BMP

California Golf Industry Best Management Practices Guide

Presented by:

California Golf Course Superintendents Association

GCSAA USGA

BMP

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BMP Best Management Practices

Best Management Practices Planning Guide & Template

GCSAA USGA

In partnership with the PGA TOUR

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EIFG | *Funded through the Environmental Institute for Golf*

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Acknowledgement

Golf Course Superintendents Association of America

The Golf Course Superintendents Association of America (GCSAA) is the professional association for the men and women who manage and maintain the game's most valuable resource — the golf course. Today, GCSAA and its members are recognized by the golf industry as one of the key contributors in elevating the game and business to its current state.

Since 1926, GCSAA has been the top professional association for the men and women who manage golf courses in the United States and worldwide. From its headquarters in Lawrence, Kansas, the association provides education, information and representation to more than 17,000 members in more than 72 countries. GCSAA's mission is to serve its members, advance their profession and enhance the enjoyment, growth and vitality of the game of golf.

Environmental Institute for Golf

The Environmental Institute for Golf (EIFG) fosters sustainability by providing funding for research grants, education programs, scholarships and awareness of golf's environmental efforts. Founded in 1955 as the GCSAA Scholarship & Research Fund for the Golf Course Superintendents Association of America, the EIFG serves as the association's philanthropic organization. The EIFG relies on the support of many individuals and organizations to fund programs to advance stewardship on golf courses in the areas of research, scholarships, education, and advocacy. The results from these activities, conducted by GCSAA, are used to position golf courses as properly managed landscapes that contribute to the greater good of their communities. Supporters of the EIFG know they are fostering programs and initiatives that will benefit the game and its environment for years to come.

United States Golf Association

The United States Golf Association (USGA) provides governance for the game of golf, conducts the U.S. Open, U.S. Women's Open and U.S. Senior Open as well as 10 national amateur championships, two state team championships and international

matches, and celebrates the history of the game of golf. The USGA establishes equipment standards, administers the Rules of Golf and Rules of Amateur Status, maintains the USGA Handicap System and Course Rating System, and is one of the world's foremost authorities on research, development and support of sustainable golf course management practices.

Acknowledgments

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Additional Acknowledgement

BMP Committee

The California BMP would like to thank the following individuals for their time and commitment to the California Golf Industry Best Management Practices Guide:

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Introduction

Introduction

The California Golf Course Superintendents Association has partnered with the Golf Course Superintendents Association of America (GCSAA), the Environmental Institute for Golf (EIFG), the PGA Tour and the United States Golf Association (USGA) to develop and implement a best management practices (BMPs) guide for golf course management.

With over 850 golf courses, a variety of climates and a complex regulatory environment, the California Golf Industry BMP offers guidelines for superintendents to manage their facilities in an efficient and environmentally sustainable manner.

The California Golf Industry BMP Committee includes superintendents from each of the California GCSA's six regional chapters (Central California, Hi-Lo Desert, Northern California, San Diego, Sierra Nevada, Southern California) as well as the California Alliance for Golf, California Golf Course Owners Association, GCSAA, Southern California Golf Association, Southern California PGA and USGA (a complete list of those involved is provided on the Acknowledgment page).

The committee employed the services of Blankinship & Associates, Inc. out of Davis, Calif. to serve as the environmental consultant and project manager. The firm's founder Mike Blankinship, staff scientist Nikki Slade as well as associate environmental specialist Kelly Phang were instrumental in overseeing the project and moving it forward over the course of two years. Their staff's understanding of agronomic, environmental and regulatory issues was critical to the completion of the guide.

The document is highlighted by 17 sections: Planning, Design and Construction; Irrigation; Surface Water Management; Water Quality Management; Nutrient Management; Cultural Practices; Integrated Pest Management; Pesticide Management; Pollinator Protection and Enhancement; Maintenance Operations; Landscape and Out of Play Areas; Energy; Groundwater Management; Air Quality, Threatened and Endangered Species; Urban Golf and Seaside Golf.

Along with the BMPs and links to state regulations and agencies, a Frequently Asked Questions (FAQS) section is available at the end of each section which serves as a quick reference for everyday situations and questions that a golf course superintendent may be confronted with.

The guide is produced in a digital platform that allows superintendents at facilities to download the document free of charge. They then have the option to further edit the

document to make it more specific to their facility and agronomic region. The digital format also provides the ability to edit and change components of the document as turf management evolves and regulations at the local, state and federal levels change.

The guide can be printed in either PDF or Word formats for distribution to regulatory agencies, lawmakers, golfers, greens committees, communities and environmental groups.

Whether it's the Sierra Nevada, the Central Valley, the desert, metro areas or California's 840 miles of coastline, the BMP provides the industry a significant platform for advocacy, education, recognition, and demonstration of professional land management.

I would be remiss if I did not thank our many partners and sponsors who contributed funds to the BMP project through our annual California Room at the Golf Industry Show. Without your financial contributions we would not have been able to put together this comprehensive guide which will assist our industry for years to come.

And last but certainly not least, thank you to BMP Committee volunteers who spent countless hours assembling and reviewing the information. Your efforts have provided a legacy that will guide golf course superintendents and operators' decisions for generations to come.

Jim Ferrin, CGCS

Sun City Roseville

President, California Golf Course Superintendents Association

BMP Index

Chapter 1: Planning, Design, and Construction

Overview of Planning, Design, and Construction

With proper planning and design, golf courses can be constructed and maintained to achieve a net positive environmental impact. This can be accomplished through a variety of means including: stormwater storage and conveyance, replacement of non-native plants with native species, establishing habitat for protected species, reducing erosion through the establishment of turf, and providing low growth vegetated buffers to prevent or slow the movement of wildfire.

Planning, Design, and Construction is a broad topic that is addressed in each of the following chapters:

- Chapter 2: Irrigation
- Chapter 3: Surfacewater Management
- Chapter 5: Nutrient Management
- Chapter 6: Cultural Practices
- Chapter 7: Integrated Pest Management
- Chapter 8: Pesticide Management
- Chapter 9: Pollinator Protection and Enhancement
- Chapter 10: Maintenance Operations
- Chapter 11: Landscape & Out of Play Areas
- Chapter 12: Energy
- Chapter 13: Groundwater Management
- Chapter 14: Air Quality
- Chapter 15: Threatened and Endangered Species
- Chapter 16: Urban Golf
- Chapter 17: Seaside Golf

Numerous cross references are present in the Best Management Practice sections of this chapter to aid the reader in finding relevant information.

All embedded hyperlinks below can be found in the References section of this guide.

Regulatory Considerations

Principles

- Local and state regulations may be in place in your location. Early engagement among developers, designers, local community groups, and permitting agencies is essential to designing and constructing a golf facility that minimizes environmental impact and meets the approval process.

- Local requirements may include compliance with county or city ordinances, such as grading requirements, dust control, and stormwater management.
- California law includes a requirement to assess potential environmental impacts and mitigate significant ones. This is done by preparing documents according to California Environmental Quality Act (CEQA).
- A CEQA analysis can help guide regulatory agencies during issuance of permits and approval of projects. CEQA applies to all discretionary projects proposed to be conducted or approved by a California public agency, including private projects requiring discretionary government approval.
- If your project is on or has something to do with a Federal government property, you may need to include a National Environmental Policy Act (NEPA) analysis.

Best Management Practices

- Refer to the following chapters for additional information:
    - Chapter 2: Irrigation
    - Chapter 3: Surfacewater Management
    - Chapter 5: Nutrient Management
    - Chapter 6: Cultural Practices
    - Chapter 7: Integrated Pest Management
    - Chapter 8: Pesticide Management
    - Chapter 9: Pollinator Protection and Enhancement
    - Chapter 10: Maintenance Operations
    - Chapter 11: Landscape & Out of Play Areas
    - Chapter 12: Energy
    - Chapter 13: Groundwater Management
    - Chapter 14: Air Quality
    - Chapter 15: Threatened and Endangered Species
    - Chapter 16: Urban Golf
    - Chapter 17: Seaside Golf
- Determine if your proposed project is subject to CEQA. If so, review the summary of the most recent document submission requirements found here.
- Stay up-to-date with revisions and amendments to CEQA. Updates may be located here or you can subscribe to the Office of Planning and Research distribution here.

Planning and Design

Principles

- Proper planning will minimize expenses resulting from unforeseen construction requirements.
- Good planning provides opportunities to maximize/integrate environmentally favorable characteristics into the property. This often requires the involvement of golf course architects, golf course superintendents, civil engineers, soil scientists, agronomists, irrigation designers, ecologists, etc.

- Proper design will meet the needs of the stakeholders, protect the locations environmental resources, and be economically sustainable.

Best Management Practices

- Refer to the chapters listed under ‘Principles’
- Assemble and retain a qualified team consisting of:
    - CEQA consultant
    - Golf course architect
    - Golf course superintendent
    - Clubhouse architect
    - Irrigation engineer
    - Environmental engineer
    - Energy analyst
    - Economic consultant
    - Civil engineer
    - Biologist
    - Soil scientist
    - Geologist
    - Golf course builder
    - Legal team
- Determine objectives
- Complete a feasibility study

    - Are needs feasible given existing resources?
        - Financial
        - Environmental
        - Water
        - Energy
        - Labor
        - Materials
        - Governmental regulatory requirements/restrictions

- Select an appropriate site that is capable of meeting stakeholder needs.
- Select grass type(s) suited for the course’s climate, soils, and irrigation water quality and quantity needs.
- Integrate sustainable maintenance practices in the development, maintenance, and operation of the course.
- Design the course to minimize the need to alter or remove existing native landscapes. The routing should identify the areas that provide opportunities for restoration.
- Design the course to retain as much natural vegetation as possible. Where appropriate, consider enhancing existing vegetation through the supplemental planting of native vegetation/materials next to long fairways, out-of-play areas, and along water sources supporting fish and other water-dependent species.

- Design out-of-play areas to retain or restore existing native vegetation where possible. Nuisance, invasive, and exotic plants should be removed and replaced with native species that are adapted to that particular site.
- Greens

    - Select a location that has adequate sunlight to meet plant-specific needs and provides sufficient drainage.
    - Choose a green size and sufficient number of hole locations that is large enough to accommodate traffic and play damage, but not so large that it is unsustainable with your resources.
    - Select an appropriate root-zone material as designated by the USGA.
    - Consider the number of bunkers as it relates to resources available for daily maintenance.
    - Design greens irrigation separate from other course areas.
    - Select a turf species/variety that meets stakeholders' needs while adhering to the principle of "right plant, right place."

- Plant only certified turfgrass.
- Decide whether bunkers will contain drainage.
- Consider bunker entry and exit points. Consider wear patterns and create adequate space for ingress/egress points on greens, tees, fairways, and bunkers.
- Select the proper color, size, and shape of bunker sand that meets course needs.
- Define play and out-of-play boundaries.

Construction

Principles

- Construction should be completed with care to minimize environmental impact and financial ramifications caused by poor construction techniques.
- California has special environmental laws that need to be considered before beginning any construction project.

Best Management Practices

- Refer to the chapters listed under "Overview of Planning, Design, and Construction."
- Implement mitigation measures, if any, as a result of the CEQA process.
- Conduct a pre-construction conference with stakeholders.
- Construction should be scheduled to meet turfgrass establishment and site drainage goals.
- Stabilize soils to minimize soil erosion and maximize sediment containment.

- Maintain a construction progress report and communicate the report to the proper permitting agencies.
- Use qualified contractors who are experienced in the special requirements of golf course construction.

Grow-In

Principles

- Turfgrass establishment is a unique phase in turfgrass growth, which can require greater quantities of water and nutrients than established turfgrasses.
- The turf establishment phase should be planned carefully to maximize turf establishment and minimize potential impacts to surfacewater and groundwater from fertilizers.

Best Management Practices

- Refer to chapters listed under “Overview of Planning, Design, and Construction.”
- Prior to placement of sod, seed, or sprigs, clear the area of unwanted vegetation.
- Check erosion and sediment control devices are in place and properly maintained.
- Sprigs should be “knifed-in” and rolled to hasten root establishment.
- Sod should be topdressed to fill in the gaps between sod pieces. This hastens establishment and provides a smoother surface.
- When using sod, nutrient applications should be delayed until sod has sufficiently rooted.
- When using sprigs, application rates for nitrogen, phosphorous, and potassium should correspond to percent ground cover (i.e., increasing rate as ground coverage increases.)
- Light, frequent soluble-nitrogen sources should be used during grow-in.
- Nutrients should be applied, in either foliar or granular formulations, to the turf surface. Incorporating nutrients into the root zone does not result in more rapid establishment and increases environmental risk.
- To hasten establishment, mow as soon as the sod has knitted-down, when sprigs have rooted at the second to third internode, and seedlings have reached a height of one-third greater than intended height-of-cut.

Erosion and Sediment Control

Principles

- Soil carried by wind and water erosion may transport fertilizers or pesticides off site.
- Erosion and sediment control are a critical component of golf course construction and grow-in.

Best Management Practices

- Refer to the following chapters for additional information:
    - Chapter 2: Irrigation
    - Chapter 3: Surfacewater Management
    - Chapter 5: Nutrient Management
    - Chapter 10: Maintenance Operations
    - Chapter 11: Landscape & Out of Play Areas
    - Chapter 13: Groundwater Management
    - Chapter 16: Urban Golf
    - Chapter 17: Seaside Golf
- A Stormwater Pollution Prevention Plan (SWPPP) should be developed to address this issue. A SWPPP is often required as part of a county grading or other permit.
- Elements of a SWPPP include, but are not limited to, the use of straw waddles, silt fences, and vegetative cover to reduce or eliminate erosion and resulting off-site sediment movement.
- Vegetative cover like hydro-seeding or hydro-mulching can offer soil stabilization.
- Use dry detention basins/catchments to buffer flooding and excessive runoff that may contain sediment.
- The placement of bunkers and the shaping of contours surrounding a green should allow proper drainage and provide for capture of runoff from the green.
- Increase height of turf cut adjacent to surfacewater or riparian zones to slow and allow infiltration of nutrient and pesticides into surface soil where it will adsorb or degrade.
- Ideally, littoral zones should have a slope of about 1 foot vertical to 6-10 foot horizontal.
- For the littoral zone in lakes and ponds, consider constructing random small dips and ridges of a few inches to a foot to promote diversity within the plant community.
- Armor culvert intakes and use energy dissipators to prevent erosion during storm events.
- Check culverts and remove debris that may deter flow that could cause erosion of the intake area.

Wetlands

Principles

- California considers wetlands as either Waters of the United States (WOTUS) or Waters of the State (WOTS). In either case, these designations carry significant legal ramifications. For example, soil disturbance in and around a wetland may constitute a “dredge and fill” activity in which the activity may require a permit or be prohibited.

- Wetlands can have multiple overlapping jurisdictions of federal, state, and local agencies. At the federal level alone, the U.S. Army Corps of Engineers (USACE), USEPA, U.S Fish and Wildlife Service (FWS), and National Oceanic and Atmospheric Administration (NOAA) Fisheries may all be involved.
- Wetlands act both as filters for pollutant removal and as habitat for many species of birds, insects, fish, and other aquatic organisms.
- When incorporated into a golf course design, wetlands should be maintained and separated from managed turf areas with native vegetation or structural buffers.
- Unknowing creation of a wetland may provide habitat for species that require special attention and, therefore, limit activities in and around the wetland.

Best Management Practices

- Refer to the following chapters for more information:
    - Chapter 3: Surfacewater Management
    - Chapter 5: Nutrient Management
    - Chapter 7: Integrated Pest Management
    - Chapter 8: Pesticide Management
    - Chapter 15: Threatened and Endangered Species
- Evaluate if wetlands have been properly delineated, and that proper permitting has been obtained before working in and around wetlands.

Drainage

Principles

- Adequate drainage is necessary for growing, healthy grass.
- Drainage of the golf course features is only as good as the system's integrity. Damaged, improperly installed, or poorly maintained drainage systems will result in inferior performance that negatively impacts play and increases risks to water quality.

Best Management Practices

- Refer to the following chapters for information:
    - Chapter 2: Irrigation
    - Chapter 3: Surfacewater Management
- When constructing drainage systems, pay close attention to engineering details such as subsoil preparation and the placement of gravel, slopes, and backfilling.
- Internal golf course drains should not drain directly into an open waterbody, but should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediment.
- The drainage system should be routinely inspected to check proper function.

Surfacewater: Stormwater, Ponds, and Lakes

Best Management Practices

- Refer to the following chapters for information:
    - Chapter 3: Surfacewater Management
    - Chapter 5: Nutrient Management
    - Chapter 7: Integrated Pest Management
    - Chapter 8: Pesticide Management
    - Chapter 15: Threatened and Endangered Species

Maintenance Facilities

Best Management Practices

- Refer to the following chapters for information:
    - Chapter 5: Nutrient Management
    - Chapter 8: Pesticide Management
    - Chapter 10: Maintenance Operations
    - Chapter 12: Energy
    - Chapter 14: Air Quality

External Certification Programs

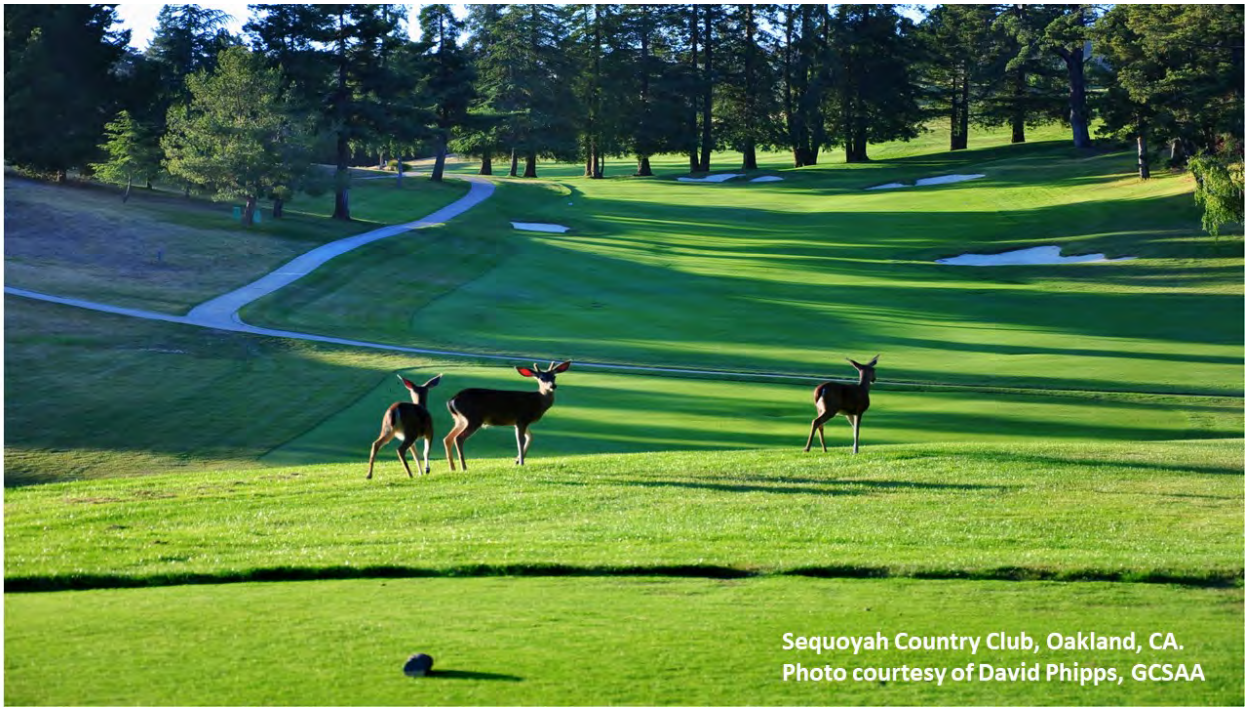
Principles

- Programs like e-Par and Audubon Cooperative Sanctuary Program (ACSP) can help golf course superintendents protect the environment, communicate their efforts to the public, and comply with regulations.
- The ACSP is not associated with the Audubon Society.
- Golf courses may gain recognition for their environmental education and certification efforts.

Best Management Practices

- Obtain and review materials to ascertain whether the facility should seek certification.
- Assess the cost/benefit of certification. What value does it bring?
- Work with staff to establish facility goals that lead to certification.
- Establish goals to educate members about the certification program. This could include signage on the course and in the club house, webpage postings, and school field trips.

Wildlife Considerations



Principles

- Golf courses often provide critical links between urban and rural/natural environments.
- Maintaining wildlife habitat on golf courses maintains biological diversity and migration corridors, which is especially important in the urban environment.
- Most golfers enjoy observing non-threatening wildlife as they play the game.

Best Management Practices

- Refer to the following chapters for additional information:
    - Chapter 3: Surfacewater Management
    - Chapter 7: Integrated Pest Management
    - Chapter 9: Pollinator Protection and Enhancement
    - Chapter 15: Threatened and Endangered Species
- Identify the different types of habitat specific to the site.
- Identify the habitat requirements (food, water, cover, space) for identified wildlife species.
- Identify species on the site that are considered threatened, endangered, or listed by California or the Federal government, including species the state deems “of special concern.”
- Preserve critical habitat and migration corridors.
- Design and locate cart paths to minimize environmental impacts. Construct the paths of permeable materials, if possible.
- Remove nuisance and exotic/invasive plants and replace them with native species.
- Maintain clearance between the ground and the lowest portion of a fence or wall to allow wildlife to pass, except in areas where feral animals need to be excluded.
- Retain dead tree snags for nesting and feeding sites, provided they pose no danger to people or property.
- Construct and place birdhouses, bat houses, and nesting sites in out-of-play areas.
- Plant butterfly gardens around the clubhouse and out-of-play areas.
- Retain riparian buffers along waterways to protect water quality and provide food, nesting sites, and cover for wildlife.
- Minimize stream or river crossings to protect water quality and preserve stream banks.

Frequently Asked Questions (FAQs)

1. I keep hearing about "CEQA". What is it and how does it apply to my golf course?

The California Environmental Quality Act (CEQA), requires state and local government agencies to inform other relevant agencies and the public about the potential environmental impacts of a proposed project and to reduce the project's environmental impacts to the extent feasible. CEQA documents are often required when a new golf course is built or undergoes a significant renovation.

The environmental factors considered under CEQA include:

- Aesthetics
- Agricultural Resources
- Air Quality
- Biological Resources
- Cultural Resources
- Geology/Soils
- Hazardous Materials
- Water Quality
- Land Use/Planning
- Mineral Resources
- Noise
- Population/Housing

- Public Services
- Recreation
- Transportation/Traffic
- Utilities/Service Systems

These environmental factors and more specific considerations are listed under the Appendix G: Checklist found here. A summary of the most recent document submission requirements for CEQA may be found here.

2. What should I know about the CDFW Lake and Streambed Alteration (LSA) Program?

The California Department of Fish and Wildlife (CDFW) is the agency responsible for protecting fish, wildlife resources, and their habitats. Part of that mission includes reviewing projects that would change the components and/or structure of waterbodies in project construction or renovation. The LSA program is intended to protect aquatic and riparian resources during and after construction.

CDFW should be informed if a project on your golf course would impact a river, stream, or lake by:

- Diverting or obstructing the natural flow
- Changing the bed, channel, or bank
- Using material from the river, stream, or lake
- Depositing material into the river, stream, or lake

For questions specific to individual projects and sites, please contact the CDFW office in your region. A list of contacts and their jurisdiction is located here. For notification forms and instructions, see the CDFW website here.

References

NOTE: Links to webpages and PDFs were active as of June 16, 2019. Access to those web resources and information presented therein are subject to change.

Audubon Cooperative Sanctuary Program. 2019. Retrieved from: https://audubonintemational.org/acsp-for-golf/

ePar. 2019. CEQA updates. Retrieved from: http://opr.ca.gov/ceqa/updates/

California Governor's Office of Planning and Research. 2018. Current CEQA Guidelines Update. Retrieved from: http://opr.ca.gov/ceqa/updates/guidelines/

CEQA Checklist: http://resources.ca.gov/ceqa/guidelines/Appendix_G.html

CEQA documents: http://opr.ca.gov/clearinghouse/ceqa/document-submission.html

CDFW LSA: https://www.wildlife.ca.gov/conservation/lsa

CDFW LSA regional contacts: https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=155211&inline

CDFW LSA notify/instructions: https://www.wildlife.ca.gov/Conservation/LSA/Notify-CDFW

State Water Resources Control Board (SWRCB) Construction General Permit (CGP): https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

Chapter 2: Irrigation

Overview of Irrigation

Photo Courtesy of Toro

The supplemental use of water to irrigate golf course play and non-play areas is essential to supporting healthy turfgrass and landscape plant health. It is also necessary to sustaining optimal playability, aesthetics, marketability, and membership satisfaction.

The purpose of this section is to identify best management practices (BMPs) related to irrigation water. Irrigation BMPs may provide an economic, regulatory compliance, and environmental stewardship advantages to those who employ them as part of their irrigation management plan. Several benefits of adopting BMP are:

- Conserving water and power
- Protecting water quality on and adjacent to the golf course
- Maintaining optimal playing conditions
- Increasing pump and equipment life longevity
- Demonstrating responsible environmental stewardship
- Complying with regulatory requirements

All embedded hyperlinks below can be found in the References section of this guide.

Water Management Approaches

Conservation and Efficiency

Conservation and efficiency considers the strategic use of appropriate golf course and irrigation design, plant selection, computerized and data-integrated scheduling, and alternative water quality/supply options that maximize plant health benefits and reduce the potential for negative impacts on natural resources.

Resource Protection

Resource protection is an integrated approach that includes irrigation practices as part of the golf course design, groundwater use, pesticide and nutrient practices, and regulatory compliance measures as they concern environmental stewardship and policy.

More information about pesticide and nutrient management and groundwater can be found in their respective chapters.

Regulatory Considerations

Principles

Groundwater

- All users of groundwater, irrigation included, must comply with the Sustainable Groundwater Management Act (SGMA). SGMA requires that by January 21, 2022, groundwater basin specific Groundwater Sustainability Plan (GSPs) must be developed by Groundwater Sustainability Agencies (GSAs).
- Refer to Chapter 13: Groundwater Management for more information.

Water Quality

- There are nine (9) Regional Water Quality Control Boards (RWQCB) throughout California that are overseen by the State Water Resources Control Board (SWRCB). The SWRCB sets policy and guidance on matters such as water quality and reclaimed water use.
- Because California is so geographically and hydrologically diverse, individual RWQCBs may implement rules differently. It is critical that you know which RWQCB your golf course is located in so that you gain familiarity with the rules specific to your area.

Water Rights

Prior to golf course renovation or construction, the availability, quality and quantity of water must be determined. Having a right to use water is critical. Below are important elements of California water rights:

- Different than any other western state, California handles surface water and groundwater separately.

