™ Wet Shoe & Boot Cleaner; ESCA, <https://esca-tech.com/product/boot-blaster-wet-shoe-boot-cleaner/>
- HACCP SmartStep™ Boot Scrubber with Handle; Nelson Jameson, <https://nelsonjameson.com/HACCP-SMARTSTEP-Boot-Scrubber-with-Handle-p18258.html>
- Greelyman Boot Cleaner; Greely, <https://www.greelyman.com/contractor-models/>