- The California Constitution (Article X, Section 2) requires that all water resources must be put to beneficial use, prevent waste or unreasonable use or unreasonable method of use.
- Rights to groundwater are being developed by the SGMA process mentioned above and described in the Groundwater chapter.
- A water right is a legal entitlement authorizing water to be diverted from a specific source and put to use. Rights to surface water are a form of property right that allows the holder to use, but not own, the water and fall into the following two (2) general categories:
    - Riparian Rights. These rights are part and parcel of a property and involve the bank of a river or any area where water naturally touches the land. This right is typically superior to an appropriative right and does not allow seasonal water storage.
    - Appropriative Rights. This is based on a physical diversion and use of water and requires a permit from the State Water Resources Control Board (SWRCB). This right can be lost through abandonment, forfeiture or prescription. There are special rules for pre-1914 water rights, described in the SWRCB FAQs found here.

Best Management Practices

- If you use groundwater, determine what GSA is responsible for your golf course's location. Gain familiarity with the GSA's objectives, other users of groundwater in the basin and the overall status of your basin's groundwater use to begin assessing potential impacts to your golf course.
- Determine what RWQCB has jurisdiction in the area your golf course is located. Assess what Total Maximum Daily Loads (TMDLs), or other impairments exist near your course. If these impairments are related to sediment and erosion or pesticides or fertilizers you use, assess potential impacts to surface and groundwater that may be caused or exacerbated by the golf course's irrigation practices.
- Irrigation practices to consider that may impact water quality include over irrigation that results in runoff or percolation past the root zone.
- Evaluate if your golf course has rights to the water it uses.
- Design and/or maintain a system to meet the golf course's peak water requirements under normal and high use conditions.
- Develop an annual water budget for the golf course. Water budgets can be determined through the use of the California Irrigation Management Information System: http://www.cimis.water.ca.gov/ Additionally, the USEPA WaterSense Budget Tool provides data and a downloadable Excel spreadsheet to assist in developing a water budget:

    https://www.epa.gov/watersense/water-budget-data-finder
    https://www.epa.gov/sites/production/files/2017-06/ws_water_budget_tool.xlsx

- Look for ways to increase efficiency and reduce energy use associated with irrigation systems and practices, including scheduling, ensuring the pump, systems and power sources are properly matched, using the lowest feasible operating pressure, and balancing energy loss of less efficient equipment to irrigation systems repair or replacement costs.

Irrigation Water Suitability

Principles

- Take into account your golf course's turf type(s), soil characteristics including leaching ability or lack thereof, depth to groundwater and topography as it relates to runoff or low spots where water may drain and pool.
- Assess characteristics of your irrigation water source(s) to determine compatibility with the aforementioned golf course characteristics. For example, factors such as salt content, pH, hardness and in some cases trace metals can impact turf quality.
- Reclaimed water from wastewater treatment plants is a viable irrigation water option to consider, but the factors mentioned above should be evaluated.
- Because treatment plant operations can vary with time, check with the plant operator or perform your own testing on a regular basis to evaluate the quality of the water and its suitability to your needs.
- Capture of stormwater and subsequent use as irrigation water is viable irrigation water option to consider.

Best Management Practices

- Consider the use of alternatives to potable water such as reclaimed water that are appropriate and sufficiently available to meet golf course needs.
- If reclaimed or other high salt content irrigation water is used, regularly monitor the quality of this water and salt accumulation in the root zone. If not adequately flushed during winter rains, flushing of the root zone with freshwater may be necessary. Consult an agronomist to determine appropriate testing of soil and water.
- If your golf course overlays shallow groundwater, routinely monitor the depth to water and how it reacts to your irrigation and fertilization practices. Sample groundwater from analytes such as salts and nitrogen to assess impacts, if any, from your practices.
- Reclaimed and other non-potable water supply mains must have a cross-connection and backflow prevention device in place and operating correctly.
- Post signage in accordance with local and state requirements when reclaimed water is in use.
- Account for the nutrients in reclaimed water when making fertilizer calculations.

Sodic (High Sodium) Water Irrigation

Principles

- Reclaimed water from wastewater treatment plants are typically high in salts, including sodium. Excess salt in irrigation water can adversely impact turf quality and may have long term impacts to soil and its ability to sustain a viable root zone.

Best Management Practices

- Monitor reclaimed water quality regularly.
- Retain an agronomist with expertise in turf to perform irrigation water and soil testing to determine what amendments to either soil or irrigation water are necessary.
- Use salt-tolerant varieties, such as seashore paspalum, may mitigate potential impacts from the use of high salt content irrigation water.
- Make turf selections with considerations for your region, including climate, pest-resistance and water needs. The UC Statewide IPM guide for selecting a turf species based on specific tolerances can be use. For landscape plants, you can use the USDA Plants Database to select species that are native to your area and have a high salinity tolerance.

Reclaimed Water

Principles

- Recycled or reclaimed water is water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource (Wat. Code § 13050(n)).
- Under 22 CCR § 60304 (a), recycled water used for the surface irrigation of unrestricted access golf courses shall be a disinfected tertiary recycled water.
- Tertiary recycled water is wastewater that is filtered and disinfected according to the standards found under 22 CCR 60301.230.
- Individual water reclamation requirements are dictated by your Regional Water Quality Control Board (RWQCB).

Best Management Practices

- Follow BMPs mentioned above under “Irrigation Water Suitability” and “Sodic Water Irrigation”.
- Prior to irrigating with reclaimed water, test the irrigation water on several turf plots to assess potential impacts to the turf and soil.
- Consider blending freshwater with reclaimed water to dilute salt present in the reclaimed water.
- Use purple pipe for reclaimed water and mark appropriate locations with “Non-Potable” signage per RWQCB and local county environmental health department (EHD) regulations.
- Build flexibility into your irrigation system in case your reclaimed water source becomes unavailable, you have an alternative source.
- Recognize that the RWQCB and/or the local County EHD may require a setback distance of up to 50 feet between irrigated areas and potable water supply wells and areas occupied by people.
- Confirm with the treatment plant that they maintain a residual chlorine level of 0.5 mg/L or greater to reduce any potential odors, slime, and bacterial regrowth.
- Keep up-to-date on recycled water policy via e-mail found at: https://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.html
- For more water quality control policies for recycled water, visit the State Water Resources Control Board webpage: https://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/

Water Conservation and Efficient Use Planning

Principles

- Employ an irrigation system that allows for remote control of heads and operates using soil moisture sensors and weather data, including estimates of evapotranspiration (Eto), based on a weather station located on the golf course. This system will have flow meters and totalizers so that water use can be monitored.

- Using data from the irrigation system, document watering practices and golf course water use to demonstrate conservation.
- Communicate to your water supplier and membership the sophistication of your irrigation system and the science behind determining how the golf course is irrigated.
- If you take areas out of play to conserve water, communicate this to membership with signage.
- Consider planting native drought tolerant grasses in these out of play areas.
- Be proactive about telling the non-golfing public about your water conservation practices. Invite school field trips (e.g., the GCSAA educational outreach program First Green), local community groups, and the local newspaper to your golf course so you can show them how your water conservation methods save water and create and maintain habitat.

Best Management Practices

- Consider selecting drought-tolerant varieties of turfgrass.
- Plant out of play areas with drought-resistant native or other well-adapted, noninvasive plants that provide an attractive and low-maintenance landscape.
- As a part of your irrigation system operation, closely monitor soil moisture levels. Whenever practicable, irrigate at times when the least amount of evaporative loss will occur. To review at what time evapotranspiration is lowest in your region during a given month, you can use the Department of Water Resources CIMIS map tool.
- If properly designed, rain and runoff captured in water hazards and stormwater ponds may provide supplemental irrigation water.
- If you capture stormwater in an on-site pond or reservoir, assess the emergent vegetation around the perimeter. Although plants such as cattails, tules, bulrush and iris are helpful in stabilizing banks and in some cases providing habitat and some aesthetic value, they can use significant amounts of water and displace storage capacity. Consider controlling these plants as needed to conserve water.
- Flow meters can wear out over time and may require calibration. Accurate flow data is critical in assessing water use efficiency and is in some cases required by the water supplier. Contact the manufacturer to assess and calibrate meters as needed.

Irrigation System Design

Principles

- Irrigation systems should be properly designed and installed to maximize turf health and irrigation water use efficiency.

Best Management Practices

- Design should account for optimal distribution efficiency and effective root-zone moisture coverage. Target 80% or better Distribution Uniformity (DU).
- Design should allow the different areas of the golf course to be irrigated independently and remotely.
- As an initial irrigation schedule, the UC Statewide Integrated Pest Management Program provides an overview of irrigation scheduling based on California region, turf grass species, and sprinkler output. This tool can be found at http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/irrsched.html. This should ultimately be customized and modified based on the golf course's local climatic soil and growing conditions, including the evapotranspiration (ETo).
- The irrigation water application rate must not exceed the infiltration rate, which is the soil's ability to absorb and retain water. Conduct tests at various locations on the golf course to assess the ability of your golf course's soil to effectively take water.
- The design operating pressure must account for peak-use times and supply line pressures at final buildout for the entire system.

- Many California utilities (San Diego Electric, SMUD, PG&E, etc.) provide information on their webpage with off-peak, partial peak, and peak hour rates and times by month. Determine if a standard time-of-use plan might benefit your golf course. See the Energy Chapter for more information.
- Turf and landscape areas should be zoned separately. Specific use areas (greens, tees, primary roughs, secondary roughs, fairways, native, trees, shrubs, etc.) must also be zoned separately.
- Irrigation system design should account for the potential use of freshwater to leach salt buildup in the rootzone due to poor-quality water sources and/or sodic soils by providing access to freshwater.
- Sprinklers should be spaced according to the manufacturer's and designer's recommendations and should take into account average wind conditions on the golf course. Wind measurements can be taken using a handheld anemometer or viewed on the California Wind Mapper website: http://windmapper.com/CA/observations
- Water supply systems (for example, wells, and connections to municipal supplies) should have backflow prevention devices per applicable code.
- Install manual quick-coupler valves near greens, tees, and bunkers so these areas can be hand-watered as needed.
- Install part-circle heads along lakes, ponds, and wetlands margins.
- Install part-circle or adjustable heads to avoid overspray of impervious areas such as cartpaths, roads and sidewalks.
- Use single head controls to maximize distribution uniformity and enhance water conservation.
- Pressure and flow should be evaluated to determine that the correct nozzles are being used and that the heads are performing according to the manufacturer's specifications.

Irrigation Pumping System

Principles

- Pump stations should be sized to provide adequate flow and pressure. They should be equipped with control systems that protect distribution piping, provide for emergency shutdown necessitated by line breaks, and allow maximum system scheduling flexibility.
- Variable frequency drive (VFD) pumping systems should be considered if dramatically variable flow rates are required. The frequency of electrical transients (such spikes and surges) should be evaluated as these adversely impact VFDs.

Best Management Practices

- The design operating pressure must account for peak-use times and supply-line pressures at final buildout for the entire system.
- VFD systems can potentially lengthen the life of older pipes and fittings and conserve energy.
- Include high- and low-pressure sensors that shut down the system in case of breaks and malfunctions.
- Monitor power consumption, flow rate and totalized flow to assess changes that may suggest leaks or pump or distribution problems.
- Enlist the assistance of your power utility, local county Resource Conservation District (RCD) or pump supplier to perform pump efficiency testing if you use

groundwater. This testing is often free and may be useful in conserving power, water and money.
- Install emergency shutdown devices to address line breaks.

Irrigation System Program and Scheduling

Photo Courtesy of Toro

Principles

- Irrigation scheduling must take into account current and predicted local weather conditions, turf water requirements and soil intake capacity to prevent excess water use that could lead to leaching and runoff.
- Plant water needs are determined by ETo, recent rainfall, recent temperature extremes and soil moisture.
- Irrigation should not occur on a calendar-based schedule, but should be based on ETo, soil moisture and weather. To review at what time evapotranspiration is lowest in your region during a given month, you can use the Department of Water Resources CIMIS map tool.
- Other factors to consider are soil type, soil leaching capacity and topography as these are important in the control of runoff and erosion.
- The golf course's irrigation system should be operated based only turf needs or to water-in a fertilizer or pesticide application as directed by the label.

Best Management Practices

- The golf course's irrigation system and integrated weather station should have rain sensors to adjust irrigation as needed depending on the golf course conditions and the amount of rain received.
- Irrigation rates should not exceed the maximum ability of the soil to absorb and hold water.
- The irrigation schedule should be integrated with the application of soil amendments, fertilizers and pesticides that are required to be watered in.
- Because reclaimed water and some groundwater contains nitrogen, often in the form of nitrate, this needs to be taken into account when calculating fertilizer application rates. Obtain the concentration of nitrate and other constituents in irrigation water by submitting a sample to an analytical laboratory.
- Visually monitor for localized dry conditions or hot spots to identify poor irrigation efficiency or a failed system component.
- Use multiple representative soil moisture sensors to assist in scheduling timing and duration of irrigation.
- Periodically perform catch-can uniformity tests in areas of the golf course that exhibit under or overwatering or areas of stressed turf adjacent to healthy turf and replace irrigation nozzles when distribution uniformity falls below acceptable thresholds.
- Reducing dry spots and soil compaction improves water infiltration, which in turn reduces water use and runoff in other areas.
- Use handheld moisture meters (e.g. POGO, Field Scout) to evaluate soil moisture in large turf areas.

Turf Drought Response

Principles

- Do not wait until visible symptoms (wilting, etc.) of moisture stress appear before irrigating.
- Consider preparing a drought management plan in the event that irrigation water availability is reduced. For example, this plan may include reducing or eliminating irrigation in certain areas of fairway and allowing them to be played dry or taken out of play.

Best Management Practices

- Use soil moisture meters as either part of the irrigation system or hand-held models to assist in determine irrigation needs. For example, a hand-held soil moisture meter can be used to spot check areas to assess conditions and make informed decisions about the need to adjust sprinkler heads, irrigation timing and duration or to institute hand watering.
- Depending on turf type and soil conditions, frequent, short duration irrigation may promote shallow rooting, increase soil compaction, and stress the turf making it susceptible to pests.

- For fairways and roughs, consider using infrequent and deep irrigation to encourage deep rooting.
- Use cultural practices such as adjusting for proper mowing height and frequency and maintain mowing equipment with sharp blades to prevent injury to turf. Aerate, verticut and dethatch to promote healthy, deep root development and to allow for sufficient water and air movement through the root zone.
- Use appropriate turfgrass species adapted to the location of the golf course being managed. The UC Statewide IPM guide provides guidance for selecting turf species with low water need in California while accounting for other factors, such as salinity tolerance and traffic endurance.
- When preparing a drought management plan, use a phased approach to cut back water use. See the Developing a Drought-Emergency Plan article here for additional guidance.

Irrigation System Maintenance

Principles

- Golf course irrigation system maintenance involves four major efforts: auditing, preventive maintenance (PM), corrective maintenance, and record keeping.
- Good system management starts with good preventive maintenance (PM) procedures and recordkeeping. Maintaining a system is more than just fixing sprinkler heads.
- Corrective maintenance (CM) is simply the act of fixing what is broken. It may be as simple as cleaning a clogged orifice, or as complex as a complete renovation of the irrigation system.
- Periodic audits provide for assessment of irrigation system performance and allow for CM and/or PM.
- Recordkeeping is critical to keep track of system performance, cost and frequency of component repair and replacement.

Best Management Practices

- Establish a routine monitoring and maintenance schedule for pumps, valves, fittings, and sprinkler heads that follow the manufacturer's recommendations.
- At a minimum, daily inspection should include assessment of the pump station and irrigation heads to check for misalignment, clogging, scale or slime buildup, leaks and chronic wet or dry spots.
- Check filter operations frequently and keep records of changeouts. An unusual increase in the amount of debris may indicate problems with the water source.
- Application/distribution efficiencies should be checked regularly. Implement a PM program to replace worn components before they adversely impact irrigation that may then lead to poor quality turf, erosion, wet or dry spots, etc.
- Consider retaining an irrigation professional to conduct an irrigation audit every three to five years.

- Document equipment run-time, lubrication, filter change, overhaul, replacement, adjustment and other preventive maintenance and compare to the manufacturer's recommended schedule.
- If the irrigation system requires frequent repairs, it is necessary to determine why these failures are occurring. For example:
    - Pipe failures may be caused not only by material failure, but also by problems with the pump station.
    - Wiring problems could be caused by corrosion, rodent damage, or frequent lightning or power surges.
    - Control tubing problems could result from poor filtration.

Pond Location, Design and Maintenance

Principles

- The size, shape, and depth of ponds may affect how they perform as an irrigation water source.
- The golf course itself and its ponds are often part of regional stormwater control and treatment systems.
- Introduction of nutrients such as fertilizer and grass clippings into a pond may enhance the growth of undesirable vegetation and algae that may then result is adverse aesthetic impacts that include foul odors.

Best Management Practices

- Prior to the construction of a pond, or the alteration of an existing one, several important permits should be considered:
    - The US Army Corps of Engineers (USACE) requires a Section 404 permit when dredge and fill are proposed in a Water of the United States ("WOTUS"). The determination of whether or not a WOTUS exists is an important first step in determining whether or not a permit is needed.
    - The RWQCB may require a 401 water quality certification if the USACE issues a 404 permit.
    - The California Department of Fish and Wildlife (CDFW) may require a 1600 streambed alteration agreement if the bed and bank of an existing water body are altered.
- Local county public works of the flood control agency should be consulted to assess impacts of the new or altered pond.
- Recognize that for the ponds to fulfill their flood control mission, in many cases, they should be drained in the late fall in order to have capacity to accommodate winter rain and act as a modulating buffer or temporary storage for stormwater.
- Assess the emergent vegetation around the perimeter of the pond. Although plants such as cattails, tules, bulrush and iris are helpful in stabilizing banks and in some cases providing habitat and providing some aesthetic value, they can use significant amounts of water and displace storage capacity. Consider controlling these plants as needed to conserve water.

- Control of floating, submerged or emergent aquatic vegetation and algae in the pond may be needed in order to easily access irrigation water, prevent pump intake clogging or maintain desirable aesthetics. If aquatic pesticides are being considered, a National Pollutant Discharge Elimination System (NPDES) aquatic pesticide permit may be needed if the application is to a WOTUS.
- Currently,less than 20 active ingredients are registered for use in California and are allowed for use in the NPDES aquatic pesticide permit. Products containing these active ingredients are specifically labeled for aquatic use. Always read and follow label directions.
- A variety of fountains, mixers and aerators are available for ponds. These devices can perform a variety of functions such as vertically and horizontally mixing the water and increasing dissolved oxygen. The result can be a reduction in odor and in some cases a lessening of algae and aquatic weeds.
- Because each pond is different, the management practice(s) employed to meet objectives will vary. A pond management specialist should be consulted as appropriate.
- When mowing the lake edge, collect or direct clippings away from the water to areas were runoff will not bring the clippings into the lake or pond.
- Minimize the unintentional introduction of fertilizers and pesticides into ponds by creating a 10 foot buffer around the pond perimeter to prevent algae and aquatic weeds.
- If fish are present, dissolved oxygen (DO) in the water is critical for their survival. Different fish species require different DO. More information can be found here: https://www.water-research.net/index.php/dissovled-oxygen-in-water

Winterization and Spring Startup

Grizzly Ranch Golf Club
Portola, CA.

Photo courtesy of Jeff Jensen, GCSAA

Principles

- Winterization of the irrigation system is important to protect the system and reduce equipment failures resulting from freezing.

Best Management Practices

- Flush and drain above-ground irrigation system components that could hold water.
- Remove water from all conveyances, pumps and supply and distribution devices that may freeze with compressed air or open drain plugs at the lowest point on the system.

Non-Play and Landscape Areas

Principles

- Identify potential environmentally sensitive areas such wetlands or vernal pools.
- Natural vegetation should be retained and enhanced for non-play areas to conserve water.
- Plant out of play areas with drought-resistant native or other well-adapted, noninvasive plants that provide an attractive and low-maintenance landscape.

Best Management Practices

- If you take areas out of play to conserve water, communicate this to membership with signage.
- Consider planting native drought tolerant grasses in out of play and landscape areas.
- For landscape plants, you can use the USDA Plants Database to select species that are native to your county and have a high drought tolerance.
- Use the CDFW California Natural Diversity Database (CNDDB) found here https://www.wildlife.ca.gov/Data/CNDDB to find endangered, threatened or listed species near your golf course.
- Refer to the Endangered Species chapter of this guide for information about the presence of threatened or protected species and their habitat.
- Use the Cal Flora database found here http://www.calflora.org/ to supplement your search of the CNDDB database.
- Additionally, the Cal Flora database can be used to assist in the selection of plants suited to the geography, soils and climate of your golf course. More information can be found here: https://www.calflora.org/entry/wgh.html

Wellhead Protection

Principles

- Wellhead protection is the establishment of protection zones and safe land-use practices around water supply wells in order to protect aquifers from accidental contamination.
- Prior to installation of a well, well construction details must be provided to the local County EHD in order to obtain a permit. The EHD will inspect the well after its completion.

Best Management Practices

- See the Groundwater and Planning, Design, and Construction Chapters for more about installation of new wells.
- Use backflow-prevention devices at the wellhead, on hoses, and at the pesticide mix/load station to prevent contamination of the water source.
- Properly abandon unused wells using guidance from your local county EHD.
- Surround new wells with bollards or a physical barrier to prevent impacts to the wellhead.
- Inspect wellheads and the well casing at least annually for leaks or cracks; make repairs as needed.
- Maintain records of new well construction and modifications to existing wells.
- Obtain a copy of the well log for your course's well to evaluate the local geology and the depth to water. These factors will have a bearing on what aquifer the well is accessing and may have provide information on groundwater quality.
- For insight into water quality parameters in surrounding locations, the Water Board Geotracker GAMA database provides water chemistry parameters of wells in California.
- Never apply fertilizers or pesticides next to a wellhead.
- Never mix and load pesticides next to a wellhead if not on a pesticide mix/load pad.

Frequently Asked Questions (FAQs)

1. I am looking to develop or update my water budget. Where do I find the relevant information I need?

The United States Environmental Protection Agency (USEPA) WaterSense has a useful water budget downloadable spreadsheet that can help you calculate a water budget for your golf course. You will need to know your ETo, rainfall per month, and peak watering month. If you do not already know this information, you can either use the USEPA WaterSense Water Budget Data Finder or the California Irrigation Management Information System (CIMIS) to find data specific to your location.

2. How do I know which Regional Water Board jurisdiction I am a part of?

There are nine regional water quality control boards in California. You can view a map of the divisions to determine what jurisdiction you fall under.

3. Where can I find out more about water rights and who do I contact?

The State Water Resources Control Board has an Electronic Water Rights Information Management System (eWRIMS) that can assist in determining your water rights.

4. How can I find out which regions in California suffer from high risk of sodic well water?

The State Water Resources Control Board (SWRCB) provides information about water quality in California through the Groundwater Ambient Monitoring and Assessment (GAMA) Program GeoTracker. The Geotracker has the option to view the Total Dissolved Solids (TDSs) or other chemicals for a variety of monitoring wells by location.

Another option is to view the California Department of Water Resources (DWR) Bulletin 118. This publication offers both Statewide and Regional reports that contain information on water quality hazard areas, including sodium percentage.

To find out if your irrigation water has salinity problems, you can measure the Electrical Conductivity (EC) or Total Dissolved Solids (TDS) using a conductivity meter/hydrometer or submit samples to a water analysis laboratory in your area. The California Water Board provides a list of California ELAP Certified Laboratories for your convenience.

You can also learn more about the soils in your area of interest by using the USDA Web Soil Survey.

5. What do I do to mitigate sodic water damage to my golf course?

Using sodic water for irrigation on golf courses can affect soil structure, pH, and turf health.

Best management practices to address salt accumulation on golf courses due to irrigation include:

- Hiring an agronomist with experience in turf to test both irrigation water and soil to assess problems and recommend solutions.
- Select salt-resistance turf and landscape plant species. This will need to be balanced with other turf considerations for your region, including climate, pest-resistance and water needs. The UC Statewide IPM guide for selecting a species based on specific tolerances can be used. For landscape plants, you can use the USDA Plants Database to select species that are native to your county and have a high salinity tolerance. This Database also considers other growth requirements which can be used to customize the needs for your golf course. An additional source for California plants native to your county is the Calflora Database.

- Consider using multiple irrigation water sources. Considerations should include blending, and the reliability and stability of all sources.
- Use good fertilizer/nutrient/sediment management to protect sources of irrigation water from salt intrusion.
- Check that your irrigation system design and operation allows for ETo-based distribution and take into account course-specific characteristics that may influence percolation or runoff.
- To learn more about the soil characteristics on your course, you can use the Soil Web Survey tool.
- Having good drainage is required for salt removal that would otherwise accumulate in top layers of soil. If you have a high-clay soil, sand-capping might be an option.
- Utilize good fertilizer and erosion control practices to decrease introduction of fertilizer to shallow groundwater or surface water. For BMPs related to nutrient management and erosion control, see Section 5: Nutrient Management and Section 1: Plan, Design, and Construction of this guide, respectively.

6. Are there any special rules about the use of reclaimed water in California?

- Under 22 CCR § 60304 (a), recycled water used for the surface irrigation of unrestricted access golf courses shall be a disinfected tertiary recycled water.
- Tertiary recycled water is wastewater that is filtered and disinfected according to the standards found under 22 CCR 60301.230.
- Individual water reclamation requirements are dictated by your Regional Water Quality Control Board (RWQCB). Requirements may include the use of setbacks from wells and areas occupied by people.
- Always use purple pipe for reclaimed water
- Keep up-to-date on recycled water policy e-mail list, found at: https://www.waterboards.ca.gov/resources/email_subscriptions/swrcb_subscribe.html
- Maintain a recommended residual chlorine level of 0.5 mg/L or greater to reduce any potential odors, slime, and bacterial regrowth.
- For more water quality control policies for recycled water, visit the State Water Resources Control Board webpage: https://www.waterboards.ca.gov/water_issues/programs/water_recycling_policy/

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Sodic Water and Irrigation

Carrow, R.N. and R.R. Duncan. 2011. Best Management Practices for Salt-Affected Golf Courses: Why and How? Green Section Record Vol. 49 (26). Available at http://gsrpdf.lib.msu.edu/ticpdf.py?file=/article/carrow-best-7-1-11.pdf (Accessed: April 18th, 2018)

Wu and Dodge. Landscape Plant Salt Tolerance Selection Guide for Recycled Water Irrigation. Department of Plant Sciences, University of California, Davis. Available at http://slosson.ucdavis.edu/files/215300.pdf

Water Management Tools

California Department of Water Resources (DWR). 2012. California Irrigation Management Information System (CIMIS): Reference Evapotranspiration Zones. Available at https://cimis.water.ca.gov/App_Themes/images/etozonemap.jpg

WaterSense Water Budget Tool: https://www.epa.gov/watersense/water-budget-tool

WaterSense Water Budget Data Finder: https://www.epa.gov/watersense/water-budget-data-finder

CIMIS: http://www.cimis.water.ca.gov/Default.aspx

State Water Resources Control Board (SWRCB) Frequently Asked Questions (FAQs): Pre-1914 water rights. Available at: https://www.waterboards.ca.gov/waterrights/board_info/faqs.html#toc178761091

State Water Resources Control Board (SWRCB) National Pollution Discharge Elimination System (NPDES). Available at https://www.waterboards.ca.gov/water_issues/programs/npdes/pesticides/weed_control.html

State Water Resources Control Board (SWRCB) Water Rights Applications: Permitting and Licensing Program: https://www.waterboards.ca.gov/waterrights/water_issues/programs/applications/

Landscape and Turf Selection

Irrigation Association and American Society of Irrigation Consultants. 2014. Landscape Irrigation Best Management Practices. Available at https://www.irrigation.org/IA/Advocacy/Standards-Best-Practices/Landscape-Irrigation-BMPs/IA/Advocacy/Landscape-Irrigation-BMPs.aspx?hkey=93b546ad-c87a-41b8-bf70-8c4fd2cff931

Harivandi, M.A., V.A. Gibeault, M.J. Henry, L. Wu, P.M. Geisel, and C.L. Unruh. 2001. Turfgrass Selection for the Home Landscape. University of California, Agriculture and Natural Resources. Available at http://anrcatalog.ucanr.edu/pdf/8035.pdfhttp://anrcatalog.ucanr.edu/pdf/8035.pdf

Foy, J. 2006. Selecting the Right Grass. USGA Green Section Record. Available at http://gsr.lib.msu.edu/2000s/2006/061101.pdf (Accessed: April 18th, 2018)

UC Statewide IPM: http://ipm.ucanr.edu/TOOLS/TURF/TURFSPECIES/index.html

USDA Plants Database: https://plants.usda.gov/adv_search.html

CalFlora: http://www.calflora.org/

Drought and Water Budgeting

California Department of Water Resources (DWR). 2008. Urban Drought Guidebook. Available at: http://www.allianceforwaterefficiency.org/WorkArea/linkit.aspx?ItemID=1298

California Department of Water Resources (DWR). 2016. Best Management Practices for the Sustainable Management of Groundwater: Water Budget BMP. Available at https://www.water.ca.gov/LegacyFiles/groundwater/sgm/pdfs/BMP_Water_Budget_Final_2016-12-23.pdf

Gross, P. 2013. Developing a Drought-Emergency Plan: A step-by-step guide to help your golf facility prepare for mandatory water restrictions. Green Section Record Vol.51 (14). Available at: http://gsrpdf.lib.msu.edu/ticpdf.py?file=/article/gross-developing-7-12-13.pdf

Sprinklers

Harivandi, M.A. and V.A. Gibeault. Managing Lawns on Heavy Soils. University of California, Agriculture and Natural Resources. Available at http://anrcatalog.ucanr.edu/pdf/7227.pdf (Accessed: April 18, 2018)

Harivandi, M.A. and V.A. Gibeault. Managing Lawns in Shade. University of California, Agriculture and Natural Resources. Available at: http://anrcatalog.ucanr.edu/pdf/7214.pdf (Accessed: April 18, 2018)

Martin, D.L., T.W. Down, S.R. Melvin, A.J. Corr, and W.L. Kranz. 2011. Evaluating Energy Use for Pumping Irrigation Water. Proceedings of the 23rd Annual Central Plains Irrigation Conference. Available at: https://www.ksre.k-state.edu/irrigate/oow/p11/Kranz11a.pdf (Accessed: April 18th, 2018)

Pacific Energy Center. 2006. Pacific Energy Center's Guide to: California Climate Zones and Bioclimatic Design.

Regional Water Boards FAQs: https://www.waterboards.ca.gov/publications_forms/publications/factsheets/docs/region_brds.pdf

Regional Water Boards map: https://www.waterboards.ca.gov/waterboards_map.html

Electronic Water Rights Information Management System: https://www.waterboards.ca.gov/waterrights/water_issues/programs/ewrims/

GAMA GeoTracker: http://geotracker.waterboards.ca.gov/gama/gamamap/public/default.asp?CMD=runreport&myaddress=California

Bulletin 118: https://www.water.ca.gov/Programs/Groundwater-Management/Bulletin-118

ELAP Certified Laboratories: http://waterboards.maps.arcgis.com/apps/webappviewer/index.html?id=bd0bd8b42b1944058244337bd2a4ebfa

USDA Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

Chapter 3: Surfacewater Management

Overview of Surfacewater Management

Surfacewater management is a broad topic that has also been addressed in the following chapters:

- Chapter 2: Irrigation
- Chapter 5: Nutrient Management
- Chapter 7: Integrated Pest Management
- Chapter 8: Pesticide Management
- Chapter 10: Maintenance Operations
- Chapter 13: Groundwater Management

Numerous cross references are present in this chapter to aid the reader in finding relevant information.

All embedded hyperlinks below can be found in the References section of this guide.

Regulatory Considerations

Principles

- Golf course owners and superintendents should know the regulatory requirements that apply to surfacewater at their golf facility.

Best Management Practices

- The following agencies have some form of jurisdiction over surfacewater and should be consulted as necessary:

Agency	Area of Jurisdiction
State Water Resources Control Board (SWRCB)	Water Quality, Water Rights
Regional Water Quality Control Board (RWQCB)	Water Quality, Wetlands
California Department of Pesticide Regulation (DPR)	Pesticide usage
California Department of Water Resources (DWR)	Dams, water storage, and conveyance
California Department of Fish and Wildlife (CDFW)	State-listed Species and Habitat, Streambed alteration
US Fish and Wildlife Services (USFWS)	Federally-listed Species and Habitat

National Marine Fisheries Service (NMFS)	Anadromous fish
Mosquito and Vector Control Boards	Mosquito control

Stormwater

Principles

Golf courses play a critical role in stormwater management. For example, golf courses are often downstream of, and surrounded by paved surfaces such as neighborhoods. As rain falls on these paved surfaces, instead of percolating, it runs off and is collected and conveyed to areas capable of handling both large quantities and high rates of stormwater delivery. These areas, including golf courses and other features such as detention basins, are capable of slowing the flow of water and allowing it to dissipate into adjacent creeks and streams and into groundwater. Factors that affect stormwater behavior on the golf course include soil type, topography, and turf and other vegetative coverage.

When golf courses are designed and built, their ability to accommodate stormwater is a critical consideration. In fact, many community master planning processes include golf courses as a location to receive stormwater, and in some cases, temporarily flood.

Stormwater Best Management Practices (BMPs) are intended to guide operation and maintenance activities on the golf course to achieve detention, percolation, and dissipation while minimizing erosion and sedimentation. BMPs also exist for construction activity which may be subject to the State Water Resources Control Board (SWRCB) Construction General Permit (CGP), in which case a Stormwater Pollution Prevention Plan (SWPPP) is needed.

Stormwater generally consists of nonpoint source pollution. Nonpoint pollution, which is both natural and caused by humans, comes from daily activity. Pollutants commonly found in stormwater include the microscopic wear products of brake linings and tires; oil; shingle particles from roofs; soap; dirt; worn paint particles from car washing; leaves and grass clippings; pet and wildlife wastes; lawn, commercial, and agricultural fertilizers; and pesticides.

Best Management Practices

- Install swales and slight berms, where appropriate, around the water’s edge, along with buffer strips, to reduce the movement of nutrients and pesticides into surfacewater.
- Reduce the speed at which stormwater travels across the course in order to maximize infiltration into soil, reducing runoff. Surfacewater velocity can be reduced by placement of dense, well-rooted vegetation along paths of travel. In some cases, infiltration trenches or French drains are appropriate at slowing and infiltrating stormwater.

- Consider the use of pervious pavers, or brick or concrete pavers separated by sand and planted with grass, to increase stormwater infiltration in hardscape such as parking lots, cart paths, etc.
- Be aware that changes in slope or grade of the course may influence stormwater flow. Consult the local stormwater agency/public works department before planning significant earthmoving activity. If the course is undergoing renovation or is a new course under construction, in addition to local grading and construction permit requirements, activities may require a SWRCB Construction General Permit (CGP). This permit requires preparation of a Stormwater Pollution Prevention Plan (SWPPP) that describes BMPS to prevent erosion and sedimentation that may impact surfacewater. More information on the permit is available at https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html
- For more information about BMPs related to stormwater usage, see Chapter 2: Irrigation and Chapter 10: Maintenance Operations.

Water Rights

(Adopted from Chapter 2: Irrigation)

Prior to golf course renovation or construction, the availability, quality, and quantity of water must be determined. Having a right to use water is critical. Below are important elements of California water rights:

- Different than any other western state, California handles surfacewater and groundwater separately.
- The California Constitution (Article X, Section 2) requires that all water resources must be put to beneficial use, prevent waste or unreasonable use or unreasonable method of use.
- A water right is a legal entitlement authorizing water to be diverted from a specific source and put to use. Rights to surfacewater are a form of property right that allows the holder to use, but not own, the water and fall into the following two (2) general categories:
    - Riparian Rights. These rights are part and parcel of a property and involve the bank of a river or any area where water naturally touches the land. This right is typically superior to an appropriative right and does not allow seasonal water storage.
    - Appropriative Rights. This is based on a physical diversion and use of water and requires a permit from the State Water Resources Control Board (SWRCB). This right can be lost through abandonment, forfeiture or prescription. There are special rules for pre-1914 water rights, described in the SWRCB FAQs found here.

Best Management Practices

- Check that your golf course has rights to the water it uses.
- Determine what RWQCB has jurisdiction in the area your golf course is located. Assess what Total Maximum Daily Loads (TMDLs), or other impairments exist near your course. If these impairments are related to sediment and erosion or pesticides or fertilizers you use, assess potential impacts to surfacewater that may be caused or exacerbated by the golf course's irrigation practices.
- Use irrigation practices as described in this chapter that minimize runoff that may impact water quality in nearby surfacewater.

Surfacewater Quality Protection

Principles

- Water quality in golf course lakes and ponds or adjacent creeks and streams should be understood and protected.
- Many regulatory requirements exist to protect surfacewater quality. The appropriate regulatory agencies should be consulted. See the Regulatory Considerations section for more about the role each entity plays in water quality protection.
- IPM should be used, as described in Chapter 7: Integrated Pest Management, to establish thresholds and manage pests near surfacewater.

Best Management Practices

- Use irrigation practices as described in this chapter that minimize runoff that may impact water quality in nearby surfacewater.
- Find out information on the soils on your course using the US Department of Agriculture (USDA) SoilWeb found here: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- Identify impervious surfaces, such as building roofs, parking lots, cart paths, and walkways, and assess drainage, runoff and erosion, if any, that is created during rain events. Implement mitigation if erosion is occurring. A good source of stormwater BMPs that protect surfacewater can be found in the California Stormwater Quality Association (CASQA) BMP Handbooks found here: https://www.casqa.org/resources/bmp-handbooks
- Identify locations on the golf course that either receive or discharge surfacewater.
    - For locations on the golf course that receive surfacewater, understand the source of this water and impairments, if any. If this incoming water is impaired, sample and analyze it as described later in this chapter. Document this impairment so that the course is not potentially implicated in a water quality exceedance. Investigate the source of the impairment and assess options to mitigate the impact.
    - For locations on the course that discharge surfacewater, sample and analyze it as described later in this chapter. Document the quality of this discharged water so that the golf course is not potentially implicated in a water quality exceedance by the receiving party. If sampling and analysis of surfacewater discharged from the course suggest a possible impairment, investigate the source of the impairment and assess options to mitigate the impact.
- See Chapter 8: Pesticide Management and Chapter 10: Maintenance Operations and Pesticide Management for pesticide and fuel equipment handling, spill/leak prevention, emergency preparedness, and response measures.

Water Quality Testing

Principles

- Knowing the quality of the water on your golf course and adjacent waterbodies upstream and downstream provides important information on the impacts, if any, that the course has on surfacewater quality. This information may be useful in addressing water quality concerns of citizens, regulators, or other parties.
- Retain a qualified environmental scientist to design a sampling and analysis plan for your course.
- Ongoing, routine water sampling provides meaningful trends over time. A single sample is rarely meaningful in isolation.
- Suggested surfacewater analytes may include: nitrogen (ammonia and nitrate), phosphorus (phosphate), total dissolved solids (TDS), dissolved oxygen (DO), heavy metals, oil and grease, and any pesticides expected to be used on the golf course.
- Through proper sampling, laboratory analysis, interpretation of results, recommendations, and record keeping, testing can be used to manage surfacewater quality and nutrients more efficiently.
- Depending on your location, irrigation water may contain enough nitrate to make a significant contribution to your fertilization plans.
- Depending on your source of irrigation water, significant variation exists throughout California for important water chemistry characteristics such as dissolved solids, pH, salinity, hardness, trace metals, etc. Knowing these parameters is critical in determining turf response to nutrient application methods, rates, and timing and potential impacts to receiving waters like adjacent creeks and streams.
- Analytical laboratories doing your analysis should follow standard protocol that may include a variety of drinking water methods or Standard Methods of Water and Wastewater Analysis (often referred to as “Standard Methods”).
- Laboratory quality may vary. Try and select a lab that participates in the SWRCB Environmental Laboratory Accreditation Program (ELAP).

Water Quality Standards

Principles

- Once data on golf course water quality is obtained, it is important to compare it to relevant water quality criteria established by the SWRCB and USEPA. The SWRCB Compilation of Water Quality Goals may be found here: https://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/
- Water quality standards may be found in:
    - California Code of Regulations Title 22; and

- Regional Water Quality Control Board (RWQCB) Water Quality Control Board (RWQCB) Basin Plans. These basin-specific documents can be found at each of their respective RWQCB webpages. Find the RWQCB for your golf course here: https://www.waterboards.ca.gov/waterboards_map.html

- Several SWRCB programs exist that may be relevant to your course. They are:

  - *The Agricultural Waiver ("Ag Waiver") Program*: Details may be found at https://www.waterboards.ca.gov/water_issues/programs/agriculture/. The Ag Waiver program is largely implemented by the RWQCBs who have asked production agriculture to form water quality coalitions who have the responsibility to sample and analyze surfacewater to assess impacts from farming that include issues related to pesticide and fertilizer contamination.
  - *The US EPA 303(d) list*: This list is made up of impaired water bodies and a description of the contaminants that caused the impairment. In some cases, restrictions exist on what activities are allowed in and around these water bodies. More information may be found at: https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml
  - Note that Total Maximum Daily Loads (TMDLs) reflect a federal requirement to address long-standing water quality problems that have not been adequately addressed. TMDLs attempt to identify and control both point and non-point contaminant sources that are RWQCB region specific. Common TMDLs exist for sediment, mercury and PCBs.

- You may want to compare your golf course's water quality data to nearby surfacewater bodies. Several important data repositories exist:

  - The SWRCB Surfacewater Ambient Monitoring Program (SWAMP). Details can be found here: https://www.waterboards.ca.gov/water_issues/programs/swamp/
  - The SWRCB California Environmental Data Exchange Network (CEDEN) can be found here: http://ceden.org/about_us.shtml
  - The United States Geological Survey (USGS) has data presented here: https://waterdata.usgs.gov/ca/nwis/qw/
  - The California Department of Pesticide Regulation (DPR) Surfacewater Database (SURF) can be found here: https://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

- The California Department of Water Resources (DWR) has both water quantity (flow, gage height, stage, etc.) and water quality data here: http://wdl.water.ca.gov/waterdatalibrary/index.cfm

Pond and Lake Design and Maintenance

(Adopted from Chapter 2: Irrigation)

Principles

- The size, shape, and depth of ponds may affect how they perform aesthetically and as an irrigation water source.
- The golf course itself and its ponds are often part of regional stormwater control and treatment systems.
- Introduction of nutrients, such as fertilizer and grass clippings, into a pond may enhance the growth of undesirable vegetation and algae, potentially resulting in adverse aesthetic impacts such as foul odors.
- Surfacewater circulation, both laterally and vertically, are critical for maintaining water quality and preventing sludge and sediment build up, excessive plant and algae growth, and undesirable odors.

Best Management Practices

- Prior to the construction of a pond, or the alteration of an existing one, several important permits should be considered:
    - The US Army Corps of Engineers (USACE) requires a Section 404 permit when dredge and fill are proposed in a Water of the United States ("WOTUS"). The determination of whether or not a WOTUS exists is an important first step in determining whether or not a permit is needed.

    - When the USACE issues a 404 permit, they may require that a 401 Water Quality Certification be obtained from the RWQCB.
    - The California Department of Fish and Wildlife (CDFW) may require a 1600 Streambed Alteration Agreement if the bed and bank of an existing water body is altered.
- Local county public works or the flood control agency should be consulted to assess potential impacts of the new or altered pond to stormwater flow and retention.
- Recognize that for the ponds to fulfill their flood control mission, in many cases, they should be drained in the late fall to fulfill capacity needs for accommodating winter rain. These ponds act as a modulating buffer or temporary storage for stormwater.
- If a pond drains into a creek or river potentially contains pesticide, first analyze the water to check that concentrations are not above the benchmark, as mitigation measures would need to be implemented.
- When mowing the lake edge, collect or direct clippings away from the water to areas where runoff will not bring the clippings into the lake or pond.
- Minimize the unintentional introduction of fertilizers and pesticides into ponds by creating a minimum 10 foot buffer around the pond perimeter. Many pesticides list a greater distance; always follow the label.
- The use of vegetative buffers may reduce pesticide and fertilizer runoff into ponds.
- Monitor the dissolved oxygen (DO) in waterbodies. If fish are present, the DO is critical for their survival. Different fish species have different DO requirements. More information can be found at https://www.water-research.net/index.php/dissovled-oxygen-in-water.
- Monitor pond water levels for water loss that can't be explained by evaporation. If seepage is occurring, it may be necessary to line or seal the pond.

Integrated Pest Management (IPM) For Surfacewater

Principles

- IPM can be used to identify pests, set tolerance thresholds, and identify methods of control
- Phytoplankton, which give water its green appearance, provide the base for the food chain in ponds. Tiny animals called zooplankton use phytoplankton as a food source.
- Large aquatic plants (aquatic macrophytes) are present on the water surface (floating), in the water column (submerged), or both (emergent).
- Plant life growing on pond and lake perimeters may play a useful role in stabilizing the bank and reducing erosion, thus improving water quality. This vegetation may also slow the flow of water entering the waterbody and allow fertilizers and pesticides to degrade prior to entering the water.

- The use of aquatic plants to improve the appearance of a pond (aquascaping) can be included as part of the overall landscape design.
- The introduction of aquatic triploid grass carp and herbicides and algaecides must be approved via permit from the CDFW and SWRCB, respectively.
- The addition of biological controls (active yeast, bacteria, etc.) to control sediment buildup, odor, etc. typically do not require a permit.
- The addition of phosphorus scavenging materials, such as alum and lanthanum, may be useful in reducing the amount of phosphorus from the water column and, thus, reducing the amount of algae and plant growth. Permitting requirements vary between RWQCBs.
- Mosquitoes and other vectors breed in standing surfacewater and can be vectors for diseases and viruses harmful to humans and animals, including Zika and West Nile.

Best Management Practices

- Assess the emergent vegetation around the perimeter of the pond. Although plants such as cattails, tules, bulrush, and irises are helpful in stabilizing banks and/or providing habitat and aesthetic value, they can use significant amounts of water and displace storage capacity. Consider controlling these plants as needed to conserve water.
- Control of floating, submerged, or emergent aquatic vegetation and algae in the pond may be needed to easily access irrigation water, prevent pump intake clogging, or maintain desirable aesthetics. If aquatic pesticides are being considered, a National Pollutant Discharge Elimination System (NPDES) aquatic pesticide permit may be needed if the application is to a WOTUS.
- If there is potential for drift to a WOTUS, absent other drift problems, obtain an aquatic permit and use a pesticide with an aquatic label. For more about WOTUS, see Chapter 2: Irrigation.
- Currently, less than 20 active ingredients are registered for use in California that are allowed for use in the NPDES aquatic pesticide permit. Products containing these active ingredients are specifically labeled for aquatic use. Always read and follow label directions.
- Consider hiring a contractor to assist in your aquatic resource management, aquatic herbicide selection and application, establishing an IPM approach and NPDES aquatic pesticide permit compliance.
- A variety of fountains, mixers, and aerators are available for ponds. These devices can perform a variety of functions, such as vertically and horizontally mixing the water and increasing DO. The result can be a reduction in odor and, in some cases, a reduction of algae. Some vendors that supply aeration include EP Aeration. You can find more info at http://epaeration.com/.
- Properly designed ponds with narrow edge vegetation are more resistant to problems than those with highly maintained turf immediately adjacent to the pond edge.

- For suggestions on management of aquatic weeds, refer to Chapter 7: Integrated Pest Management and see the Aquatic Pest Control Pesticide Application Compendium, Vol. 5.B
- Mosquito and Vector Control Agencies exist throughout California and provide a variety of Integrated Pest Management (IPM) services that include biological and chemical control of larval and adult stage mosquitoes.
- The Mosquito and Vector Control Association of California (MVCAC) maintains a list of its members here: https://www.mvcac.org/about/member-agencies/
- For more about mosquitoes and other pest management, see Chapter 7: Integrated Pest Management and Chapter 8: Pesticide Management.

Flood Awareness

Principles

- Be aware of the possibility of floods on or near your course.

Best Management Practices

- Find out if your region is at risk of flooding and have the tools you need in case of an emergency. More information about individual preparation may be found at http://storms.ca.gov/individual-preparation/
- If you are in the Central Valley Region, know your flood risk by using the Levee Flood Protection Zone (LFPZ) maps provided by the CA Department of Water Resources (DWR), found at http://gis.lfpz.water.ca.gov/lfpz/
- If you are on the California Coast, view sea level rise and potential coastal flooding impact areas and relative depth using the Sea Level Rise Viewer from the National Oceanic and Atmospheric Administration (NOAA). Link: https://coast.noaa.gov/slr/

Frequently Asked Questions (FAQs)

1. How can I handle stormwater drainage in my golf course? (From Chapter 5: Nutrient Management)

First, it is important not to fertilize before a rain event so stormwater containing nutrients does not go somewhere it may be problematic. Second, it is important to reduce erosion and sedimentation on your golf course by maintaining vegetated buffers of both turf and non-turf species.

To complement smart fertilizer application timing and erosion control, building a stormwater detention facility may be an aesthetically pleasing and environmental-friendly management practice to consider. They can improve water quality by acting as a natural filter. Some benefits include:

- Improves water quality by a variety of natural means, such as nutrient uptake by resident plants
- Provides wildlife habitat and carbon sequestration
- Reduces quantity of runoff leaving the golf course

For more about stormwater wetlands on golf courses, see: https://brunswick.ces.ncsu.edu/wp-content/uploads/2013/04/stormwater-golf-course.pdf?fwd=no

CAUTION: Creation of a stormwater detention facility, pond, lake, wetland, swale or wet area may unintentionally create a Waters of the United States (WOTUS) and/or habitat for endangered or threatened species. Federal and state rules on how a WOTUS and endangered and threatened species are managed can be complex and costly. Before embarking on the creation of a feature like this on your golf course, consult a knowledgeable professional. More details can be found in Chapter 3: Surfacewater Management, Chapter 2: Irrigation, Chapter 8: Pesticide Management, and Chapter 15: Threatened and Endangered Species.

2. Where can I find out more about water rights and who do I contact? (From Chapter 2: Irrigation)

The State Water Resources Control Board has an Electronic Water Rights Information Management System (eWRIMS) that can assist in determining your water rights.

3. I have heard the term Waters of the United States (WOTUS). What does that mean and how do I find out if my course has or is near a WOTUS?

If your golf course is a part of the WOTUS, you are subject to the Clean Water Act Section 404 Permit Program which is reviewed by the US Army Corps of Engineers (USACE).

Find out more about the Waters of the United States and 404 Permit Program here:

https://www.epa.gov/wotus-rule

https://www.epa.gov/cwa-404/section-404-permit-program

http://www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/Obtain-a-Permit/

See Chapter 2: Irrigation and Chapter 8: Pesticide Management for more about WOTUS.

4. Are there certain exemptions from definitions of Waters of the State that are applicable to golf course ponds and lakes?

Wetland delineation procedures exempt manmade wetland features larger than one acre in size, if constructed for certain purposes, including detention, infiltration or treatment of storm water runoff, among other exceptions. In all, there are ten (10) exceptions. Projects planned in several of these categories of waters are also not subject to the Procedures' burdensome application process. Learn more here.

5. Should I be concerned about nutrients getting into the pond or lake on my golf course? (From Chapter 5: Nutrient Management)

Yes. Both nitrogen and phosphorus can cause significant, unintentional, and unwanted aquatic plant and algae growth. This may result in unsightly ponds covered with aquatic plants. As these plants die, their decomposition may result in oxygen depletion in the water which may lead to anaerobic decomposition of the plant material. This type of decomposition is often associated with foul "rotten egg" type odor. Some types of algae that grow may produce toxins that can be injurious to animals if they swim in and/or drink the water.

6. What permits do I need to alter my pond or add pesticides to my pond?

Permits that may apply to your pond and lakes include:

- NPDES permitting for weed control: https://www.waterboards.ca.gov/water_issues/programs/npdes/pesticides/weed_control.shtml
- CDFW Lake and Streambed Alteration Agreements (FGC 1600): https://www.wildlife.ca.gov/Conservation/LSA
- CDFW Private (Fish) Stocking Permit: https://www.wildlife.ca.gov/aquaculture#22164164-regulations-guidelines-and-permit-applications
- Section 404 Dredge and Fill Permit (Se FAQ #3) https://www.waterboards.ca.gov/board_reference/majorfunctions/dredge_fill.pdf
- Local County grading and/or stormwater or flood control agency permits. Contact your County Public Works Department.
- For additional permitting information, see Chapter 1: Planning, Design, and Construction.

7. What is the Clean Water Act Section 303(d) List of Impaired Waters?

An overview of Section 303(d) of the Clean Water Act may be found: https://www.epa.gov/tmdl/overview-identifying-and-restoring-impaired-waters-under-section-303d-cwa

To determine if your golf course contributes to the 303(d) list of impacted water bodies here, go the "map" tab at https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2012.shtml

If you are contributing to a 303(d) impaired water body, determine which pollutants contribute and create a BMP based on the pollutants. For more guidance on BMP selection, contact Mike at (530) 757-0941.

8. What is Section 404 of the Clean Water Act? When do I need a Section 404 permit?

The US Army Corps of Engineers (USACE) requires a Section 404 permit when dredge and fill are planned in a water body such as a wetland, stream, creek or pond that meets the criteria of a Water of the United States ("WOTUS"). The determination of whether or not a WOTUS exists is an important first step in determining whether or not a permit is needed. The Section 404 permit applies to waterbodies that include wetlands and ponds.

9. What is a 401 Water Quality Certification and Wetlands Program? When do I need one?

Under the Clean Water Act, the 401 Water Quality Certification and Wetlands Program regulates discharges of fill and dredged material. This program focuses wetlands, riparian areas, and other waterbodies with high resource value, although applies to other water resources as well.

Most projects are regulated by the State Regional Boards. Additional details on 401 Water Quality Certification and , application information, and fee schedules may be found at the SWRCB website here:
https://www.waterboards.ca.gov/water_issues/programs/cwa401/

The RWQCB may require a 401 Water Quality Certification if the USACE issues a 404 permit.

10. How do I prevent fertilizer and pesticide run-off from entering surfacewater?

First, only apply the correct type and amount of fertilizer and pesticide, and only when needed. Seek the advice of a Pest Control Adviser, turf agronomist, or other trained professional, as needed.

Second, consider the use of buffer strips between the application area and a surfacewater body. Buffer strips can consist of nothing more than turf with a high height of cut that will slow water down and allow percolation of pesticides and fertilizers into the ground. Find more information regarding stormwater BMPs here: California Stormwater Quality Association (CASQA) BMP Handbooks:
https://www.casqa.org/resources/bmp-handbooks

For additional best management practices for fertilizer maintenance, see Chapter 5: Nutrient Management. For more information about pesticide usage BMPs, see Chapter 8: Pesticide Management.

11. What IPM Practices can I use to control mosquitos? (From Chapter 7: Integrated Pest Management)

Mosquitos are statewide nuisances that can cause allergic reactions in some people and are vectors for diseases, such as West Nile virus. Although there are precautions that people can take to avoid being bitten, such as the use of effective repellants and wearing long-sleeve shirts and pants outdoors, reducing mosquito populations on golf courses is something the superintendent can control.

Best Management Practices for larval- or adult-stage mosquitos include:

- Reduce breeding sites.
- Dump out or seal any stagnant water containers, such as buckets, flower pots, trash barrels, and recycling bins.
- Clean and maintain structural water sources that could be susceptible to mosquito breeding, such as ponds and birdbaths. \
- Avoid over-irrigating and regularly maintain and inspect any retention basins that might house larvae.
- Reduce harboring areas for adult mosquitos.
- Mow grass as short as possible while still maintaining turf health and aesthetic value.
- Promoting air circulation by thinning shrubs and removing excess leaves/tree bark/debris.
- Consult with your local County Mosquito and Vector Control Agency who are members of the Mosquito and Vector Control Association of California (MVCAC) Information can be found here: http://www.mvcac.org. They may accomplish the following for you or advise you on how to do it on your own.
- Stock small fish in ponds that eat mosquito larvae, such as gambusia.
- Stock other organisms that feed on mosquitos (e.g., frogs and damselfly nymphs), although there is debate as to how much of their diet consists of mosquitos and would, therefore, contribute to mosquito control.
- Application of Surface Agents: Apply a surface agent that prevents mosquito larvae and pupae from breathing at the water's surface. Some examples include highly refined mineral oils or monomolecular films.
- Application of Insect Growth Regulators: Some insect growth regulators interfere with mosquito maturation process. An example is methoprene, which has very low human toxicity and is long-lasting.
- Application of Larvicides: Some subspecies of Bacillus thuringiensis (e.g., israelensis) are effective against mosquito larvae but have low human and plant toxicity.
- Application of Adulticides: because some mosquito populations have been documented as developing pesticide resistance, especially to older pesticides, consult your local county mosquito and vector control agency or MVCAC.

12. What BMPs can I use to prevent adverse impacts to surfacewater at my golf course?

Mitigation measure efficiency should be decided based on the primary mechanism through which potential impacts are expected. For example, course-textured soils are more prone to leaching which may impact groundwater, while hardpan layers/fine-texture soils may promote runoff to surfacewater.

- Efficient irrigation and well-timed irrigation can significantly reduce erosion and runoff and allow time for these pesticides and fertilizers to be taken up by plants or degraded.
- Always apply pesticides and fertilizers according to label directions.
- Obtain the advice of an agronomist to gain information on turf health and nutrition so that appropriate fertilizers are applied correctly and at the right time to minimize or reduce potential impact to surfacewater.
- As necessary, obtain the advice of a DPR-licensed Pest Control Adviser (PCA) and get written recommendations on your use of pesticides so that they are appropriate and are applied correctly and at the right time to minimize or reduce potential impact to surfacewater.
- For those applying pesticides, have them obtain their DPR Qualified Applicator Certificate (QAC) or Qualified Applicator (QAL) license. Individuals with these licenses are trained on the proper application of pesticides and play an important role in carefully following the PCA recommendations.
- Do not mix, load or handle pesticides or fertilizers near a surfacewater body.

For more information about nutrient and pesticide management, see Chapter 5 Nutrient Management and Chapter 8 Pesticide Management of this BMP Guide.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

USEPA. 2019. Approved Drinking Water Analytical Methods. Retrieved from: https://www.epa.gov/dwanalyticalmethods/approved-drinking-water-analytical-methods

USEPA. 2019. Approved CWA Chemical Text Methods. Retrieved from: https://www.epa.gov/cwa-methods/approved-cwa-chemical-test-methods

Chapter 4: Water Quality Management

Overview of Water Quality Management

Because water quality management is a broad topic, it cannot be adequately covered in one chapter alone without losing context for its meaning relative to the various facets of golf course management. Therefore, a discussion of water quality management is integrated into the following chapters:

- Chapter 1: Planning, Design, and Construction
    - Erosion and Sediment Control
    - Wetland Management
    - Stormwater
    - Pond Design and Maintenance
    - Surfacewater Quality Protection
- Chapter 2: Irrigation
    - Recycled/Reclaimed Water
    - Irrigation Water Suitability
    - Sodic Water Management
    - Groundwater Quality and Management
    - Impaired Waters and Total Maximum Daily Load (TMDL) Program
    - Pond Design and Maintenance
    - Waters of the United States (WOTUS) and National Pollution Discharge Elimination System (NPDES)
- Chapter 3: Surfacewater Management
    - Waters of the United States (WOTUS) and National Pollution Discharge Elimination System (NPDES)
    - Stormwater
    - Surfacewater Quality Protection
    - Water Quality Testing and Standards
    - Pond Design and Maintenance
    - Aquatic Weed Management/Integrated Pest Management
- Chapter 5: Nutrient Management
    - Nitrates and Fertilizer Usage
    - Groundwater Quality Protection and Management
    - Stormwater Drainage
    - Irrigation Water Testing
- Chapter 7: Integrated Pest Management
    - Aquatic Weed/Mosquito Management

    - Pesticide Usage

- Chapter 8: Pesticide Management

    - Waters of the United States (WOTUS) and National Pollution Discharge Elimination System (NPDES)
    - Aquatic Weed/Mosquito Management
    - Pesticide Usage
    - Groundwater Quality Protection and Management

- Chapter 10: Maintenance Operations

    - Fuel Management
    - Hazardous Waste Management

- Chapter 13: Groundwater Management

    - Groundwater Quality Protection and Management

- Chapter 17: Seaside Golf

    - Pesticide and Fertilizer Usage

Chapter 5: Nutrient Management

Overview of Nutrient Management

Proper nutrient management plays a key role in course playability and aesthetics by helping create and maintain healthy, vigorous turf. Nutrients allow turfgrass to recover from damage, increase its resistance to stress, and increase its playability.

Careful nutrient management is necessary to reduce the potential risk of environmental impact. For example, nutrients may move beyond the turfgrass via leaching or runoff and affect water quality. Some organisms, like algae, respond to increases in nutrient loading and, in some cases, have adverse aesthetic and health impacts. The goal of a nutrient management plan is to apply the minimum necessary nutrients to achieve an acceptable playing surface and apply these nutrients in a manner that maximizes their plant uptake while minimizing adverse impacts to the environment.

All embedded hyperlinks below can be found in the References section of this guide.

Regulatory Considerations

Principles

- It is unlawful to sell an unregistered fertilizer product in California. The California Department of Food and Agriculture (CDFA) runs the Fertilizing Materials Inspection Program to ensure products are in compliance with California Code of Regulations. Compliance includes inspection and verification of nutrient content, proper labeling, and metals analysis.
- Parts of California have groundwater adversely impacted by nitrates. Many farming operations in California are required to prepare Nitrogen Management Plans (NMPs) as part of the Irrigated Lands Regulatory Program enforced by the California Environmental Protection Agency (CalEPA) Regional Water Quality Control Board (RWQCB).
- Currently, golf courses are not required to prepare an NMP.

Best Management Practices

- Ensure your fertilizer is licensed.
- Read this chapter to learn how to protect groundwater from potential nitrate impacts

Soil and Irrigation Water Testing

Principles

- Regular and routine soil and irrigation water testing provide important information to formulate a nutrient management plan.
- Retain a qualified turf agronomist or soil scientist to design a sampling and analysis plan for your course.
- Through proper sampling, laboratory analysis, interpretation of results, recommendations, and record keeping, regular testing can be used to manage nutrients more efficiently.
- Depending on your location, irrigation water may contain enough nitrate to make a significant contribution to your fertilization plans.
- Depending on your source of irrigation water, significant variation exists throughout California for important water chemistry characteristics such as dissolved solids, pH, salinity, hardness, trace metals, etc. Knowing these parameters is critical in determining turf response to nutrient application methods, rates, and timing.

Best Management Practices

- Regular, accurate and consistent sampling is essential to providing useful test information over time.
- The purpose of a soil test is to provide the grower with a prediction of a plant's response to an applied nutrient.
- Keep historic test data so that changes can be noted.

Plant Tissue Testing

Principles

- Because of the mobility and conversion of elements within soil, soil sampling can be less predictable than tissue testing. Tissue testing provides a precise measurement of nutrients within the plant. Tissue test sufficiency ranges are only as good as the correlation data of a given element to an acceptable quality level of a given turfgrass. Typically, tissue correlation data are more prevalent than soil test correlation data and, therefore, programs designed around tissue testing may provide more reliable results.
- Through proper sampling, consistent intervals, and record keeping, tissue sampling may be used to measure and evaluate existing turf health.

Best Management Practices

- Tissue samples should be collected during regular mowing.
- Do not collect tissue after any event that may alter the nutrient analysis. Events may include fertilization, topdressing, pesticide applications, etc.
- Place tissue in paper bags, not plastic.
- If possible, allow tissue samples to air-dry at your facility before mailing them.

- Poor-quality turfgrass of concern should be sampled separately from higher-quality turfgrass.
- When turfgrass begins to show signs of nutrient stress, a sample should be collected immediately.
- More frequent tissue sampling allows a more accurate assessment of your turfgrass nutrient status changes over time.
- The quantity of tissue analysis you choose to use is entirely up to you and your needs. However, two to four tests per year are common on greens and one to two tests per year are common on tees and fairways.
- Keeping tissue tests from prior years will allow you to observe changes over time.
- Tissue testing can provide good evidence of the impact of your nutrient management plan.

Fertilizers Used in Golf Course Management

Principles

- Understanding the components of fertilizers, the fertilizer label, and the function of each element within the plant are all essential in the development of an efficient nutrient management program
- Most chemicals in excess may be toxic to plants.

Terminology

- Grade or analysis is the percent by weight of the macronutrients Nitrogen (N), Phosphorous (P) and Potassium (K) that is guaranteed to be in the fertilizer. This is commonly referred to as “NPK”. For example, a fertilizer that contains 32 % N, 0 % P and 4% K is labelled “32-0-4”.
- The label is intended to inform the user about the contents of the fertilizer product. The label should be read and followed. The fertilizer label may contain:
    - Brand
    - Grade
    - Manufacturer’s name and address
    - Guaranteed analysis
    - “Derived from” statement
    - Net weight
    - Metal content, if any
- Consider basing the choice of fertilizer on the "action" of the applied elements for the conditions/timing present.

Macronutrients

<u>The role of nitrogen (N)</u>

Nitrogen is required by the plant in greater quantities than any other element except carbon (C), hydrogen (H), and oxygen (O). Nitrogen plays a role in numerous plant functions, including an essential component of amino acids, proteins, and nucleic acids. Nitrogen is taken up by plants through the roots as either ammonium cation (NH4+) or nitrate anion (NO3-).

- *Fate and transformation of N*
  The goal of all applied nutrients is to maximize plant uptake while minimizing nutrient losses. Understanding each process will increase your ability to make sound management decisions and ultimately lead to an increase in course profitability and a reduction in environmental risk.
    - *Nitrogen process*
        - *Mineralization*: the microbial mediated conversion of organic N into plant-available NH4
        - *Nitrification*: the microbial-mediated conversion of NH4 to NO3
        - *Denitrification*: the microbial mediated conversion of NO3 to N gas; this primarily occurs in low-oxygen environments and is enhanced by high soil pH.
        - *Volatilization*: the conversion of NH4 to NH3 gas.
        - *Leaching*: the downward movement of water and nutrients below the rootzone.
        - *Runoff*: the lateral movement of water and nutrients beyond the intended turfgrass location.
    - *The release mechanism and factors influencing N release from available N sources*
      Understanding how certain N sources should be blended and applied is an essential component in an efficient nutrient management plan. In many cases, N sources are improperly applied without regard to their release characteristics. This can decrease plant uptake and increase the risk of negative environmental impacts, such as nitrate leaching to groundwater. Each N source (particularly slow-release forms) is unique and, therefore, should be managed accordingly. Applying a polymer-coated urea in the same manner one would apply a sulfur-coated urea greatly reduces the value of the polymer-coated urea. Similarly, applying 2 pounds of N from ammonium sulfate may cause burning to the turf, while applying 2 pounds of N from certain polymer-coated ureas may not provide the desired turfgrass response. Rate, application date, location, and turfgrass species all should be included in your nutrient application decision.
- *Soluble nitrogen sources*

    - Urea (46-0-0)
    - Ammonium nitrate (34-0-0)
    - Ammonium sulfate (21-0-0)
    - Diammonium phosphate (18-46-0)
    - Monoammonium phosphate (11-52-0)
    - Calcium nitrate (15.5-0-0)

    - Potassium nitrate (13-0-44)

- *Slow-release nitrogen sources*
  A slow-release N source is any N-containing fertilizer where the release of N into the soil is delayed either by requiring microbial degradation of the N source, by coating the N substrate which delays the dissolution of N, or by reducing the water solubility of the N source.
  These include:

    - Sulfur-coated urea
    - Polymer/resin-coated urea
    - Isobutylidene diurea
    - Urea-formaldehyde/urea-formaldehyde reaction products
    - Natural organic

- *Urease and nitrification inhibitors*

    - Urease inhibitors reduce the activity of the urease enzyme, resulting in a reduction of volatilization and an increase in plant-available N.
    - Nitrification inhibitors reduce the activity of *Nitrosomonas* bacteria, which are responsible for the conversion of NH_4^+ to NO_2. This reduced activity results in a reduction of N lost via denitrification and an increase in plant-available N.

<u>The role of phosphorous (P)</u>

Phosphorus can be a growth-limiting factor for many unintended organisms and is a major contributor to eutrophication of water bodies. Thus, proper timing and rates should be implemented to reduce the risk of off-site movement of phosphorus.

Many golf courses have some amount of annual bluegrass (poa annua, or “poa”). The presence of poa on greens may create a variety of undesirable characteristics that include uneven putting surfaces and increased susceptibility to disease as compared to bent grass. Generally speaking, use of phosphorus-containing fertilizer on bentgrass putting greens may enhance poa establishment and promote encroachment.

Phosphorus forms high-energy compounds that are used to transfer energy within the plant. Phosphorus may remain in an inorganic form or may become incorporated into organic compounds. Phosphorous application rates should be based upon soil test results derived from documented correlations demonstrating a turf response to soil test phosphorous levels.

- *P deficiency symptoms*
    - Initially, reduced shoot growth and dark green color may be observed
    - Later, lower leaves may turn reddish at the tips and then the color may progress down the blade

- *P fertilizer sources*

    - Diammonium phosphate
    - Concentrated superphosphate
    - Monoammonium phosphate
    - Natural organics

The role of potassium (K)

Potassium is of no environmental concern, but can be an economic concern, particularly when over-utilized. Generally, potassium concentrations in turfgrass tissue are about ⅓ to ½ that of nitrogen.

Potassium is not a component of any organic compound and moves readily within the plant. Potassium is a key component of osmoregulation which has been documented to increase stress resistance.

- *K deficiency symptoms*
    - Except under severe, documented deficiencies, K may not have an observable influence on turfgrass quality. Yellowing of older leaves followed by tip dieback and scorching of leaf margins have been reported.
- *K fertilizer sources*

    - Potassium sulfate
    - Potassium chloride
    - Potassium nitrate

Secondary Macronutrients

Secondary macronutrients are essential to plant function and are required in quantities less than N, P, and K, but more than micronutrients. These include calcium (Ca), magnesium (Mg), and sulfur (S).

The role of calcium (Ca)

- Soil health, including for purposes of soil conditioning, aggregation, percolation and salt management
- Important component of cell walls and structure
- Found in gypsum, limestone, and calcium chloride

The role of magnesium (Mg)

- Central ion in the chlorophyll molecule and chlorophyll synthesis
- Found in S-Po-Mg, dolomitic limestone, and magnesium sulfate

The role of sulfur (S)

- Metabolized into the amino acid, cysteine, which is used in various proteins and enzymes
- Found in ammonium sulfate, elemental sulfur, gypsum, and potassium sulfate

Micronutrients

Understanding the role of each micronutrient within the plant should provide you with a greater understanding of why these nutrients are critical in proper turfgrass management.

Micronutrients are essential for proper turfgrass health, but they are required in very small quantities compared to macronutrients. Micronutrients include iron (Fe), manganese (Mn), boron (B), copper (Cu), zinc (Zn), molybdenum (Mo), and chlorine (Cl).

<u>The role of iron (Fe)</u>

- Is part of the catalytic enzymes and is required for chlorophyll synthesis
- Affects photosynthesis, nitrogen fixation, and respiration

<u>The role of manganese (Mn)</u>

- Involved in photosynthesis
- Required as a cofactor for ≈35 enzymes
- Required for lignin biosynthesis

<u>The role of boron (B)</u>

- Found in the cell wall and probably required for the structural integrity

<u>The role of copper (Cu)</u>

- The copper-containing protein plastocyanin is involved in photosynthesis
- Cofactor for a variety of oxidative enzymes

<u>The role of zinc (Zn)</u>

- Structural component of enzymes
- Required for protein synthesis
- Affects carbohydrate metabolism

<u>The role of molybdenum (Mo)</u>

- Primarily related to nitrogen metabolism
- Affects structural and catalytical functions of enzymes

The role of chlorine (Cl)

- Required for the oxygen-evolving reactions of photosynthesis
- Required for cell division in both leaves and shoots

Best Management Practices

Take advantage of a soil laboratory and/or a consulting soil scientist or agronomist to help determine the nutrient content of your turf tissue, soil and irrigation water to then determine the amount and type of fertilization needed.

A partial list of professionals that may be able to offer assistance include:

- Turfgrass Culture (Ali Harivandi): http://turfgrassculture.com/
- Mark Mahady & Associates (Mark Mahady)
- Pace Turf (Larry Stowell and Wendy Gelernter): https://www.paceturf.org/
- UC Riverside (Jim Baird): https://plantbiology.ucr.edu/people/faculty/baird.html
- Irrigation & Turfgrass Services (Mike Huck)

Soil pH

Principles

- Measuring soil pH is an important part of understanding the golf course's soil characteristics. In most cases, a pH of 6.3 is ideal because it provides the greatest probability of micronutrient availability. Soil pH adjustments often occur slowly and can be temporary.
- California soils are often either saline or sodic (often referred to as "alkaline" soils) and have a high pH level of approximately 7.8.

Best Management Practices

- To increase soil pH, apply a liming material (calcium carbonate, calcium oxide, dolomitic limestone) that contains Ca^{2+} and neutralizes acidity.
- To lower soil pH, products containing elemental sulfur can be applied.
- In some cases, application of irrigation water with a reduced pH can be an effective way to address alkaline soils. Reducing irrigation water pH can be done by several means, including the addition of acid or the use of a sulfur burner.
- Use the UC Davis/NRCS/California Agriculture and Natural Resources California Soil Properties tool to learn about soil types in your area.

Nutrient Management

Principles

- Due to variability in golf course soils, weather, topography, budget, manpower, etc., nutrient management must be flexible.
- Understand the importance of nutrient application timing for the desired plant response.

Best Management Practices

- Consider the current nutrient status of the soil when determining how much fertilizer to use.
- Apply nutrients when turfgrass is actively growing. The UC Statewide Integrated Pest Management Program provides general fertilization times by month and species for different regions in California.
- General physical and chemical soil properties can be determined through an interactive map compiled by the California Soil Resource Lab (UC Davis/UC-ANR) and the USDA Natural Resources Conservation Service.
- Apply slow-release N fertilizers at the appropriate time of year to maximize the products' release characteristics. For example, an application of slow-release N to warm-season turfgrasses in fall may not be as effective as the same application applied in early summer because of the prolonged release time in fall.
- Use of slow-release materials should take into consideration the nitrogen release rate and the conditions that result in release. If insufficient material is applied, the desired response may not be observed.
- Some slow release materials rely on temperature-dependent microbial activity. If temperatures are not adequately high for microbial activity to occur, nutrients may not be available to the turf.
- The reduced height of cut and excessive traffic damage on putting greens results in an increased need for growth, leading to an increased need to supply plant nutrients.
- Tees and landing areas often have higher fertility requirements than fairways and roughs because they suffer constant divot damage.
- Fairways and roughs often require less nutrient inputs than other locations because of their increased height of cut and return of nutrients from clippings left in place after mowing.
- Exercise caution when applying nutrient applications during turfgrass establishment as these applications may be susceptible to loss via leaching and runoff if the turf is not sufficiently developed.
- Be aware of the different types of spreaders and understand the advantages and disadvantages of each.
- Not all fertilizers can be spread with every spreader. For example, if sulfur-coated urea was spread through a drop spreader, the sulfur coating could be damaged, essentially leading to an application of soluble urea.
- Choose the appropriate spreader for a given fertilizer material. Some examples include:
    - Walk-behind rotary

    - Drop spreader
    - Bulk rotary
    - Spray
- Always calibrate and adjust your spreader to reduce off-site application and apply the correct amount of fertilizer
- Proper fertilizer storage, loading, and clean-up reduces environmental risk.
- Avoid applying fertilizer to soils that are at, or near, field water holding capacity or following rain events that leave the soils wet.
- Do not apply fertilizer when heavy rains are likely.
- Encroachment and establishment of poa on greens may be enhanced by the use of phosphorus-containing fertilizers. Therefore, be mindful of your use of phosphorus on greens that contain poa.

Potential Fertilizer Impacts to Surfacewater and Groundwater

Principles

- Nitrate is a highly soluble form of nitrogen that, under certain conditions, can adversely impact surface and ground water.
- Because nitrate is an anion, it is negatively charged and, therefore, is poorly retained in most soils. This is in contrast to the ammonium cation which is positively charged and readily retained in most soils.
- Nitrate in drinking water can cause methemoglobinemia, a reduction in the ability of blood to carry oxygen, in pregnant women and infants. The drinking water Maximum Contaminant Level (MCL) for nitrate is 45 milligrams per liter (mg/L). This is equivalent to 10 mg/L of nitrate expressed as nitrogen.
- Nitrate contaminated groundwater can be found in many areas of California and is a significant concern in the Tulare Lake Basin and Salinas Valley areas.
- Phosphorus fertilizer can be formulated to be highly soluble
- Phosphorus reaching surfacewater may provide an important nutrient source for aquatic plants and algae and may contribute to eutrophic (nutrient-rich) conditions.
- Eutrophic conditions may result in significant plant growth that upon plant death and decomposition may result in anoxic (oxygen-poor) water.
- Anoxic conditions may result in fish die-off and production of unpleasant odors
- Conditions that may result in potential impacts to surfacewater from nitrate include:
    - Sandy and/or high porosity soils
    - Sloped ground
    - Incorrect irrigation techniques (too much, too frequently, wrong location, etc.)
- Conditions that may result in potential impacts to groundwater from nitrate include:

    - Sandy and/or high porosity soils

    - Shallow groundwater
    - Fertilizer handling, spills, or applications near an improperly installed groundwater well
    - Applications before or during rain events

- The best long-term solution to mitigate potential migration (leaching) of nitrate to groundwater is s
- Fertilizer, cultural, and infrastructure management all play a role in preventing nutrient contamination in surface and ground water.

Best Management Practices

- Reduce the need for fertilizer by using effective cultural practices that keep plants healthy. Refer to Chapter 6: Cultural Practices for more information.
- Establish buffer zones between fertilized areas and surfacewater to reduce potential introduction of fertilizer into the water that may result in eutrophication.
- Pond and lake water circulation and aeration may assist in addressing anoxic conditions.
- Determine fertilizer requirements by assessing the nutrient status of the soil and plant.
- Calculate the estimated amount of fertilizer needed to correct a nutrient deficiency based on soil reports and tissue analysis. See the UC IPM resource found here: http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/fertrate.html. Another good resource is Meentemeyer and Whitlark 2016 Turfgrass Fertilization.
- Don't fertilize at high rates during dormant periods. As a preliminary assessment, use the UC IPM fertilization tool to determine when to best fertilize, based on California region.
- Assess the potential hazard to groundwater near your golf course using the Nitrate Groundwater Pollution Hazard Index found here: http://ciwr.ucanr.edu/Tools/Nitrogen_Hazard_Index/
- If you fertigate (mix fertilizer or nutrients with irrigation water), you must use backflow prevention devices to prevent potential impacts to source water
- Do not mix, load, or store fertilizers near a groundwater well. See Chapter 13: Groundwater Management for additional information.

Frequently Asked Questions (FAQs)

1. How can I find out if my golf course is near an area that has groundwater impacted by nitrate?

Go the map located here and find your course:
https://www.waterboards.ca.gov/water_issues/programs/nitrate_project/nitrate_tool/

2. Are there specific regions in California that suffer from nitrate in groundwater?

Yes. Risk of groundwater contamination by nitrate varies across California. Aquifer vulnerability can be seen in this map:
https://water.usgs.gov/nawqa/nutrients/pubs/wcp_v39_no12/#FIG1

Additional areas of concern include:

The Tulare Lake Basin and parts of the Salinas Valley
http://groundwaternitrate.ucdavis.edu/files/138956.pdf

Central Valley https://californiawaterblog.com/2017/09/17/groundwater-nitrate-sources-and-contamination-in-the-central-valley/

Santa Ana and San Joaquín Valley
https://www.waterboards.ca.gov/gama/docs/coc_nitrate.pdf

3. How can I handle stormwater drainage in my golf course?

First, it is important not to fertilize before a rain event so that stormwater containing nutrients do not go somewhere it may be problematic. Second, it is important to reduce erosion and sedimentation on your golf course by maintaining vegetated buffers to prevent stormwater from going somewhere it should not.

To complement smart fertilizer application timing and erosion control, building a stormwater detention facility may be an aesthetically pleasing and environmental-friendly management practice to consider. They can improve water quality by acting as a natural filter. Some benefits include:

- Improves water quality by a variety of natural means, such as nutrient uptake by resident plants
- Provides wildlife habitat and carbon sequestration
- Reduces quantity of runoff that leaves the golf course

For more about stormwater wetlands on golf courses, see:

https://brunswick.ces.ncsu.edu/wp-content/uploads/2013/04/stormwater-golf-course.pdf?fwd=no

CAUTION: Creation of a stormwater detention facility may unintentionally create a Waters of the United States (WOTUS) and/or habitat for endangered or threatened species. Federal and state rules on how a WOTUS and endangered and threatened species are managed can be complex and costly. Before embarking on the creation of a feature like this on your golf course, consult a knowledgeable professional. More details can be found in Chapter 3: Surface Water Management, Chapter 2: Irrigation, Chapter 8: Pesticide Management, and Chapter 15: Threatened and Endangered Species.

4. Should I be concerned about nutrients getting into the pond or lake on my golf course?

Yes. Both nitrogen and phosphorus can cause significant, unintentional, and unwanted aquatic plant and algae growth. This may result in unsightly ponds covered with aquatic plants. As these plants die, their decomposition may result in oxygen depletion in the water which may lead to anaerobic decomposition of the plant material and adverse impacts to fish and other aquatic life. This type of decomposition is often associated with foul "rotten egg" type odor. Some types of algae that grow may produce toxins that can be potentially injurious to animals if they swim in and/or drink the water. The use of buffer zones around lake and pond perimeters to reduce fertilizer inputs and the use of circulation pumps and/or aerators may be appropriate.

5. What do I need to know about submitting tissue or turf samples for analysis of nutrient levels?

This can be highly variable and based on several factors, including the turf type and phenology, time of year, location on the golf course, etc. It is recommended that you consult with a qualified turf agronomist or soil scientist so that the proper sample is collected, the proper analysis is run, and the results are correctly interpreted.

6. How can I review the label of the fertilizer that I am considering buying and determine if it contains the nutrients as advertised and is properly registered in California?

Visit the CDFA Fertilizer Product Database and enter the manufacturer or product name: https://apps1.cdfa.ca.gov/fertilizerproducts/

7. I've heard that some fertilizers contain heavy metals. How can I learn more?

You're right! Go to this CDFA webpage and enter the manufacturer or product name: https://apps1.cdfa.ca.gov/fertilizerproducts/

8. How can I find out more about soil properties on or near my golf course?

The depth to restrictive layer, water holding capacity, soil composition, and other physical and chemical characteristics can be viewed through:

https://casoilresource.lawr.ucdavis.edu/ca-soil-properties/

https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Baird, J. University of California, Riverside faculty page. Available at https://plantbiology.ucr.edu/people/faculty/baird.html (Accessed: February 25, 2019).

California Department of Food and Agriculture (CDFA). CDFA Fertilizer Product Database. Available at https://apps1.cdfa.ca.gov/fertilizerproducts/ (Accessed: February 25, 2019).

Harivandi, A. 2019. Turfgrass culture. Available (soon) at http://turfgrassculture.com/ (Accessed: February 25, 2019).

Meentemeyer, B. and Whitlark, B. 2016. Turfgrass Fertilization: Supplement only when needed to provide better turf and playability. Green Section Record Vol. 54 (9). Available at http://gsrpdf.lib.msu.edu/ticpdf.py?file=/article/meentemeyer-whitlark-turfgrass-5-6-16.pdf (Accessed: February 25, 2019).

North Carolina State Extension. 2012. Stormwater Wetlands for Golf Courses. Available at https://brunswick.ces.ncsu.edu/wp-content/uploads/2013/04/stormwater-golf-course.pdf?fwd=no Accessed: February 25, 2019).

Ransom, K. and Harter, T. 2017. Groundwater Nitrate Sources and Contamination in the Central Valley. Available at https://californiawaterblog.com/2017/09/17/groundwater-nitrate-sources-and-contamination-in-the-central-valley/ (Accessed: February 25, 2019).

State Water Resources Control Board (SWRCB). 2017. Groundwater Information Sheet: Nitrate. Available at https://www.waterboards.ca.gov/gama/docs/coc_nitrate.pdf (Accessed: February 25, 2019).

State Water Resources Control Board (SWRCB). Is my property near a nitrate-impacted water well? Available at https://www.waterboards.ca.gov/water_issues/programs/nitrate_project/nitrate_tool/ (Accessed: February 25, 2019).

Stowell, L. and Gelernter, W. Pace Turf. Available at https://www.paceturf.org/ (Accessed: February 25, 2019).

United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS). Web Soil Survey database. Available at https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx (Accessed: February 25, 2019).

United States Geological Survey (USGS). 2015. A National Look at Nitrate Contamination of Ground Water webpage. Available at https://water.usgs.gov/nawqa/nutrients/pubs/wcp_v39_no12/#FIG1 (Accessed: February 25, 2019).

University of California Division of Agriculture and Natural Resources. 2019. Nitrate Groundwater Pollution Hazard Index. Available at http://ciwr.ucanr.edu/Tools/Nitrogen_Hazard_Index/ (Accessed: February 25, 2019).

University of California Statewide Integrated Pest Management Program. 2017. When to fertilize tool. Available at http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/fertwhen.html (Accessed: February 25, 2019).

University of California Statewide Integrated Pest Management Program. 2017. Recommended fertilizer rates. Available at http://ipm.ucanr.edu/TOOLS/TURF/MAINTAIN/fertrate.html (Accessed: February 25, 2019).

University of California, Davis, United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), and California Agriculture and Natural Sources California Soil Properties tool. Available at https://casoilresource.lawr.ucdavis.edu/ca-soil-properties/ (Accessed: February 25, 2019).

University of California, Davis. 2012. Addressing Nitrate in California's Drinking Water with a Focus on Tulare Lake Basin and Salinas Valley Groundwater. Prepared for the State Water Resources Control Board (SWRCB). Available at http://groundwaternitrate.ucdavis.edu/files/138956.pdf (Accessed: February 25, 2019).

Chapter 6: Cultural Practices

Overview of Cultural Practices

Cultural practices such as mowing, cultivation, overseeding, and shade tree management are necessary to provide a high-quality playing surface and enhance plant health. Healthy turf resists pest pressure and is a critical part of an Integrated Pest Management (IPM) program.

Cultural practices are highly dependent on turf type and local conditions such as course traffic, soil, weather and quality and quantity of irrigation water. For example, cultivation is an important tool to address heavily trafficked areas such as putting greens and tee boxes that maybe subject to deterioration from compacted soil and thatch accumulation.

Unlike annual crops, which offer the opportunity for periodic tilling of the soil profile to correct problems like soil compaction, turfgrass does not offer opportunities for significant physical disturbance of the soil without destroying the playing surface. Therefore, careful timing and execution of cultural practices is critical to the success of a superintendent.

All embedded hyperlinks below can be found in the References section of this guide.

Mowing

Principles

- Mowing is the most basic yet one of the most important cultural practice to consider. It impacts turf density, growth, texture, color, root development, and wear tolerance.
- Frequent mowing will increase shoot density and tilling. It will also decrease root and rhizome growth as a result of plant stress associated with removal of leaf tissue.
- Infrequent mowing results in alternating cycles of vegetative growth followed by scalping, which further depletes food reserves of the plants.
- Proper mowing height is a function of the species/cultivar being managed and the intended use of the site. Other factors influencing mowing height include mowing frequency, shade, mowing equipment, time of year, root growth, and abiotic and biotic stress.
- Maintaining an optimal root-to-shoot ratio is critical. Turfgrass plants that are mowed too low will require a substantial amount of time to provide the food needed to produce shoot tissue for future photosynthesis. If turf is mowed too low in one event, an imbalance occurs between the remaining vegetative tissue and the root system, resulting in more roots being present than the plant needs. As a result, the plants will slough off the unneeded roots. Root growth is least affected when no more than one-third of leaf area is removed in a single mowing.
- Failure to mow properly will result in weakened turf with poor density and quality.

Best Management Practices

General

- Mowing frequency should increase during periods of rapid growth and decrease during dry, stressful periods.
- If turf becomes too tall, it should not be mowed down to the desired height all at once. Such severe scalping reduces turf density and can result in a dramatic reduction in root growth. Tall grass should be mowed frequently and height gradually decreased until desired height of cut is achieved.
- Grass clipping removal should not exceed one-third of the total height of the actual height of the plant being mowed.

Mowing Equipment

- Mower blades should be kept sharp so that damage to the turf leaf does not occur. Dull blades will result in shredding of leaf tissue, increasing water loss and the potential for disease development.
- Reel mowers are ideally suited for maintaining turfgrass stands that require a height of cut below 1.5 inches. They produce the best quality when compared to other types of mowers.
- Rotary mowers, when sharp and properly adjusted, deliver acceptable cutting quality for turf that is to be cut above 1 inch in height.
- Flail mowers are most often used to maintain utility turf areas that are mowed infrequently and do not have a high aesthetic requirement.

Grass Clipping Management

- Turfgrass clippings are a source of nutrients, containing 2% to 4% nitrogen on a dry-weight basis, as well as significant amounts of phosphorus and potassium.
- Clippings should be returned to the site during the mowing process unless the presence of grass clippings will have a detrimental impact on play. Cases when clippings should be removed include times when the amount of clippings is so large that it could smother the underlying grass or on golf greens where clippings might affect ball roll.
- Clippings should be disposed of properly to prevent undesirable odors near play areas and to prevent fire hazards.
- Consider composting clippings or dispersing them evenly in natural areas where they can decompose naturally without accumulating in piles.

Shady and Cloudy Environments

- Shade affects turfgrass growth by filtering out sunlight. As a result, turfgrass plants respond by growing upright in an effort to capture more light to meet their photosynthetic needs. As a result, mowing height should be increased by at least 30% to improve the health of turf grown in a shaded environment.

- The use of the plant growth regulators such as trinexapac-ethyl has been shown to improve overall turf health when used as a regular management tool for grasses growing in shaded environments.
- Environmental stresses such as prolonged cloudy weather or drought can have a significant impact on turf health. Increase mowing heights as much as use will allow in order to increase photosynthetic capacity and rooting depth of plants.

Cultivation Mowing

Principles

Cultivation involves disturbing the soil or thatch through the use of various implements to relief of soil compaction, reduce thatch/organic matter buildup and improved water and air exchange. Cultural practices greatly reduce disease pressure and fungicide use as plant health has an impact on disease and fungicide use.

- Cultivation techniques will result in disturbance of the playing surface that can require significant time for recovery.
- Improving the soil profile in the rootzone helps alleviate compaction and provides space to allow air and water for root growth.
- Frequency of cultivation depends on a number of factors including traffic intensity and level of soil compaction.
- Cultural practices greatly reduce disease pressure and fungicide use. Plant health of turfgrasses has impact on disease and fungicide use.
- Cultivation techniques discussed below include:

  Aerification, which addresses soil compaction and improves soil drainage

  Vertical cutting (Verticutting) reduces accumulated thatch and organic matter that if left in place may reduce root growth, encourage disease, and create undesirable playing conditions.

  Sand applications will smooth the playing surface, control thatch, and potentially change the physical characteristics of the underlying soil when done in conjunction with core aerification.

Best Management Practices

Aerification

- Core aerification involves removal of small (0.25- 0.75-inch diameter) cores or plugs from the soil profile. Annual core aerification programs should be designed to remove 15%-20% of the surface area. High-traffic areas may require a minimum of two to four core aerifications annually.
- Core aerification should be conducted only when grasses are actively growing to aid in quick recovery of surface density.

- Vary depth of aerification events by incorporating varying length tines to prevent development of compacted layers in the soil profile.
- Solid tines cause less disturbance to the turf surface and can be used to temporarily reduce compaction and soften surface hardness during months when the growth rate of grasses has been reduced. Benefits of solid-tine aerification are temporary because no soil is removed from the profile.
- Deep-drill aerification creates deep holes in the soil profile through use of drill bits. Soil is brought to the surface and distributed into the canopy. Holes can be backfilled with new root-zone materials if a drill-and-fill machine is used. These machines allow replacement of heavier soils with sand or other materials in an effort to improve water infiltration into the soil profile.

Vertical Cutting

- Slicing and spiking reduce surface compaction and promote water infiltration with minimal surface damage.
- Slicing is faster than core aerification but is less effective and is best accomplished on moist soils.
- A spiker can break up crusts on the soil surface, disrupt algae layers, and improve water infiltration.
- Vertical mowing (verticutting) can be incorporated into a cultural management program to achieve a number of different goals. The grain of a putting green can be reduced by setting a verticutter to a depth that just nicks the surface of the turf. Deeper penetration of knives will stimulate new growth by cutting through stolons and rhizomes while removing accumulated thatch.

- Verticutting depth for thatch removal should reach the bottom of the thatch layer and extend into the surface of the soil beneath the thatch.
- Initiate vertical mowing when thatch level reaches 0.25 to 0.5 inch in depth. Shallow vertical mowing should be completed at least monthly on putting greens to prevent excessive thatch accumulation.
- Dethatching with a verticutter is an aggressive practice that is not recommended on golf putting greens because of the damage that occurs and the extensive recovery time required.
- Groomers, or miniature vertical mowers attached to the front of reels, are effective at improving management of grain and improving plant density through cutting of stolons.

Sand Application

- Topdress the playing surface with sand following core aerification and heavy vertical mowing to aid in recovery of turf. Rates will vary from 0.125 to 0.25 inch in depth and will depend on the capacity of the turf canopy to absorb the material without burying the plants.
- Light, frequent applications of topdressing sand on putting greens can smooth out minor surface irregularities, aiding in the management of thatch accumulation.
- Use only weed-free topdressing materials with a particle size similar to that of the underlying root zone.
- Use of finer materials can result in layering and can have a negative impact on water infiltration.

Overseeding Warm-Season Turfgrass

Principles

- The purpose of overseeding is to establish a temporary cool-season grass into the warm-season base for improved color and playability during the fall and winter when the warm-season grass enters dormancy. This practice is most common in Southern California.
- Overseeding increases the need for irrigation and routine mowing and may result in significant thinning of the base grass during spring transition.
- Successful overseeding programs require year-long planning and incorporate all aspects of root-zone cultivation and weed control in an effort to maintain health of the warm-season turfgrass while allowing successful establishment of the overseeded cool-season grass species.

Best Management Practices

- Thatch depth greater than 0.5 inch in the warm-season turfgrass base will prevent good seed-to-soil contact and will result in sporadic germination and establishment. Remove thatch as part of an active cultivation program before overseeding.
- Reduce or eliminate fertilization of the base grass three to four weeks before the planned seeding date to minimize growth and competition.
- Core-aerify the soil four to six weeks before the planned overseeding date to open turf canopy and aid in uniform establishment of overseeded grass.

- Select warm season grass species/cultivars that are adapted to the desired use, taking note of disease resistance and spring transition traits. Cool season cultivars with improved heat tolerance can delay spring transition and create increased competition for water, nutrients, and light with the warm-season cultivars.
- Irrigate newly planted overseed to maintain constant moisture levels, not allowing the soil surface to dry out. Gradually reduce irrigation once the seedlings have been mowed.
- Do not fertilize with nitrogen immediately before or during establishment of overseed as the N may encourage warm-season turfgrass competition and increase disease potential.
- Move hole locations on putting greens daily during the establishment period to minimize damage to seedlings from foot traffic.
- Reduce fertilizer rates in spring to slow growth of overseeded grass. Once warm-season turfgrass regrowth is apparent, restore fertilizer applications to stimulate growth of the warm-season turfgrass.
- Colorants (dyes and pigments) can be used to provide winter color to dormant grasses.
- Overseeding practices can generate significant dust that may require dust control measures.
- The timing of overseeding is critical to success; if it’s too hot, you have reduced germination and competition from your warm season grass; if it’s too cold, the turf never has time to mature prior to frost."
- Consider partial overseeding as opposed to wall to wall

Shade and Tree Management

Principles

- In general, most turfgrasses perform best in full sun.
- Excessive shade reduces photosynthesis and air circulation, thus increasing the susceptibility of the turf to pest and disease problems.
- Shade and tree management are critical parts of an IPM program.

Best Management Practices

- Prune tree limbs and roots as needed to reduce competition with turf for sunlight, water, and nutrients.
- When possible, trees located near closely mowed areas such as tees and greens should be removed or their canopy should be thinned to promote good turf growth.
- Understand the variability in sun angles at different times of the year and how this affects turf health.
- Conduct a shade audit to identify problem areas.

- Conduct a tree survey that identifies each tree's location, species, health, life expectancy, safety concerns, value and special maintenance requirements.
- Refer to Chapter 11: Landscape and Out-of-Play Areas for more information on trees.
- Limbs may be chipped for reuse as mulch to help retain moisture around trees and plants.
- Be cautious of planting trees too close to cart paths because damage to the cart path may occur as trees mature.
- "Where possible, tree canopies shading turf areas should be raised to allow more natural light to penetrate turf stands. "

Frequently Asked Questions (FAQs)

1. What can I find more about region-specific growing information?

- UC Statewide IPM
- UC Master Gardener Program
- UC Riverside Turfgrass Management reports
- The National Turfgrass Evaluation Program
- Information on plants: http://www.calflora.org/
- Sunset Garden Plant Selection: https://www.sunset.com/garden/climate-zones
- Sunset Western Garden Book: https://www.sunset.com/garden/new-sunset-western-garden-book

2. What can I find more about turf drought response?

Information on BMPs to address drought may be found in Chapter 2: Irrigation.

3. What other BMP chapters should I review for more insight into cultural practices?

- Chapter 2: Irrigation
- Chapter 5: Nutrient Management
- Chapter 7: Integrated Pest Management
- Chapter 11: Landscape

4. What resources are available for the management of non-native and invasive species?

The Integrated Pest Management chapter contains information and resources for addressing weeds, including invasive species. Additionally, the UC IPM program's Aquatic Pest Control Pesticide Application Compendium, Vol. 5 can help you manage invasive aquatic plants.

Also, the California Invasive Plant Council (Cal-IPC) is an excellent resource. More information can be found here: https://www.cal-ipc.org/

5. What resources are available for supporting the planting of native species?

The Calflora database can be used to assist in the selection of plants suited to the geography, soils and climate of your course. More information can be found here: https://www.calflora.org/entry/wgh.html

For landscape plants, you can use the USDA Plants Database to select species that are native to your county.

Another excellent resource is the California Native Plant Society (CNPS). More information can be found here: https://www.cnps.org/

6. What are the benefits of turf and golf courses in fire prone areas?

In the case of a fire, dry grasses and other vegetation may incidentally serve as fuel that propagates and spreads flames. If enough heat is present, nearly any plant will burn. Golf courses and large turf areas can serve as firebreaks that protect homes when short, well-watered turf is present.

As described in Patrick Gross's 2009 article Golf Course on the Fire Line, benefits of golf courses in the context of fire-prone areas include:

- Healthy turf is less likely to burn due to high water content
- Turf's proximity to the ground reduces its propensity to spread the fire
- Large open areas with minimal fuel, such as golf courses, create a defensible space, serving as a firebreak or safe zone for firefighters. These open spaces also reduce the chance wind-blown embers may spread to other plants and houses.
- Water resources on golf courses can sometimes be used as a source for firefighters.
- Trees are less likely to ignite on golf courses due to being surrounded by turf (stopping the "ladder effect")

7. I have vertebrate pests that are eating my foliage and compromising the aesthetics of my golf course. What can I do?

Best Management Practices for addressing deer, jackrabbits, geese, and other vertebrate pests are described in Chapter 7: Integrated Pest Management.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Calflora: information on wild California plants. 2019. Available at: https://www.calflora.org/entry/wgh.html

Gross, P. 2009. Golf Courses on the Fire Line. Green Section Record. Available at: http://gsrpdf.lib.msu.edu/ticpdf.py?file=/2000s/2009/091113.pdf

National Turfgrass Evaluation Program (NTEP). 2018. California National Turfgrass Evaluation Program. Available at: http://www.ntep.org/states/ca.htm

O'Connor-Marer, P. 2001. Aquatic Pest Control Pesticide Application Compendium, Vol. 5. Regents of the University of California Division of Agriculture and Natural Resources. Available for purchase at http://ipm.ucanr.edu/IPMPROJECT/ADS/manual_aquaticpestcontrol.html

United States Department of Agriculture. Natural Resources Conservation Service. Advanced search and download. Available at: https://plants.usda.gov/adv_search.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. The UC Guide to Health Lawns: Index. Available at: http://ipm.ucanr.edu/TOOLS/TURF/PESTS/index.html

University of California Master Gardener Program: Find a UC Master Gardener Program. Available at: http://mg.ucanr.edu/FindUs/

University of California Riverside. 2019. Turf Management Reports. Available at: https://turfgrass.ucr.edu/management_reports.html

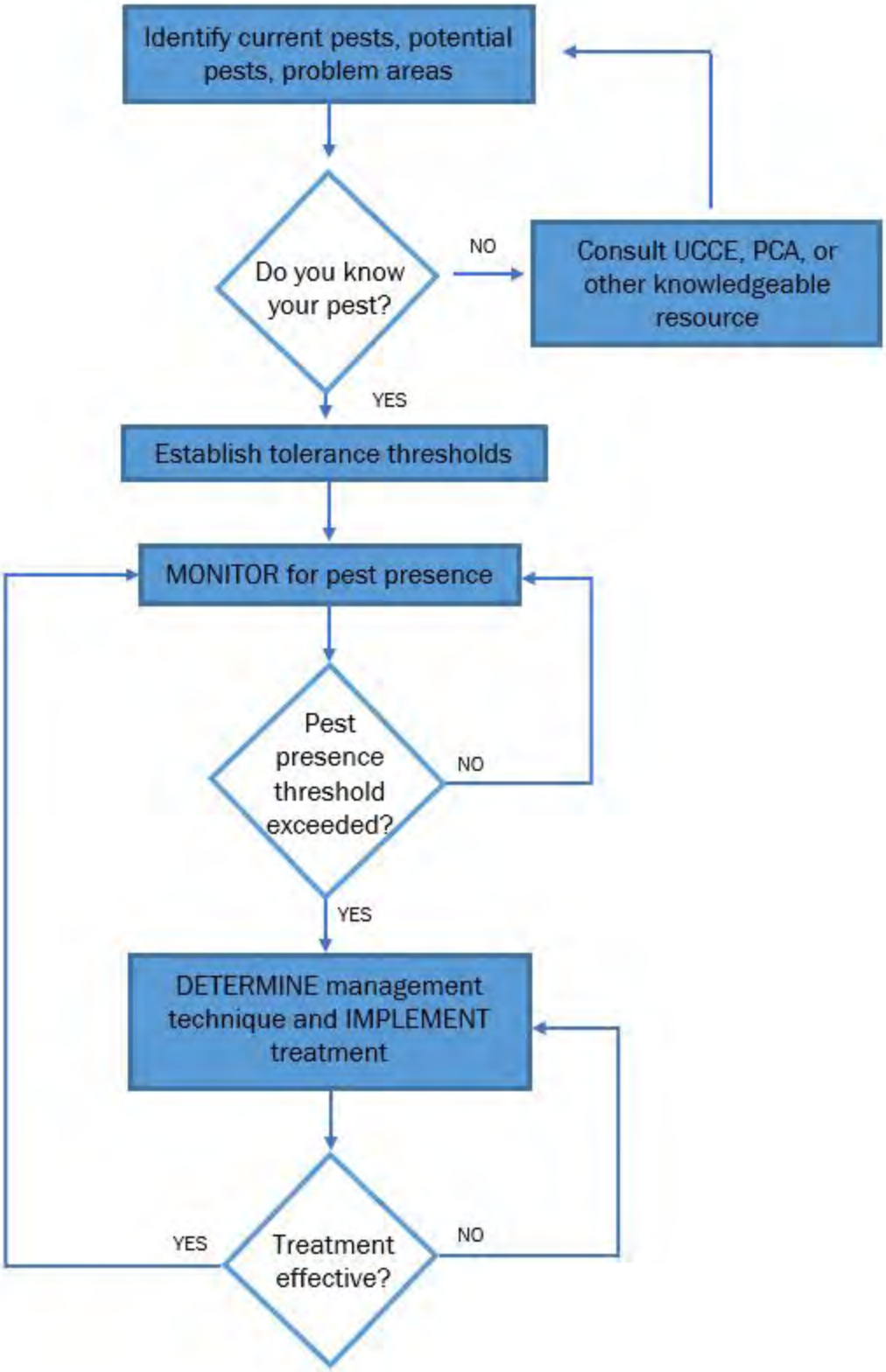
Chapter 7: Integrated Pest Management

Overview of IPM

Principles

- The University of California Statewide IPM Program defines IPM as follows:
- “IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.”
- Consistent with this definition and to meet the pest control objectives, we suggest that the following six (6) components be included in an IPM Plan:
    - Pest Identification
    - Establishment of Acceptable Tolerance Thresholds
    - Monitor for Pest Presence
    - Select Management Options If Thresholds Exceeded
    - Evaluate Effectiveness
    - Keep Records of the Process
- An example IPM flow chart below.

Sample IPM Flow Chart



Best Management Practices

- The University of California Statewide IPM Program provides a diagnostic tool to assist in the identification of pests and IPM management tips for a variety of these pests.
- In California, restrictions apply that prohibit the use of certain pesticides near listed, special-status species. See the Threatened and Endangered Species chapter for more information about the special laws and injunctions related to special-status species and pesticide applications.
- Use record keeping, monitoring, pest threshold practices, and action thresholds, as described later in this chapter.
- Determine the pest's life cycle and know which life stage can be controlled the most effectively (e.g., for an insect pest, whether it is an egg, larva/nymph, pupa, or adult).
- Use cultural, mechanical, or physical methods to prevent problems from occurring (for example, use mulch or weed barriers to discourage weed growth in landscaped areas), reduce pest habitat (for example, practice good sanitation in buildings, break rooms, etc.), or to help promote biological control (for example, place bat and owl boxes to enhance habitat for these species to control flying insects and vertebrate pests, respectively).
- Take preventive measures, including the use of good agronomic practices which include: proper mowing, mowing height adjustment dependent on course location, frequency and duration of aeration and/or thatch removal, turf cultivar and time of year, proper irrigation, soil drainage, etc.
- Don't hesitate to consult experts in turfgrass, soils, fertilizers, pesticides and trees as needed. An excellent starting point is the University of California Statewide Integrated Pest Management Program.
- Many experts are available for low or no cost consultation through the University of California Cooperative Extension (UCCE). UCCE specialists are often co-located with County Agriculture Commissioner's offices and can be found here.
- Determine whether the corrective action(s) taken reduced or prevented pest populations, were economical, and minimized risks by keeping records of start/end of the control technique, labor and materials used, cost, and degree of effectiveness.
- Consider organizing your IPM program as follows:
    - Table of Contents
    - Scope and Purpose
    - IPM Overview and Definitions
    - Goals
    - Roles and Responsibilities
    - Recordkeeping and Reporting
    - Training and Safety
    - Pesticide Selection and Use
    - Posting and Notification
    - IPM for [Site Type A, B, C, etc]
        - Pest Type and Identification

        - Action Level
        - Treatment Options
        - Monitoring
- The GCSAA offers an online IPM Planning tool found here: https://www.gcsaa.org/environment/bmp-planning-guide/ipm-planning-guide-resources

Regulatory Considerations

Principles

- There are currently no statewide legal mandates for the use of IPM in California.
- Several counties have IPM ordinances that restrict or prohibit the use of pesticides. Check your local CAC to determine if your county has an ordinance. Currently, counties with ordinances include:
    - San Francisco
    - San Mateo
    - Marin
- Several cities also have ordinances, such as the City of Berkeley. Check with your local CAC for details.
- See the Pesticide Management chapter for details on the manner in which pesticides are bought, stored, used and disposed. For example, See the Pesticide Management chapter for information about pesticide use reports (PURs). PURs are submitted to your local CAC which are passed along to the California Department of Pesticide Regulation (DPR).
- California has laws and regulations that pertain to pesticide use in groundwater protection areas and with consideration for threatened and endangered species. See the Groundwater Management, Endangered Species, and Pesticide Management chapters for more information on these topics.

Best Management Practices

- If in doubt regarding pesticide product use or applications, contact your local CAC or the California Department of Pesticide Regulation (DPR).
- Follow guidelines and advice provided by the Fungicide Resistance Action Committee (FRAC), Herbicide Resistance Action Committee (HRAC), and Insecticide Resistance Action Committee (IRAC).

Pest Thresholds

Principles

- The pest threshold is the point at which the damage caused by the pest is equal to or greater than whatever threshold you establish. This may be an economic, aesthetic and/or operational threshold.

Best Management Practices

- Be flexible in setting thresholds. Depending on the time of year, tournament scheduling, etc., thresholds may need to change.
- Golfers, once informed, may be more willing to accept a pest threshold than if not informed. Just like posting a green's aerification schedule in the club house or restricting cart traffic on a fairway, posting information on the presence of English daisy and its control resulting in spotty turf coverage on green collars is typically helpful.

Monitoring and Record Keeping

Principles

- Monitoring, or scouting, is a critical element of a successful IPM program.
- Record your information and don't rely on memory. Give you and your coworkers the benefit of written records so that you can gauge successes and failures and improve your pest control from year to year.
- Maintain healthy turf so it is more resistant to pest pressure than unhealthy and stressed turf.

Best Management Practices

- Train personnel to observe and document conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pest(s) are present and where so that informed decisions can be made regarding threshold exceedance and control success.
- Use resources such as the UC IPM Program to diagnose problems with turf. More information is here.
- Use resources such as the UC IPM Program to manage turf pests. More information is here.
- California requires that if pesticides are used, a monthly Pesticide Use Report (PUR) be submitted to the County Agriculture Commissioner (CAC). Refer to Chapter 8: Pesticide Management for more information

Turfgrass Selection

Principles

- Selecting pest-resistant cultivars or plant species is a very important part of IPM, and it may lead to reduced pesticide usage. Species grown outside of their zone of adaptation are more prone to pest problems.
- Species and cultivars should be managed under conditions similar to their intended use (for example, not exceeding mowing height limitations that a grass was bred or selected for).
- Select turfgrasses based on the golf course's eco-region which is likely to result in minimized irrigation, fertilizer, pesticide and maintenance inputs. Some turf species are genetically modified to be more resistant to disease/drought.

Best Management Practices

- Select the most suitable turfgrass for existing conditions and one that adheres to design specifications.
- Educate builders, developers and landscape architects, owners and golfers on which turf and landscape plants are best suited to specific areas of the golf course.
- For information of California turf species and their relative resistance and susceptibility to difference stressors, see the following publications:
    - Lawn Diseases: Hartin et al. 2011 Lawn Disease: Prevention and Management

    - Turfgrass Insects (California): http://ipm.ucanr.edu/PMG/PESTNOTES/pn7476.html
    - Turfgrass Insects (Southern California): Umeda 2012 Pest Management Strategic Plan for Turfgrass in the Low Desert Regions of Arizona, Southern California, and Southern Nevada-Southern Utah
    - The UC Statewide Integrated Pest Management Program provides information here: http://ipm.ucanr.edu/PMG/r785700111.html
    - Turf adaptations and tolerances in California can be found: http://ipm.ucanr.edu/TOOLS/TURF/TURFSPECIES/charsixsp.html
    - The National Turfgrass Evaluation Program (NTEP) offers reports of turfgrass species quality in select California regions. These reports can be viewed at: http://www.ntep.org/states/ca.htm
- Select shade-adapted grasses for areas receiving partial sun or shaded areas.
- Reduce pest and disease pressures by correcting dead spots and air-circulation issues by pruning understory and adjusting irrigation scheduling.

Biological Controls

Principles

- The biological component of IPM involves the use of natural pest predators, such as lady beetles, bats and predatory birds.
- Some biological controls can be purchased and released depending on the pest.
- Areas on the golf course can also be modified to attract and better support natural predators and beneficial organisms.

Best Management Practices

- The lady beetle, green lacewing, and soldier beetle are good examples of California insects that target insect pests. For a list of natural enemies by turf pest, you can view the UC Statewide IPM website here or consider purchasing the Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control.
- Identify areas on the golf course that can be modified to attract natural predators, provide habitat for them, and protect them from pesticide applications. Examples include bat and owl boxes.
- If practical, adjust the inputs to habitats occupied by biocontrol agents. For example, the use of buffer zones that limit the irrigation, fertilizer and pesticide use and mowing around locations intended or known to harbor beneficial insects may enhance their growth.

  If practicable, adjust the inputs to habitats occupied by biocontrol agents

- Use native plant species when possible. Use the Calscape database to search for native plants that meet the desired plant characteristics for different California regions.

Pollinators

- For more about pollinators, see the Pollinator Protection Chapter of this guide.

Pesticides

Principles

- IPM does not preclude the use of pesticides and pesticides should be viewed as one of the tools in the IPM tool box.
- Pesticides should be evaluated on effectiveness against the pest, mode of action, life stage of the pest, personnel hazards, non-target effects, potential off-site movement, and cost.

Best Management Practices

- Always read and follow pesticide label instructions.
- As necessary, obtain a written recommendation for the use of a pesticide from a DPR-licensed Pest Control Advisor (PCA) who has expertise with the pest being managed.
- Insure that staff are adequately trained in proper mixing, loading and application and have been provided the proper use of personal protective equipment (PPE) and trained on how to use it.
- Be aware of restrictions on pesticide use in your city or county. These may include ordinances that limit or prohibit the use of certain pesticides, such as the use of some herbicides within proximity of vineyards.
- Be aware of the presence of endangered, threatened or listed species and develop your pest control strategy accordingly.
- Be aware of pesticide use restrictions in areas where salmonids, red-legged frog and the Goby-11 group of species may exist. Information can be found here.
- Mix only the quantity of pesticide needed in order to avoid disposal problems, protect non-target organisms, and save money.
- Pesticides that have residue tolerance exemptions under 40 CFR 180 or are exempt from registration (i.e., “minimum risk” as defined by 40 CFR 152) are typically considered to be less toxic than pesticides without these designations. Exempt pesticide product meet criteria described in 3 CCR 6147.
- Spot-treat pests whenever appropriate.
- Rotate pesticide modes-of-action to reduce the likelihood of resistance development.
- Be aware of phytotoxicity to desirable plants and impact to non-target receptors.

Turf Disease

Principles

- Healthy, well-managed turfgrass is less likely to develop disease problems.
- Cultural factors that can influence turfgrass stress and the likelihood of disease problems include traffic, temperature, organic layer management, fertility programs, water management, and mowing height selection.

Best Management Practices

- Correctly identify the disease pathogen. This often involves sending samples to diagnostic clinics. The UC Statewide IPM Program can assist. More information is here.
- For more information about common lawn diseases in California, grass species most susceptible to these pathogens, and prevention practices, see Hartin et al. 2011 Lawn Disease: Prevention and Management.
- Correct conditions that produce stressful environments for the turf. Examples include: improve airflow and drainage and reduce or eliminate shade.
- If appropriate, preventively apply appropriate fungicides if degree-day or other models suggest that diseases are likely to occur or when conditions favor disease outbreak.
- Record and map disease outbreaks and identify trends that can help guide future treatments
- Consider changing manageable conditions in susceptible areas to reduce disease outbreaks.
- Be aware of the development of resistance. The repeated use of fungicides with the same mode of action can result in the selection of fungicide-resistant strains. Learn more here.

Weeds

Principles

- Weeds compete with turf for space, water, light, and nutrients and can harbor insect pests, plant pathogens and nematodes.
- Weed presence may detract from turf quality and playability.
- Weeds can reproduce from seed, root pieces, and special vegetative reproductive organs such as tubers, corms, rhizomes, stolons, or bulbs. People, animals, birds, wind, and water can distribute seeds.
- Weeds complete their life cycles in either one growing season (annuals), two growing seasons (biennials), or three or more years (perennials). Annuals that complete their life cycles from spring to fall are referred to as summer annuals. Those that complete their life cycles from fall to spring are winter annuals.
- Aquatic weeds can be a problem in ponds and can be either submersed (Ex: sego pond weed), floating (Ex: primrose) or emergent (Ex: cattails)

Best Management Practices

- Proper weed identification is essential for effective management and control. The Cal Weedmapper tools generates reports of weed presence by county, to assist in the identification process: https://calweedmapper.cal-ipc.org/maps/
- Weed control is based on weed identification and life stage. Species presence is often a clue about the underlying deficiency (e.g., compacted soil).
- Select and maintain healthy turf species that are adapted to the course's soil and weather to reduce weed encroachment that may lead to bare soil.
- Use weed-free seed, top dressing and soil amendments.
- Always consider the use of non-chemical strategies for controlling weeds. When a weed is removed, sprinkle seed grass in the hole.
- Avoid scalping; it reduces turf density, increasing weed establishment.
- Record and map weed presence to help identify site specific issues.
- For management of aquatic weeds, see the Aquatic Pest Control Pesticide Application Compendium, Vol. 5.
- Be aware of the development of resistance. The repeated use of herbicides with the same mode of action can result in the selection of herbicide-resistant strains. Learn more here.

Nematodes

Principles

- Plant-parasitic nematodes are microscopic roundworms (unsegmented), usually between 0.0156 and 0.125 inch (0.25 and 3 mm) in length and can be difficult to control.
- Plant-parasitic nematodes can adversely affect turfgrass health.
- Nematodes debilitate the root system of susceptible turfgrasses; plant-parasitic nematodes cause turf to be less efficient at water and nutrient uptake from the soil and make it much more susceptible to environmental stresses.
- Over time, turf in the affected areas thins out and, with severe infestations, may die. The roots of turfgrasses under nematode attack may be very short, with few, if any, root hairs, or they may appear dark and rotten.
- Turfgrasses usually begin showing signs of nematode injury as they experience additional stresses, including drought, high temperatures, low temperatures, and wear.

Best Management Practices

- The UC Statewide IPM Program has resources of nematode control that can be found here.
- When nematode activity is suspected, an assay of soil and turfgrass roots is recommended to determine the extent of the problem and corrective action(s), if any.
- If possible, divert traffic away from areas impacted by nematodes to lessen the stress on the turf.

- Increase mowing height to reduce plant stress associated with nematode presence.
- Certain fungi and bacteria may reduce populations of nematodes and are commercially available.

Mosquitos

Principles

- Mosquitos are statewide nuisances that can cause allergic reactions in some people and are vectors for some diseases, such as Zika and West Nile virus.
- Although there are precautions that people can take to avoid being bitten, such as the use of effective repellants and wearing long-sleeve shirts and pants when outdoors, reducing their populations on golf courses is something the superintendent can assist in.
- Mosquito populations can be controlled either in the adult or larval stages.

Best Management Practices

- See FAQ #5.
- See references: Vector-Borne Disease Section 2008 Overview of Mosquito Control Practices in California

Structural Pests

Principles

- Golf course structures, such as clubhouses, may be targeted for infestation by pests such as commensal rodents, ants, and cockroaches.
- The California Structural Pest Control Board, not the DPR, is the relevant regulatory agency. Learn more here.
- The three major rodents of concern in California are the Norway rat, roof rat, and house mouse.
- Commensal rodents can be hazardous as they are vectors for salmonella, typhus, tapeworms, and Hantavirus.
- The County Department of Health and some City Departments of Health may be involved if structural pests are in areas of food storage or preparation.

Best Management Practices

- Plant ornamental and landscape plants far enough from structures, such as clubhouses, to avoid creating attractive habitats near buildings. Similarly, keep trees trimmed from hanging over clubhouses and other structures to prevent roof rat access.

- In addition to landscape plants, keep trees trimmed from hanging over clubhouses and other structures to diminish Roof Rat access.
- Maintain the building envelope by weather-stripping around windows and doors, installing door sweeps, screens or other barriers, and sealing cracks and crevices to prevent pests from entering the building.
- Remove harborage by cleaning up clutter such as cardboard boxes, used tires, wood piles, etc.
- Manage trash receptacles and dumpster areas for clutter and cleanliness to minimize food sources and hiding places.
- Eliminate water sources by fixing leaky pipes, cleaning out drains and rain gutters, and preventing water from pooling on concrete or soil after irrigating landscape.
- Rinse all food and beverage containers before placing in recycling bins.
- If you do use pesticides, always follow the label.
- When using rodenticides, use anchored, tamper-proof bait stations. Keep them away from children and domestic animals.
- Take safety precautions, when cleaning up pest excreta, as some diseases may be aerosolized or otherwise transmitted through this pathway.
- Identification of rodent pests is critical for successful management practices. For example, being knowledgeable about the target pest's eating habits (i.e., if they are neophobic) may assist in bait placement strategy.
- Contact the California Structural Pest Control Board here for more information.
- Be aware of any threatened and endangered species that might be impacted by your pest management practices. See Chapter 15: Threatened and Endangered Species for more information.

Other Vertebrate Pests

Principles

- Herbivorous pests, such as deer, jackrabbits, and geese, can damage foliage and compromise the aesthetics of golf courses.
- Certain animals, such as skunks, opossums, raccoons, coyotes, mountain lions, bears, snakes, and bobcats can also serve as nuisances on golf courses by digging holes under buildings and lawns, knocking over trashcans, and damaging buildings and landscapes.
- In extreme cases, vertebrate pests may pose a risk to people if desensitized to their presence.

Best Management Practices

- Stay in communication with neighboring facilities to identify large pest observations in the area.
- Do not approach or handle any pest that poses a hazard, including those that may carry rabies (e.g., coyotes, bats).

- If you sight a pest that poses risk to person, pet, or property, contact:
    - Local animal control agency
    - Local County Ag Commissioner
    - California Department of Food and Agriculture Vertebrate Pest Control Program. Learn more here.
    - California Department of Fish and Wildlife. Learn more here.
    - United States Department of Agriculture (USDA) Animal and Plant Health Inspection Service (APHIS). Learn more here.

  Based on the type of pest, they will direct you to the correct agency to speak with.

- In many counties, informational and technical assistance for wildlife services may be free of charge (such as Nevada County Wildlife Services).
- When using a live-catch trap, select plastic boxes instead of wire to obtain complete enclosure. This prevents getting sprayed by skunks or any potential scratching/biting by scared animals.
- Screen or block beneath porches or small areas that vertebrate pests like skunks and racoons like to reside.
- Limit food sources and do not leave unsecure bird seed, compost, or trash accessible.
- Limit water and shelter sources that are attractive to predators, such as coyotes.
- Maintain and plan landscape features to eliminate safe havens, keep vegetation trimmed near buildings, clean up plant debris, and remove invasive plants that provide food and/or shelter for mice, rats, voles, ground squirrels, and gophers.
- Consider the use of low toxicity repellants, such as garlic, putrescent whole egg solids, and capsaicin, to prevent or evict vertebrate pests when appropriate.
- When considering the use of rodenticides, carefully read the label and seek the advice of a DPR-licensed Pest Control Advisor (PCA) with vertebrate pest control expertise and credentials.
- Minimize or eliminate any pest management that may result in adverse impacts to non-target animals.
- Understand the animal that is encroaching on the golf course. Some vertebrates may serve a beneficial purpose, such as gopher snakes, and/or are transient.
- Some animals may still transfer their venom or diseases after their death. Do not handle these animals (e.g., rattlesnakes) without proper training.
- When using wildlife behavior modification methods, comply with local laws (e.g., noise ordinances).
- In general, be aware of county, state, and federal laws pertaining to vertebrate pest management. Due to declining populations or genetic diversity, actions taken against specific animals (e.g., coyotes, mountain lions, etc.) may be limited. Please contact the resources mentioned at the beginning of this section for more information.
- For addressing threatened and endangered species, see the Threatened and Endangered Species chapter.

Resistance Management

Principles

- Be aware of the development of resistance. The repeated use of herbicides, insecticides, and fungicides with the same mode of action can result in the selection of resistant pests. Learn more here.

Best Management Practices

- Be aware of confirmed occurrences of herbicide resistance, as described in International Survey of Herbicide Resistant Weeds, 2019 and Sosnoskie, 2019.
- Avoid overreliance of pesticides with the same mode of action repeatedly over generations. A summary of herbicide modes of action may be found in International Survey of Herbicide Resistant Weeds, 2019 and Take Action's 2018 Herbicide Classification Chart.
- Don't use less than the minimum label rate for the target pest.
- Understand the history of herbicide use in an application area.

Frequently Asked Questions (FAQs)

1. How is Integrated Pest Management (IPM) defined in California?

According to the University of California Statewide IPM Program, "IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant plant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment."

IPM can reduce or eliminate the need for pesticide applications, but does not mean that pesticides are eliminated as tool. Some regions in California are more stringent about their IPM practices and use of pesticides. To learn more about the pesticide laws that pertain to you, see the Pesticide Management Chapter and/or contact your County Agricultural Commissioner.

The University of California Statewide Integrated Pest Management Program has additional information about using good IPM practices specific to California.

2. What are some general IPM practices that I can implement for control of turf pests?

The best way, in general, to protect turf grass from pests is to keep it healthy so it is less susceptible to insects and disease. When turf grass is suffering, it is vulnerable to

secondary infestation of insects, nematodes, disease, and cannot outcompete weeds that vie for the same space/resources. Keeping turf healthy is discussed extensively throughout this BMP guide.

- Accurately identify the pest of concern. The University of California Statewide IPM Program provides a diagnostic tool to identify pests that are affecting golf course turf. Once identified, use the IPM management tips for life cycle, monitoring information, and pest-specific management practices.
- Maintain an environment that invites beneficial arthropods.
    - The lady beetle, green lacewing, and soldier beetle are good examples of California insects that target insect pests.
    - For more beneficial biocontrol measures, you can view the UC Statewide IPM website here.
    - Use a buffer zone when applying pesticides around locations intended or known to harbor beneficial arthropods.
    - Line the golf course with hedgerows containing a variety of native plant species that invite beneficial arthropods. Use the Calscape database to search for native plants that meet the desired plant characteristics for different California regions.
- Increase education of golfers and maintenance personnel to raise their tolerance of minor aesthetic damage without compromising plant health, play, and aesthetics.

For BMPs related specifically to pollinators, see Chapter 9: Pollinator Protection.

3. What are some seasonal landscape approaches I can take to avoid and manage common pests in my region?

A seasonal landscape IPM checklist can be found here. Although not fully comprehensive of every county, it offers information about common California pests and best management practices that can be taken as preemptive measures. Consider subscribing to the monthly checklist to maintain these BMPs.

4. How do I handle samples I want to submit to a laboratory for diagnosis? Where can I find a laboratory to analyze my turf for disease/pests?

The UC Statewide IPM offers good sampling practices when submitting soil and vegetative samples for plant disease diagnostics. That can be found here.

For other classes of pests, the Plant Pest Diagnostics Center has an entomology laboratory that provides diagnostic services for a variety of pests to private industry and the public. Their website provides guidance of sample preparation and submission protocols.

5. What IPM Practices can I use to control mosquitos?

Mosquitoes are statewide nuisances that can cause allergic reactions in some people and are vectors for diseases, such as West Nile virus. Although there are precautions that people can take to avoid being bitten, such as the use of effective repellents and wearing long-sleeve shirts and pants outdoors, reducing mosquito populations on golf courses is something the superintendent can control.

Best Management Practices for larval- or adult-stage mosquitos include:

- Reduce breeding sites:
- Dump out or seal any stagnant water containers, such as buckets, flower pots, trash barrels, and recycling bins.
- Clean and maintain structural water sources that could be susceptible to mosquito breeding, such as ponds and birdbaths.
- Avoid over irrigating and regularly maintain and inspect any retention basins that might house larvae.
- Reduce harboring areas for adult mosquitos.
- Mow grass as short as possible while still maintaining turf health and aesthetic value.
- Promoting air circulation by thinning shrubs and removing excess leaves/tree bark/debris.
- Consult with your local County Mosquito and Vector Control Agency who are members of the Mosquito and Vector Control Association of California (MVCAC) Information can be found here: http://www.mvcac.org. They may accomplish the following for you or advise you on how to do it on your own:
- Stock small fish in ponds that eat mosquito larvae, such as gambusia.
- Stock other organisms that feed on mosquitos (e.g., frogs and damselfly nymphs), although there is debate as to how much of their diet consists of mosquitos and would, therefore, contribute to mosquito control.
- Application of Surface agents: Apply a surface agent that prevents mosquito larvae and pupae from breathing at the water's surface. Some examples include highly refined mineral oils or monomolecular films.
- Application of Insect Growth Regulators: Some insect growth regulators interfere with mosquito maturation process. An example is methoprene, which has very low human toxicity and is long-lasting.
- Application of Larvicides: Some subspecies of Bacillus thuringiensis (e.g., israelensis) are effective against mosquito larvae but don't affect people or plants.
- Application of Adulticides: because some mosquito populations have been documented as developing pesticide resistance, especially to older pesticides, consult your local County mosquito and vector control agency or MVCAC.
- What are some IPM BMPs I can utilize for control of invasive aquatic plants?

An excellent source of information for aquatic pest control, including the use of IPM, is the Aquatic Pest Control Pesticide Application Compendium, Vol. 5. Methods for control of aquatic pests vary based on multiple factors, including the species/nature of

the weed (e.g., submersed or emergent), physical structure of your water body, and water characteristics.

6. What are some BMPs I can use for rodent pests?

- Maintain and plan landscape features to eliminate safe havens for pests and rodents.
- Keep vegetation trimmed 18 inches from buildings and fill landscape areas with stones or similar material to prevent nesting.
- Clean up plant debris, especially from fruit-bearing trees.
- Remove invasive plants that are known to harbor or provide food for pests.

The UC Statewide IPM website explores additional options related to control of rodents, such as rats, house mice, voles, ground squirrels, and gophers.

7. What can I do to control weeds?

- Identify the species of weed and tailor an approach based on specific infestation(s). Review what weeds have been reported in your county by using the CalWeedMapper. This tool provides information about invasive species in your region, including regional distribution, lifecycle, and other plant characteristics. Weeds can also be identified using the UC Statewide IPM website.
- Customize management based on weed identification. Species presence is often a clue about the underlying deficiency (e.g., compacted soil).
- Maintain turf and landscape health using information provided in specific chapters of this BMP guide (e.g., nutrient management, irrigation) to maintain competitive characteristics.
- When practical, use non-chemical (i.e., manual or mechanical) strategies for controlling weeds. When a weed is removed, sprinkle seed grass in the hole.
- If using an herbicide, select the lowest risk one that is effective at controlling undesirable plants. Some guidance on low-risk pesticides may be found here: http://npic.orst.edu/ingred/lowrisk.html
- Renovate or replace weak areas of lawn with vigorous new turf, as needed.
- Remove thatch.

Once you have characterized your plant pest, you can use these tips for Weed Management in Landscapes and Weed Management in Lawns.

8. What BMP practices can I use inside structures?

- Maintain the building envelope by weather-stripping around windows and doors, installing door sweeps, screens or other barriers, and sealing cracks and crevices to prevent pests from entering the building.
- Remove hiding places by cleaning up clutter such as cardboard boxes, crates, used tires, wood piles.

- Manage trash bins and dumpster areas for clutter and cleanliness to minimize food sources and hiding places.
- Eliminate water sources by fixing leaky pipes, cleaning out drains and rain gutters, and preventing water from pooling on concrete or soil after irrigating landscape.
- Rinse all food and beverage containers before placing in recycling bins.

If you do use conventional pesticides, try to use the lowest risk possible with the least amount of exposure to non-target entities that will be effective at controlling the pest. Pesticides that have residue tolerance exemptions under 40 CFR 180, Subpart D are typically considered to be lower risk pesticides. Always follow the label.

9. My pest problem requires the use of pesticides. Are there pesticide laws specific to California? Are there special laws related to pesticide use in California with respect to Threatened & Endangered species? What pesticide product should I select?

Yes, California typically has stricter laws with respect to pesticide usage than on a Federal level. The first person to contact about pesticide usage is your county agricultural commissioner (CAC). Secondly, the California Department of Pesticide Regulation (DPR) is the head agency in California with respect to pesticide usage and enforcement. There several training, licensing and reporting requirements that DPR and your CAC have. For information about pesticide records, pesticide use reporting, and the use of restricted materials in California, see Section 8: Pesticide Management.

There are laws that pertain to certain pesticides and endangered species. Information about these laws can be found in the Section 15: Endangered Species section of this guide.

If you decide to use a conventional pesticide, select one that is effective but of the lowest toxicity to non-target organisms. Products with the signal word ‘Caution’ are lower in toxicity to humans than those with ‘Warning’ or ‘Danger’. However, also be conscientious of labeling related to non-target, ecological receptors such as bees and fish.

10. Are there advocacy groups in my area that are opposed to my use of conventional pesticides?

Maintaining good relationships with leaders and members of your community is an important aspect of any association, but particularly as a golf course superintendent. Some major advocacy groups in California include:

- Better Urban Green Strategies (BUGS)
- California Environmental Health Initiative
- California Sportfishing Protection Alliance
- Californians for Pesticide Reform

- Center for Environmental Health
- Communities for a Better Environment
- Deltakeeper
- Earthjustice
- Ecological Rights Foundation
- Environmental Advocates
- Environmental Working Group
- Environmental World Watch
- Forest Action Brigade
- Global Community Monitor
- MOMS Advocating Sustainability (MOMAS)
- Natural Resources Defense Council (NRDC)
- North Coast Rivers Alliance
- Northcoast Environmental Center
- Northern California River Watch
- Orange County Coastkeeper
- Our Children's Earth Foundation
- Parents for a Safer Environment
- Pesticide Action Network
- Physicians for Social Responsibility
- Raptors are the Solution (RATS)
- San Francisco Baykeeper
- Santa Monica Baykeeper
- Save the Frogs!
- Sierra Club California
- TEAM Enterprises
- The Endocrine Disruption Exchange (TEDEX)
- The Surfrider Foundation
- Topanga Creek Watershed Committee
- Ventura Coastkeeper
- Wild Equity Institute
- Wishtoyo Foundation

11. How can I maintain good relations with my neighbors?

Developing rapport with neighboring community members helps them better understand what actions you are taking to protect human and environmental health with activities on your golf course.

- Invite community members, schools and clubs and organizations over for a tour. This can include hosting an open-house, providing interactive stations for non-golfers to introduce them to the sport, workshops, presentations, and inviting employees/patrons to assist with stewardship projects around the clubhouse or golf course.

- Send out letters to neighboring property owners or homeowners associations to educate them on the golf course's involvement in integrated pest management and best management practices.
- Provide newsletters, fliers, or brochures about environmental goals and progress the golf course is taking to meet environmental objectives

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

40 CFR 152.25 Exemptions for pesticides of a character not requiring FIFRA regulation. Available at: https://www.gpo.gov/fdsys/pkg/CFR-2011-title40-vol24/pdf/CFR-2011-title40-vol24-part152.pdf

40 CFR 180. Tolerances and Exemptions for Pesticide Chemical Residues in Food. Available at: https://www.gpo.gov/fdsys/granule/CFR-2014-title40-vol24/CFR-2014-title40-vol24-part180

California Department of Food and Agriculture. 2016. Plant Pest Diagnostics Center: Sample Preparation and Submission Protocols. Available at: https://www.cdfa.ca.gov/plant/PPD/PDF/Submission_guidelines_Botany.pdf

California Department of Food and Agriculture. 2018. Plant Pest Diagnostics Center - Entomology Laboratory Overview. Available 3 CCR 6147. Exempted Pesticide Products. Available at https://www.cdpr.ca.gov/docs/legbills/calcode/020101.htm

California Department of Pesticide Regulation (DPR). 2014. Pesticide Use Enforcement Program Standards Compendium Volume 8, Guidelines for Interpreting Pesticide Laws, Regulations, and Labeling. Available at: http://www.cdpr.ca.gov/docs/enforce/compend/vol_8/entire_manual.pdf

California Invasive Plant Council. 2018. CalWeedMapper database. Available at https://calweedmapper.cal-ipc.org/maps/

California Native Plant Society. 2018. Calscape database. Available at: http://calscape.org/

Flint, M.L.. 2015. Natural Enemies Handbook: The Illustrated Guide to Biological Pest Control. University of California Press. Available at: http://anrcatalog.ucanr.edu/Details.aspx?itemNo=9038

Fungicide Resistance Action Committee. Available at http://www.frac.info/

Golf Course Superintendent Association of America (GCSAA) IPM Planning Guide. 2018. Available at https://www.gcsaa.org/environment/bmp-planning-guide/ipm-planning-guide-resources

Hartin, J., P. Geisel, and A. Harivandi. 2011. Pest Notes: Lawn Diseases: Prevention and Management. University of California Division of Agriculture and Natural Resources. Available at http://ipm.ucanr.edu/PMG/PESTNOTES/pn7497.html

Herbicide Resistance Action Committee. Available at https://www.hracglobal.com/

Insecticide Resistance Action Committee. Available at http://www.irac-online.org/

International Survey of Herbicide Resistant Weeds. 2019. International Survey of Herbicide Resistant Weeds Homepage. Available at www.weedscience.org

National Pesticide Information Center (NPIC). 2019. Low-Risk Pesticides. Available at http://npic.orst.edu/ingred/lowrisk.html

National Turfgrass Evaluation Program (NTEP). 2018. California National Turfgrass Evaluation Program. Available at: http://www.ntep.org/states/ca.htm

O'Connor-Marer, P. 2001. Aquatic Pest Control Pesticide Application Compendium, Vol. 5. Regents of the University of California Division of Agriculture and Natural Resources. Available for purchase at http://ipm.ucanr.edu/IPMPROJECT/ADS/manual_aquaticpestcontrol.html

Our Water Our World. 2016. Controlling Weeds in Your Garden. Available at http://ourwaterourworld.org/Portals/0/Weeds_4-25-18%20reduced.pdf?ver=2018-05-22-064512-727

Santa Barbara City College. 2012. Integrated Pest Management Plan. Available at: https://www.sbcc.edu/facilities/SBCC%20IPM%20Plan.pdf

Sosnoskie, L. 2019. The Current Status of Herbicide Resistance in California. Available at: https://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=29069

Take Action. 2018. Herbicide Classification Chart. Retrieved from: https://www.iwilltakeaction.com/uploads/files/57229-6-final-ta-hrm-classificationposter-lr.pdf

Umeda, K. 2012. Pest Management Strategic Plan for Turfgrass in the Low Desert Regions of Arizona, Southern California, and Southern Nevada-Southern Utah. Summary of workshop held on July 16, 2008. Phoenix, Arizona. Available at: https://ipmdata.ipmcenters.org/documents/pmsps/AZ-CA-NV-UTdesertturfgrassPMSP.pdf

United States Environmental Protection Agency (USEPA). 2018. Active Ingredients Eligible for Minimum Risk Pesticide Products. Available at: https://www.epa.gov/sites/production/files/2018-01/documents/minrisk-active-ingredients-tolerances-jan-2018.pdf

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program website homepage. 2018. Available at: http://ipm.ucanr.edu/

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2015. Seasonal Landscape IPM Checklist. Available at: http://www2.ipm.ucanr.edu/landscapechecklist/

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Agricultural Pest Management: Integrated Weed Management. Available at: http://ipm.ucanr.edu/PMG/r785700111.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Birds, mammals, and reptiles (vertebrate pests). Available at http://ipm.ucanr.edu/PMG/menu.vertebrate.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Pests in Gardens and Landscapes: Lawn Diseases - Prevention and Management. http://ipm.ucanr.edu/PMG/PESTNOTES/pn7497.html#SAMPLING

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Pests in Gardens and Landscapes: Nematodes. Available at: http://ipm.ucanr.edu/PMG/PESTNOTES/pn7489.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Pests in Gardens and Landscapes: Weed Management in Landscapes. Available at: http://ipm.ucanr.edu/PMG/PESTNOTES/pn7441.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. Pests in Gardens and Landscapes: Weed Management in Lawns. Available at: http://ipm.ucanr.edu/QT/lawnweedscard.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. The UC Guide to Health Lawns: Diagnostic key to problems in turfgrass. Available at: http://ipm.ucanr.edu/TOOLS/TURF/PESTS/diagkey.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. The UC Guide to Healthy Lawns: Identification key to weeds. Available at: http://ipm.ucanr.edu/TOOLS/TURF/PESTS/weedkey.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. The UC Guide to Health Lawns: Manage pests. Available at: http://ipm.ucanr.edu/TOOLS/TURF/PESTS/index.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2017. The UC Guide to Healthy Lawns: Turf Adaptations and Tolerances. Available at http://ipm.ucanr.edu/TOOLS/TURF/TURFSPECIES/charsixsp.html

University of California Agriculture & Natural Resources Statewide Integrated Pest Management Program. 2019. Pests in Gardens and Landscapes: Less Toxic Insecticides. Available at: http://ipm.ucanr.edu/QT/lesstoxicinsecticidescard.html#

Vector-Borne Disease Section. 2008. Overview of Mosquito Control Practices in California. California Department of Public Health. Available at: http://www.cdpr.ca.gov/docs/dept/westnile/mosqover.pdf

United States Department of Agriculture (USDA). 2019. USDA Animal and Plant Health Inspection Service (APHIS) homepage. Available at: https://www.aphis.usda.gov/aphis/home/

Chapter 8: Pesticide Management

Overview of Pesticide Management

Pesticide use should be part of an overall Integrated Pest Management (IPM) strategy that includes mechanical, biological, and cultural methods, pest monitoring, and other applicable practices. When a pesticide application is deemed necessary, its selection should be based on effectiveness, safety, toxicity to non-target species, cost, site characteristics, and its solubility and persistence in the environment.

All embedded hyperlinks below can be found in the References section of this guide.

Regulatory Considerations

Principles

- Pesticides contain active ingredients (the chemical that targets the pest) and inert ingredients such as solvents, surfactants, and carriers. Both active and inert ingredients may be controlled or regulated by federal, state, and local laws because of environmental and health concerns.

Best Management Practices

- Only apply pesticides that are registered in California.
- Only apply pesticides in a manner consistent with the label. The “Label is the Law.”
- If you have questions, contact your local County Agricultural Commissioner (CAC) or the California Department of Pesticide Regulation (DPR). Refer to the Contacts section for appropriate phone numbers.
- Only use pesticide products that are legally registered for use on the facility (for example, do not apply pesticides labeled for agricultural uses even though they may have the same active ingredient).
- Typically, pesticides permitted for outdoor use on golf course tees, greens, and fairways will include such language on the label.
- For more on pesticide use records, see the Record Keeping section of this Chapter.
- Stay up to date on the DPR Pesticide Safety Information Series (PSIS), which contains safety rules associated with pesticide applications in non-agricultural settings (e.g., golf courses).
- Be familiar with the Groundwater Protection List (GWPL). The GWPL dictates certain pesticides are designated as having the potential to pollute groundwater. See Chapter 13: Groundwater Management for a more information.

Human and Ecological Health Risks

Principles

- Recognize that risk is a combination of pesticide toxicity and exposure. In nearly any case, at a high enough dose, almost anything can be toxic. In other words, “The Dose Makes the Poison.”
- Pesticides belong to numerous chemical classes that vary greatly in their toxicity. The toxicity of a pesticide cannot be changed, but the exposure to a pesticide can be managed to reduce risk. For example, the risk of a highly toxic pesticide may be low if the exposure is sufficiently small.

Best Management Practices

- Always read and follow label directions.
- Select the least toxic pesticide.
- Use PPE, even if the label does not call for it.
- Know your course and its specific conditions. For example, be aware of soil types, depth to water, and the presence of any threatened, endangered, or listed species.
- If the label contains language describing potential environmental and/or ecological risk, such as potential injury to pollinators, fish or aquatic vertebrates, risk to groundwater, or risk to trees downslope of the application area, be certain to implement this information to reduce exposure.
- Certain pesticide active ingredients are listed as chemicals known to cause cancer, birth defects, or other reproductive harm under California Proposition 65. Use of these pesticides almost always requires that a warning be posted in a conspicuous location on the course. The Proposition 65 list is frequently updated and should be checked.
- DPR periodically publishes human health risk assessments and mitigations for pesticide active ingredients, including information about specific pesticide toxicity. Those risk assessment and mitigation documents can be found at http://www.cdpr.ca.gov/docs/whs/active_ingredient/index.htm
- Know emergency response procedures in case of an accidental spill or exposure.

Environmental Fate and Transport

Principles

- Environmental characteristics of a pesticide can often be determined by the environmental hazards statement found on pesticide product labels. The environmental hazards statement (referred to as “Environmental Hazards” on the label and found under the general heading “Precautionary Statements”) provides the precautionary language advising the superintendent of the potential hazards to the environment from the use of the pesticide. The environmental hazards

generally fall into three categories: (1) general environmental hazards, (2) non-target toxicity, and (3) endangered species protection.

Best Management Practices

- Recognize that the following characteristics influence the method that you use to treat a target pest and manage exposure to lessen the likelihood of adverse impacts to humans, ecological receptors, or the environment. This information can be found on the Safety Data Sheet (SDS) or supplied by the manufacturers' representative or your Pest Control Adviser (PCA).
    - Water Solubility: The degree to which a pesticide dissolves in water will determine what adjuvants, if any, your spray tank needs and what precautions you should take to prevent unintended effects. For example, highly water-soluble pesticides may be prone to leaching into groundwater, through a USGA green into the tile drains, or move in surface and storm water to downslope, sensitive trees.
    - Half-Life: The environmental half-life describes the time, usually in days, that the initial concentration is reduced by half. So, if you apply an herbicide at 10 oz/acre and it has a 2 day half-life, you can expect to find the equivalent of 5 oz/ac on the 2nd day after application, 2.5 oz/ac on the 4th day, etc. A half-life value is no more than an estimate and should be used with caution. Many factors can influence the half-life of a pesticide such as weather, soil temperature, soil type, etc. It is not unusual to have actual half-life values differ by several factors of 10.
    - Soil Binding Constant: This describes the "stickiness" (i.e., binding affinity) of a pesticide to soil and is measured using terms like Kd, Kf, and Koc. This characteristic is due to the chemical structure of the pesticide and may be due to the molecule having a positive charge (e.g., diquat, glyphosate) or causing it to behave like fat (i.e., lipophilic). Pesticides with higher binding affinities stick to soil whereas pesticides with lower binding affinities may move through the soil profile. Recognize that pesticides with a high binding affinity are more likely to move off-target with soil erosion. Pesticides with low soil binding affinities may be used in circumstances where hydraulic control is maintained such as in a USGA tile-drained green.
    - Vapor Pressure: This is a measure of the volatility of a pesticide. High vapor pressure pesticides can volatilize and potentially drift on hot and windy days.
- Before applying a pesticide, take into account the above characteristics and the characteristics of your course. Important course characteristics to be aware of include: proximity to surface water and stormwater drains, depth to groundwater and wells, soil type, weather patterns (including rain fall and prevailing wind), nearby parks or schools, and the presence of any threatened, endangered, or listed species.
- Reduce drift and overspray by avoiding application during adverse weather conditions, such as high winds, temperatures, and humidity. Avoid spraying at

>10 mph. Invest in a wind meter for assured wind conditions and good record keeping practices.
- Avoid applying pesticides when the wind direction is unfavorable, such as toward a sensitive site.
- Avoid applying in foggy conditions, that may result in a temperature inversion.
- Properly calibrate equipment and use coarse droplet sizes when possible. Large droplets have a tendency to produce less drift than spray from high pressure or small spray nozzle openings.
- Consider using spray technologies such as spray shields, drift guards, and/or air-induction nozzles to reduce drift.
- Keep ground booms low to the ground to reduce spray.
- Select pesticides with reduced impact on pollinators. See the Pollinator Chapter of this BMP Guide. Safety Data Sheets sometime contain information about pollinator toxicity/warnings and may be located at the CDMS website or through the manufacturer website.
- Select pesticides that are not expected to adversely impact non-target species on or near the course.
- See the Endangered Species Chapter of this guide for more about pesticide laws, injunctions, and agencies involved in protecting special-status species.

Pesticide Transportation, Storage, and Handling

Principles

- Storage and handling of pesticides can be done safely and effectively when the facility is properly sited, designed, constructed, and operated in accordance with state and local laws. California laws about the transportation, storage, and handling of pesticides can be found under 3 CCR 6670-6686. Contact your local CAC, Certified Unified Program Agency (CUPA), and Fire Department for guidance. The CUPA in your area is most likely the County Environmental Health Department. However, in some cases, such as Los Angeles and Oakland, the CUPA is the local Fire Department.
- Depending on the amount of pesticide you store, your course may be subject to California's Hazardous Materials Business Plan (HMBP) requirements. See the Maintenance Operations and the Planning, Design and Construction chapters for more information.
- If you have employees who handle pesticides, they should be appropriately trained.

Best Management Practices

- Mix and load pesticides away from sites that drain to surface water or are near conduits to groundwater such as a well head or porous soil underlain by shallow groundwater.

- Plumbed or self-contained eyewash or eye/facewash equipment which meets the requirements of sections 5, 7, or 9 of ANSI Z358.1-1981, Emergency Eyewash and Shower Equipment, incorporated herein by this reference, shall be provided at all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may come into contact with a substance which can cause corrosion, severe irritation or permanent tissue damage or which is toxic by absorption.
- Store pesticides as required by the CAC, CUPA or local fire department. Typical requirements may include one or more of the following:
    - Floors with a continuous sill to retain spilled materials and no drains, although a sump may be included.
    - Shelving made of sturdy plastic or reinforced metal.
    - Do not use wood shelving because it may absorb spilled pesticides.
    - Install automatic exhaust fans and an emergency wash station.
    - Install explosion-proof lighting with switches located outside the building so they can be turned on before staff enter the building and turned off after they leave the building.
- Pesticide Storage Areas are required to post signs visible from any probable direction of approach within 25 ft. The sign should include appropriate wording as found under 3 CCR 6674.
- Any warning notices should be repeated in non-English languages when it is feasible a person who does not understand English may come in contact with the enclosure.
- Maintain records of your pesticide inventory. Record trade name, active ingredient(s), signal word, quantity, and date of purchase.
- Pesticide SDSs should be stored separately from the storage room and be readily accessible on-site. SDSs are commonly available from the manufacturer or at http://www.cdms.net/label-database.
- Personal protective equipment (PPE) should be easily accessible and stored immediately outside the pesticide storage area in a clean, dry location.
- Do not transport pesticides in the passenger section of a vehicle.
- Never leave pesticides unattended during transport.
- Place a spill containment kit in the storage area, in the mix/load area, and on the spray rig.
- Store pesticides in original containers. It is prohibited for pesticides to be stored in any container commonly used for consumables household products, including but not limited to food and drink containers.
- Some pesticides can degrade over time, so don’t buy and store more than you need.
- Adopt a “first in–first out” inventory approach, using the oldest products first to ensure that the product shelf life does not expire.
- Place labels on every package and container. Use translucent tape over the top of labels as needed to keep them adhered and legible.
- Pesticide spills are often addressed in the same or similar manner as fuels, solvents, and oils and involve the use of Spill Prevention Control and Countermeasures (SPCC) plans and Hazardous Materials Business Plans

(HMBPs). These and related topics are covered in the Maintenance Operations Chapter.
- Have a written pesticide handler training program meeting requirements in 3 CCR 6724 that describes the materials and information used to train employees. Maintain a copy of the training program for 2 years after use.

Emergency Preparedness and Spill Response

Principles

- Accidents happen. Advanced preparation on what to do when an accident occurs is essential to mitigate the adverse impacts to human health and the environment.

Best Management Practices

- Develop a golf course facility emergency response plan which includes procedures to control, contain, collect, and dispose of spilled materials.
- Prominently post "Important Telephone Numbers for Spill Response" as follows:
    - 911
    - Local Fire Department
    - Local CUPA
    - California Governor's Office of Emergency Services, California State Warning Center: (800) 852-7550
        - If the spill is to a waterway, request that they notify the California Department of Fish and Wildlife (CDFW) and the Regional Water Quality Control Board (RWQCB)
    - If the spill is to a coastal waterway:
        - United States Coast Guard
            - San Francisco: (415) 399-3547
            - Los Angeles/Long Beach: (310) 521-3805
            - San Diego: (619) 278-7033
- Make an adequately sized spill containment kit readily available.
- Designate a spokesperson who will speak on behalf of the facility should an emergency occur.
- Host a tour for local emergency response teams (for example, firefighters, etc.) to show them the facilities and to discuss the emergency response plan. Seek advice on ways to improve the plan.
- Refer to the Maintenance Operations Chapter for additional information.

Mixing/Washing Station

Principles

- Pesticide leaks or spills, if contained, will not percolate down through the soil into groundwater or run off the surface to contaminate streams, ditches, ponds, and other waterbodies. One of the best containment methods is the use of a properly designed and constructed impervious pad with berms.

Best Management Practices

- Load and mix pesticides over an impermeable surface with berms (such as lined or sealed concrete), so that spills can be collected and managed.
- Mixing station surface should provide for easy cleaning and the recovery of spilled materials.
- Pump the sump dry and clean it at the end of each day. Liquids and sediments should also be removed from the sump and the pad whenever pesticide materials are changed to an incompatible product (that is, one that cannot be legally applied to the same site).
- Apply liquids and sediments as you would a pesticide, strictly following label instructions.
- Absorbents, such as cat litter or sand, may be used to clean up small spills and then applied as a topdressing in accordance with the label rates, or disposed of as a waste.
- Sweep up solid materials and use as intended.
- Only mix as much pesticide as you expect is needed to complete the job.

Pesticide Record Keeping

Principles

- Maintaining accurate records of pesticide-related activities (for example, purchasing, storage, inventory, applications, etc.) is essential.

Best Management Practices

- Although golf courses are not considered ‘agricultural’ by the USEPA, the DPR categorizes golf courses as ‘non-production agriculture’ as found in the Pesticide Use Enforcement Program Standards Compendium, Volume 8: Guidelines for Interpreting Pesticide Laws, Regulations, and Labeling.
- Submit monthly information on applications of pesticides to golf courses and associated landscape using Pesticide Use Reports (PURs) to your local CAC. The PUR form asks for the following information:

    1. Operator ID or license number
    2. County where the pest control was performed
    3. The month and year of pesticide use
    4. Site treated
    5. Pesticide used (including USEPA or State registration number on the label)

6. The number of applications made with each pesticide and the total number of applications made during the month. For applications in structures, the number of applications is not required.

- Non-production agricultural facilities in California are responsible for retaining pesticide use records for two (2) years as described under 3 CCR 6624.
- Certain pesticides are classified as Federal Restricted Use Pesticides (RUPs) and California restricted materials. Restricted pesticides will usually have a prominent label language stating the RUP or restricted material designation. If you are uncertain, check the DPR Product/Label Restricted Materials Database. Although restricted pesticides are not routinely used in turf maintenance, additional pre-application permitting and record- keeping requirements apply.
- Consistent with your course's IPM plan, record pesticide application information such as pest(s) present, threshold(s) exceeded, location, date, application method and rate, and efficacy to track and monitor pest control efforts and to plan future management actions.
- For more information on pesticide record keeping, see the Integrated Pesticide Management chapter.

Sprayer Calibration

Principles

- Properly calibrated application equipment is important for the following reasons:
    - Adherence to label instructions is mandatory. The label application rate that is called for must be used and can only be delivered by properly calibrated equipment.
    - The application rate on the label has been demonstrated to be effective. Using less than the label rate risks resistance development and poor performance. Using more than the label rate may unnecessarily use more pesticide than is needed to control the pest and may result in adverse impacts to on- and off-site, non-target species via run-off or drift.
    - Through the process of calibration, the spray equipment is inspected and loose or leaking fittings and hoses can be replaced. This proactive approach lessens the likelihood of a spill or release.

Best Management Practices

- Confirm that the spray technician is either a DPR Qualified Applicator License (QAL) holder, is a Qualified Applicator Certificate (QAC) holder, or is working under the direct supervision of one.
- The QAL and QAC have appropriate training to properly calibrate equipment and apply pesticides.
- Use the appropriate nozzles to minimize off-target movement and achieve the intended droplet size, spray width and overlap.

- Properly calibrate all application equipment using water at the beginning of each season (at a minimum) or after equipment modifications.
- Check equipment daily when in use.
- Calibration of walk-behind applicators should be conducted for each person, improving calibration quality by taking into consideration parameters of the individual (such as walking speed).

Types of Sprayers

Principles

- Various types and sizes of application equipment are readily available. Match the equipment (tank size, boom width, nozzle type, pressure, etc.) to your golf course's needs.

Best Management Practices

- Use the appropriate equipment size and type for your golf course.
- Use appropriate booms, nozzles, and pressure to avoid overspray and drift and meet the application rate specified on the label.
- Don't attempt using a boom sprayer when a backpack sprayer will do and vice versa.

Personal Protective Equipment

Principles

- Remember that risk is a combination of toxicity and exposure. Exposure to pesticides and resulting risk can be minimized by strict adherence to the label, including the use of PPE. Some pesticides are formulated as water soluble packages (WSP) and are self-contained in small packets that dissolve in water. This results in easy loading and mixing that minimizes exposure. Additionally, some pesticides come in closed containers that have connections compatible to spray equipment that allows for simply connecting the pesticide container to the application equipment without any mixing or loading. Check with your supplier on the availability of these tools.

Best Management Practices

- Always use PPE according to the label. Additionally, California has PPE requirements that should always be followed, found under 3 CCR 6700-6744.
- Provide adequate PPE for all employees who work with pesticides (including equipment technicians who service pesticide application equipment).
- Check that PPE is sized appropriately for each person using it.
- Make certain that PPE is appropriate for the pesticides used.

- Store PPE where it is easily accessible in a dry, clean, pesticide free storage area.
- Forbid employees who apply pesticides from wearing uniforms off the course where they may contaminate items they come in contact with.
- Provide laundering facilities or uniform service for employee uniforms.

Pesticide Container Disposal

Principles

- The containers of some commonly used pesticides are classified as hazardous waste if not properly rinsed, and as such, are subject to the many rules and regulations governing hazardous waste. The improper disposal of hazardous waste can result in expensive fines and/or criminal penalties. However, pesticide containers that have been properly rinsed can be handled and disposed of as nonhazardous solid waste. Federal law (FIFRA) and some state laws require pesticide applicators to rinse all empty pesticide containers before taking other container disposal steps. Under federal law (the Resource Conservation and Recovery Act, or RCRA), A PESTICIDE CONTAINER IS NOT EMPTY UNTIL IT HAS BEEN PROPERLY RINSED.

Best Management Practices

- Always follow label instructions for container rinsing. In some cases, this may include triple rinsing, removing the label, and cutting the container into pieces so it is no longer usable and can be disposed of as trash or recycled. If you have a question, call your local CAC or the manufacturer's representative.
- Do not re-use containers.
- Rinse pesticide containers immediately to remove maximum residue.
- Rinse containers during the mixing and loading process and add rinsate water to the finished spray mix.
- Do not throw away unused pesticide in the trash, pour it down the sink or toilet, or use it in any way not specified on the label. If you have unused or expired pesticide, check with your local CAC.

Frequently Asked Questions (FAQs)

1. I am unsure how to interpret language on a pesticide label. Where can I get guidance on label review? Who should I contact if I'm still unsure?

The California Department of Pesticide Regulation (DPR) has guidelines for interpreting pesticide laws and labels available in Pesticide Use Enforcement Program Standards Compendium, Volume 8. Your county agricultural commissioner (CAC) is an excellent resource to contact with interpretation of label language. The pesticide manufacturer's representative and the University of California Cooperative Extension (UCCE) are also valuable resources.

2. I am interested in learning more about applying pesticides safely in California. Is there a go-to source for non-agricultural setting pesticide application training aids?

DPR provides the Pesticide Safety Information Series (PSIS), which are leaflets available in English, Spanish, and Punjabi. The 'N' Series focuses on non-agricultural settings, including golf courses, and contains pesticide safety rules, guidance on pesticide products management (i.e., storage, movement, and disposal), and other information about working safely with pesticides. This series is updated periodically so check if you have the most recent version.

3. There is a school/daycare/park near my golf course. Where can I find more information about pesticide applications near schools and child care facilities?

Potential problems can result from drift of pesticides into areas occupied by people. Always read and follow label directions and pay attention to weather, including wind speed and direction. Your local CAC can advise you regarding regulations and best management practices addressing pesticide use near facilities where people may be present. If there is a risk of drift, do not apply.

4. Are there any special laws I should be aware of regarding pesticide applications in California?

First and foremost, the label is the law. All pesticides that are used in California must be registered for use by DPR and not just through the USEPA. If in doubt, confirm with your local CAC or DPR.

Some pesticides have use requirements that vary throughout California counties. For example, provisions for the use of soil fumigants can be found under3 CCR 6453-6489.

There are also laws that pertain to certain pesticides and endangered species. Please see the Endangered Species Chapter of this guide for more information.

Only pesticides labelled for aquatic use and listed on the State Water Resources Control Board (SWRCB) National Pollutant Discharge Elimination System (NPDES) Aquatic Pesticide Permit can be used to treat plants growing in Waters of the United States (WOTUS). Learn more here regarding the Aquatic Pesticide Permit and here regarding how a WOTUS is defined.

Some pesticides registered for use in California are included on the Proposition 65 ("Prop 65") list. Chemicals on the Prop 65 list are known to the state to cause cancer, birth defects, or other reproductive harm. This list is periodically updated and can be found at https://oehha.ca.gov/proposition-65/proposition-65-list. It is required by California law that businesses post warnings if citizens may be exposed to significant amounts of a Prop 65 chemical.

5. Are there any California-specific laws with respect to pesticide transportation, storage, and handling?

There are California laws specific to the transportation, storage, and handling of pesticides. These can be found at 3 CCR 6670 through 3 CCR 6686. Some of the main points include:

Store pesticides in a lockable concrete or metal building that is separate from other buildings. In the case of liquid pesticides in containers > 55 gallons, the container shall have a locked closure.

Pesticide Storage Areas are required to post signs visible from any probable direction of approach within 25 ft. The sign should include appropriate wording as found under 3 CCR 6674.

Any warning notices should be repeated in a non-English languages when it is feasible a person who does not understand English may come in contact with the enclosure.

See the Maintenance Operations Chapter for additional information about pesticide storage and handling.

6. What is a PUR? When do I need to submit one?

Although golf courses are not considered 'agricultural' by the USEPA, the DPR categorizes golf courses as 'non-production agriculture', as defined in the Pesticide Use Enforcement Program Standards Compendium, Volume 8. California requires that applications of pesticides to golf courses and associated landscape submit monthly Pesticide Use Reports (PURs) to their CAC, who report this data to DPR. Your CAC contact information may be found here.

Generally, clubhouses and associated landscaping do not require reporting unless the application is made by a licensed agricultural or structural Pest Control Business or the pesticide is a Restricted Material as listed under 3 CCR 6400 (see below).

7. What are Restricted Materials and Restricted Use Pesticides (RUPs)?

Although not commonly used in golf course settings, Restricted Materials (CA) and Restricted Use Pesticides (RUPs)(Federal) have special laws due to their high toxicity. These products will say 'Restricted Use Pesticide' on the label. Pesticide products can be restricted federally and/or in California. For more information about permitting, definitions, and regulator use requirements, you can view the DPR Pesticide Use Enforcement Program Standards, Compendium Volume 3.

A list of California Restricted Materials can be found on DPR's webpage: http://www.cdpr.ca.gov/docs/enforce/dpr-enf-013a.pdf

8. How do I get the most recent labels and safety data sheets for California registered pesticides?

The Crop Data Management System (CDMS) label database is an excellent source of the most recent pesticide labels and SDSs. You can also visit the manufacturer website which often contains product labels and SDSs.

9. What should I know about Personal Protective Equipment (PPE) in California when applying or handling pesticides?

- Use PPE in accordance with label language and any additional California PPE requirements found under 3 CCR 6700 – 3 CCR 6744.
- Worker safety regulations may change over time. For instance, in 2018, if a pesticide label requires protective eyewear, then an eyewash station must be available for handlers at the mix/load site.

10. I would like to know more about pesticides as they relate to groundwater. Where can I find more information?

See the Groundwater chapter for information about BMPs and regulations related to pesticide use and groundwater.

11. I understand that certain cities like Berkeley and Counties like Marin, San Francisco, and San Mateo have pesticide rules that differ from DPR. How can I learn more about rules specific to my area?

Contact your local CAC

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

California Code of Regulations, Title 3, Section 6400: Restricted Materials. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/020401.htm

California Code of Regulations, Title 3, Section 6453-6489: Use Requirements. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/020404.htm

California Code of Regulations, Title 3, Section 6670-6686: Storage, Transportation, and Disposal. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/030204.htm

California Code of Regulations, Title 3, Section 6674: Posting of Pesticide Storage Areas. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/030204.htm

California Code of Regulations, Title 3, Section 6700-6744: Pesticide Worker Safety. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/030302.htm

California Code of Regulations, Title 3, Section 6724: Handler Training. Available at: https://www.cdpr.ca.gov/docs/legbills/calcode/030302.htm

California Code of Regulations, Title 3, Section 6800: Groundwater Protection List:

http://www.cdpr.ca.gov/docs/legbills/calcode/040101.htm

California Code of Regulations, Title 8, Section 3380: Personal Protective Devices. Available at: https://www.dir.ca.gov/title8/3380.html

California Code of Regulations, Title 8, Section 5144: Respiratory Protection. Available at: https://www.dir.ca.gov/title8/5144.html

California Department of Food and Agriculture. 2020. Links to County Agriculture/Weights & Measures Departments. Available at https://www.cdfa.ca.gov/exec/county/countymap/

California Department of Pesticide Regulation (DPR). 2014. Pesticide Use Enforcement Program Standards Compendium Volume 8, Guidelines for Interpreting Pesticide Laws, Regulations, and Labeling. Available at: http://www.cdpr.ca.gov/docs/enforce/compend/vol_8/entire_manual.pdf

California Department of Pesticide Regulation (DPR). 2015. Pesticide Use Enforcement Program California Restricted Materials Requirements. Available at: https://www.cdpr.ca.gov/docs/enforce/dpr-enf-013a.pdf

California Department of Pesticide Regulation (DPR). 2018. Human Health Risk Assessment and Mitigation by Active Ingredient. Available at: https://www.cdpr.ca.gov/docs/whs/active_ingredient/index.htm

California Department of Pesticide Regulation (DPR). 2018. Pesticide Use Enforcement Program Standards Compendium Volume 3, Restricted Materials and Permitting. Available at: https://www.cdpr.ca.gov/docs/enforce/compend/vol_3/entirerep.pdf

California Department of Pesticide Regulation (DPR). 2018. Product/Label Database Queries & Lists: Pesticide Products Registered as Restricted Materials. Available at: https://apps.cdpr.ca.gov/label/restricted.cfm

California Department of Pesticide Regulation (DPR). 2018. Worker Health and Safety Branch Pesticide Safety Information Series. Available at: https://www.cdpr.ca.gov/docs/whs/pdf/entire_series.pdf

Code of Federal Regulations, Standard Number 1910.134: Respiratory Protection. Available at: https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.134

Crop Data Management System (CDMS) Label Database. 2018. Available at http://www.cdms.net/label-database

Office of Environmental Health Hazard Assessment (OEHHA). 2018. Businesses and Proposition 65. Available at: https://oehha.ca.gov/proposition-65/businesses-and-proposition-65

Office of Environmental Health Hazard Assessment (OEHHA). 2018. The Proposition 65 List. Available at: https://oehha.ca.gov/proposition-65/proposition-65-list

State Water Resources Control Board (SWRCB). National Pollutant Discharge Elimination System (NPDES). Available at: https://www.waterboards.ca.gov/water_issues/programs/npdes/pesticides/weed_control.html

United States Environmental Protection Agency. Section 404 of the Clean Water Act: Definition of “Waters of the United States (WOTUS)” Under the Clean Water Act. Available at: https://www.epa.gov/cwa-404/definition-waters-united-states-under-clean-water-act

Chapter 9: Pollinator Protection and Enhancement

Overview of Pollinator Protection

Flowering groundcover and landscape plantings on a golf course produce pollen and/or nectar that is attractive to pollinators. Pollinators include native bees, honey bees, butterflies, birds, and bats. The western honey bee (Apis mellifera) is one of the most important pollinators in the United States. Hundreds of other bee species, including the bumble bee (Bombus spp.), also serve as important pollinator species. California native bees include carpenter bees, digger bees, mining bees, mason bees, sweat bees, leafcutting bees, and cuckoo bees. Another important pollinator species in some parts of California is the Monarch butterfly.

In recent years, global scientific and regulatory communities have noticed a decline in the general health of honey bees, which may be caused by multiple stressors that include pests, pathogens, viruses, pesticide exposure, poor nutrition, habitat loss, and drought.

All embedded hyperlinks below can be found in the References section of this guide.

Common Threats to Pollinators

Principles

- Insecticides: Drift to non-target locations is a potentially significant threat to pollinators. Pollinators may drink water sources containing insecticide residue or dew on recently treated plants. Several classes of insecticides may be injurious to pollinators and include organophosphates (e.g., chlorpyrifos), carbamates (e.g., carbaryl), neonicotinoids (e.g., imidacloprid), and pyrethroids (e.g., permethrin).
- Habitat Modification: Depending on the amount and type of vegetation around the golf course and the manner in which it is controlled (mowing, cutting, grazing, use of herbicides, etc.), nectar and/or pollen sources for pollinators may be temporarily or permanently reduced.
- Colony Collapse Disorder is a phenomenon generally described by worker bee abandonment of healthy hives, leaving a helpless queen, nurse bees, and larvae to die without access to nectar and pollen. This disorder is thought to be due to a combination of improper insecticide use, changing climates, parasites (e.g., varroa mite), and urban development.

Best Management Practices

- Pollinator-protection language, if applicable, is a label requirement found on pesticide labels. Always follow the label, it is the law. For example, insecticide application during blooming, or during the middle of the day when pollinators are actively foraging, should be avoided.

- Use Integrated Pest Management Practices (IPM). Refer to the IPM chapter for pest identification, threshold tolerance setting, control techniques, and record keeping tips.
- Know your pesticides. Refer to the Pesticide chapter to understand the importance of reading and understanding the pesticide label and the warnings related to drift and potential impacts to non-target organisms, including pollinators.
- Reduce Drift. Monitor wind speed and direction, use coarse-droplet producing nozzles, and use drift control agents in the tank mix.
- Beekeepers are required to register their hives with the local County Agricultural Commissioner so that they can be made aware of pesticide applications that may be injurious to bees. If your golf course is near crops (e.g., oranges, almonds, and sunflowers) that are commercially pollinated, knowing about the presence of pollinators may be helpful when making pest control decisions.
- Local ordinances may exist in your county. For example, there are specific pollinator protection laws within 1 mile of citrus farming areas of Fresno, Kern, or Tulare counties from March 15 through May 15. Notification requirements exist in Butte, Glenn, and Tehama Counties. Contact your local Agricultural Commissioner for details.
- Post flyers and signs that educate the public on actions the golf course is taking to protect pollinators.
- Develop new and/or enhance monarch butterfly, bumblebee, or other pollinator habitats.

Frequently Asked Questions (FAQs)

1. I know that Monarch Butterflies are important pollinators that are often well known by the public. What should I know and where can I learn more?

Invested stakeholders, such as the Monarchs in the Rough Program and Xerces Society, are available to assist superintendents with information and technical support to beautify golf courses while participating in the monarch/pollinator protection movement.

However, be aware that planting milkweed indiscriminately is not advised. San Francisco lepidopterist Liam O'Brien suggests that If you live in Northern San Mateo County or San Francisco County, do not plant milk weed. This is because if the plant was never there, introduction of milkweed may unintentionally disrupt monarch overwintering, reproduction, or migration behavior. See more information here: https://baynature.org/article/plant-milkweed-save-monarchs/

Similarly, the Xerces Project booklet Managing for Monarchs in the West discusses the importance of using native milkweed species. Among other reasons, the use of year-round, tropical milkweed species may result in greater risk of monarch parasites, such as Ophryocystis elektroscirrha (OE).

To keep up-to-date on the status of the monarch butterfly, visit the U.S. Fish and Wildlife Service Assessing the Status of the Monarch Butterfly.

2. What plants should I consider using if I want to attract pollinators?

According to the Xerces Society, California native plants support between 1,200-1,500 native bee species and over 200 butterfly species. The Xerces Society provides region-specific California information about hedgerows, plants, and seed mixes, as well as links to information on pollinator habitat and biology: http://xerces.org/pollinators-california-region/

Use seeding and transplants to establish native landscape plants that are adapted to local regions. Custom seed mixes are available that contain pollinator/monarch-friendly wildflowers, specified by California region (e.g., “Central Valley Wildflowers”). These can be purchased from a variety of sources including Hedgerow Farms Seed Store: https://www.hedgerowfarms.com/online-store

3. What are California-specific regulations regarding pollinators that I need to keep in mind?

Contact your local County Agricultural Commissioner. See the Regulations and Pollinators sources in the References section of this guide for more details.

4. Where can I read California-specific laws and regulations regarding the notification of beekeepers in specific counties?

For California Laws Pertaining to Bee Management and Honey Production, see the California Department of Food and Agriculture (CDFA)Laws Pertaining to Bee Management and Honey Production and California Laws Pertaining to the Protection of Bees.

5. I understand that some insecticides have a lower potential impact on pollinators and this is related to the residual toxicity (RT). Where can I learn more?

Information on pesticide active ingredient residual time to 25% mortality (RT25) can be found tabulated on the USEPA webpages below:

https://pesticidestewardship.org/wp-content/uploads/sites/4/2016/07/rt25-data-revised.pdf

https://www.epa.gov/pollinator-protection/residual-time-25-bee-mortality-rt25-data#about

6. How can I find out about the location of bee hives in my area so that I don’t impact them as a result of the pesticide use??

The California Agricultural Commissioners and Sealers Association (CACASA), the California Association of Pest Control Advisors (CAPCA), the California Department of Food and Agricultura (CDFA), and California Department of Pesticide Regulation (CDPR) have collaborated to create an online registration and mapping tool that connects County Ag departments and Pest Control Advisers (PCAs) to bee colony information. The mapping tool, BeeWhere, allows for a determination of bee colonies within a mile of a planned pesticide application. Pesticide applicators can check the status of the BeeWhere tool through www.beewherecalifornia.com. The BeeWhere website is in the pilot phase, and therefore the website reminds users to check with the local Agricultural Commissioner's Office until the BeeWhere tool reaches full capabilities.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Regulations and Pollinators

California Code of Regulations 3 CCR 6656. 2001. Citrus/Bee Protection Area. Available at : https://govt.westlaw.com/calregs/Document/I9F670E90D45A11DEB97CF67CD0B99467?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

CDFA California Laws Pertaining to Bee Management and Honey Production. Available at: https://www.cdfa.ca.gov/plant/pollinators/docs/Laws-Bee-Management.pdf

CDFA California Laws Pertaining to the Protection of Bees: https://www.cdfa.ca.gov/plant/pollinators/docs/Regulations-for-Protection-of-Bees.pdf

Pesticides and Pollinators

BeeWhere: Available at: https://beewherecalifornia.com/register-here/

Pesticide Environmental Stewardship. Pesticide Toxicity to Bees: Available at: https://pesticidestewardship.org/pollinator-protection/pesticide-toxicity-to-bees/

Pesticide Environmental Stewardship. Read and Follow the Label. Available at : https://pesticidestewardship.org/pollinator-protection/read-and-follow-the-label/

U.S. Environmental Protection Agency (USEPA). 2018. Residual Time to 25% Bee Mortality (RT25) Data: https://www.epa.gov/pollinator-protection/residual-time-25-bee-mortality-rt25-data#about

U.S. Environmental Protection Agency (USEPA). Tips for Reducing Pesticide Impacts on Wildlife. Available at: https://www.epa.gov/safepestcontrol/tips-reducing-pesticide-impacts-wildlife

Washington State Department of Agriculture (WSDA): 2013. 10 Ways to Protect Bees from Pesticides. Available at: https://agr.wa.gov/fp/pubs/docs/388-TenWaysToProtectBeesFromPesticides.pdf

Cultural Practices, Landscape, and Pollinators

California Department of Pesticide Regulation (DPR). 2018. California's Managed Pollinator Protection Plan (MP3). Available at: http://www.cdpr.ca.gov/docs/enforce/pollinators/ca_managed_pollinator_protection_plan.pdf

Larson, J.L., R.C. Williamson, and P.J. Liesch. 2016. Conservation of Native and Domestic Pollinators in Managed Turfgrass Landscapes. University of Wisconsin-Extension. Available at:: https://learningstore.uwex.edu/Conservation-of-Native-and-Domestic-Pollinators-in-Managed-Turfgrass-Landscapes-P1812.aspx

Monarch Joint Venture. Ophryocystis elektroscirrha (OE) Factsheet. Available at https://monarchjointventure.org/images/uploads/documents/Oe_fact_sheet.pdf (Accessed: May 16th, 2019).

North Central IPM Center. 2016. BMPs Best Management Practices for Turf Care and Pollinator Conservation: Available at: https://www.ncipmc.org/action/bmpturf.pdf

North Central IPM Center. Best Management Practices for Turf Care and Pollinator Conservation Fast Facts. Available at: https://www.ncipmc.org/action/fastfactsbmpturf.pdf

The Pollinator Partnership. 2019. Ecoregional Planting Guides. Available at: http://pollinator.org/guides

USDA Natural Resources Conservation Service Resources: Insects and Pollinators. Available at: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/plantsanimals/pollinate/

USDA Natural Resources Conservation Services: Working Lands for Monarch Butterflies Factsheet. Available at: https://www.nrcs.usda.gov/wps/PA_NRCSConsumption/download?cid=nrcseprd1369640&ext=pdf

Williamson, R. Chris. 2018. Pollinators in the Turfgrass Ecosystem: Best Management Practices. GCM Online. Available at: https://www.gcmonline.com/news/pollinator-best-management-practices

Xerces Society Pollinator Conservation Resources. Available at: http://xerces.org/pollinators-california-region/

Chapter 10: Maintenance Operations

Overview of Maintenance Operations

The storage and use of fuel, oil and chemicals used for golf course equipment operation and maintenance requires compliance with a variety of California regulations to protect worker health and safety and the environment.

Pesticide storage and use is discussed in Chapter 8: Pesticide Management.

All embedded hyperlinks below can be found in the References section of this guide.

Storage and Handling of Chemicals

Principles

- Proper handling and storage of pesticides and petroleum-based products is important to protect worker safety and the environment and comply with regulations. Non-compliance may result in significant fines and penalties.
- Certain chemicals are listed as chemicals known to cause cancer, birth defects, or other reproductive harm under California Proposition 65. Use of these chemicals almost always requires that a warning be posted in a conspicuous location on the course. The Proposition 65 list is frequently updated and should be checked regularly.
- The California Air Resources Board (CARB) and regional air pollution control districts (APCDs) often have jurisdiction over a variety of issues that include fuel storage and diesel emissions. The local APCD should be consulted to determine requirements.

Best Management Practices

- Individuals conducting emergency chemical cleanups should be properly trained under requirements of California Occupational Safety and Health Administration (Cal/OSHA) and federal Occupational Safety and Health Administration (OSHA).
- Maintain detailed records of current chemical inventory. Safety Data Sheets (SDS) for each chemical should be made available to all employees.
- Ensure that oil containers and small fuel containers (service containers) are properly labeled and stored within the facility.

Equipment Storage and Maintenance

Principles

- Storing and maintaining equipment properly will extend useful life, reduce repairs, protect the environment and help meet regulatory compliance requirements.

Best Management Practices

- Store and maintain equipment in a covered area on a concrete or similar impervious surface to limit the risk of fuel, lubricant and fluid leaks from impacting soil or water.
- Store equipment in areas protected from rainfall to increase equipment longevity and reduce unnecessary maintenance. This also prevents rain from washing lubricants from the exterior of the equipment and possibly impacting soil or water.
- Seal floor drains unless they are connected to a holding tank or sanitary sewer with permission from the local wastewater treatment plant.
- Perform maintenance activities that uses solvents, fuel, oil, antifreeze, etc. indoors and away from storm drains or locations that lead to storm drains or surfacewater.
- Store solvents and degreasers in an appropriately rated flammable metal cabinet away from ignition sources in a well-ventilated area.
- Always use appropriate PPE when working with solvents.
- Never allow oil, fuel, antifreeze, solvents or degreasers to drain to waterbodies, wetlands, storm drains, sewers, or septic systems.

Waste Management

Principles

- Proper disposal of waste materials is critical for protection of water and natural resources.
- The County Certified Unified Program Agency (CUPA) has responsibility for enforcing many of the rules related to waste management.
- It is critical to differentiate and segregate hazardous waste from other types of waste.
- Empty pesticide containers as discussed in Chapter 8: Pesticide Management.

Best Management Practices

- Details on handling of pesticide-related waste is included in Chapter 8. Pesticide Management.
- Used oil, oil filters, antifreeze, solvents, batteries and fluorescent lights should not be disposed of with typical trash and instead should be segregated and disposed of at your local county landfill or with appropriate vendors who hold State of California and USEPA licenses for such work.

- Numerous vendors exist that provide oil and solvent recycling and disposal. They include Clean Harbors, Stericycle and Safety-Kleen. Your fuel and lubricant supplier may have other suggestions or themselves be able to provide this service.
- Place recycling receptacles in the maintenance facility for paper and plastic and aluminum containers

Equipment Washing

Principles

- Wash water generated from equipment-washing facilities can be a source of potential impacts to soil and surfacewater and groundwater.

Best Management Practices

- Equipment washing areas should drain to an oil/water separator before draining to a sanitary sewer or holding tank.
- Consider the use of a closed-loop wash-water recycling system.
- Grass-covered equipment should be brushed or blown off with compressed air before being washed. Use of compressed air instead of washing with water is often easier on hydraulic seals, can lead to fewer oil leaks and doesn't use water or generate wash water that may contain grass clippings, oil, lubricants, etc.
- Spring-operated shut-off nozzles should be used.
- Do not allow any wash water to flow into creeks, streams, swales or drainages or to storm drains.
- To the extent practicable, use biodegradable non-phosphate detergents and non-solvent based degreasers like Simple Green®.

Fueling Facilities

Principles

- Safe storage of fuel, oil and hazardous materials and waste, including use of above-ground tanks and containment facilities, is critical to worker safety and the protection of the environment.
- Applicable regulations are implemented by the local CUPA, who in most cases in the County Environmental Health Department (EHD). For example, the County EHD enforces California's Aboveground Petroleum Storage Act (APSA) and the associated Spill Prevention Control and Countermeasures (SPCC) and Hazardous Materials Business Plan (HMBP) programs.
- The CARB is responsible for certification procedures for vapor recovery systems in aboveground storage tanks.

Best Management Practices

- Locate fueling facilities on concrete (not asphalt) pavement in a well-lit area.
- Make fire suppression and spill-containment equipment available.
- Use of double walled above ground fuel tanks (ConVault®) when feasible.
- Depending on amount of fuel stored (typically greater than 1,320 gallons) and other factors, the course may need to meet the requirements of California's APSA or the Federal SPCC program.
- Contact your local air quality management district to determine applicable requirements for your aboveground storage tanks.
- See the Frequently Asked Questions (FAQs) at the end of this chapter for details.

Pollution Prevention

Principles

- Although not currently subject to State Water Resources Control Board (SWRCB) Industrial General Permit (IGP) rules, it is important to prevent pollution from occurring during rain events. This includes preventing grass clippings, sediment and petroleum from entering storm drains or running off of the course.
- If the course is undergoing renovation or is a new course under construction, in addition to local grading and construction permit requirements, activities may require a SWRCB Construction General Permit (CGP). This permit requires BMPs to prevent erosion and sedimentation that may impact surfacewater. More information on the permit is available at https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

Best Management Practices

- Refer to Chapter 8: Pesticide Management for BMPs associated with the storage and use of pesticides.
- Never discharge equipment wash water or other material to the sanitary sewer system without written permission from the utility.
- Never discharge equipment wash water or other material to a septic tank.
- Use a closed-loop wash-water recycling system and follow appropriate BMP.
- See the FAQs at the end of this chapter.
- For more information about stormwater, see Chapter 3: Surfacewater Management.

Frequently Asked Questions (FAQs)

1. What role does Cal/OSHA play for golf courses?

Cal/OSHA plays a role in:

- Injury and Illness Recordkeeping and Reporting
- Emergency Preparedness and Response
- Medical and First Aid
- Hazard Communication
- Personal Protective Equipment
- Occupational Noise Exposure
- Performing inspections

Information on keeping an injury and illness prevention program IIIP), Emergency Action Plan development, personal safety devices and safeguards, hazard communication, and checklists for OSHA inspections, see the Cal/OSHA website:

https://www.dir.ca.gov/dosh/dosh1.html

2. What is considered hazardous waste in California?

Hazardous waste, as defined by the California Department of Toxic Substances Control (DTSC), is liquid, solid, or contained gas waste with properties that make it potentially dangerous or harmful to the environment or human health. For example, hazardous waste can include discarded used materials or unused commercial products, such as fuel, antifreeze, solvents or batteries.

There are four categories of hazardous waste that are found under 22 CCR 66261. Wastes may be considered hazardous if they are ignitable, corrosive, reactive, or toxic.

For more about what is considered hazardous waste by the DTSC, see https://www.dtsc.ca.gov/HazardousWaste/.

3. How is waste classified in California?

Waste is classified as either hazardous or non-hazardous under the federal Resource Recovery and Conservation Act (RCRA) or State of California rules implemented DTSC.

Hazardous waste can be further divided into RCRA hazardous waste, non-RCRA hazardous waste, or universal waste. A RCRA waste falls under one of three lists created by the U.S. EPA, known as the “F” List, “K” List, or “P/U” List, found under 40 CFR 261.31, 40 CFR 261.32, and 40 CFR 261.33. Non-RCRA hazardous waste is

waste that is regulated in the state that is not RCRA hazardous waste and can be described under 22 CCR 66261.101.

4. I have an aboveground petroleum storage tank. What do I need to do to be compliant with the Aboveground Petroleum Storage Act (APSA)?

The Aboveground Petroleum Storage Act (APSA) is a California statute that is implemented, enforced, and administered by the California Fire Office of the State Fire Marshal. From a practical standpoint, the local county CUPA or fire department often takes a lead role in assessing compliance.

A facility is regulated under APSA if it has a total capacity of 1,320 gallons or more of petroleum in aboveground storage tanks, including tanks in underground areas. In addition, if a facility has a total capacity of less than 1,320 gallons of petroleum and has one or more tanks in an underground area, then only the tanks in an underground area are subject to APSA. Learn more at: http://osfm.fire.ca.gov/cupa/apsa

A good example of the APSA compliance program in Imperial County is available here: https://www.dtsc.ca.gov/HazardousWaste/CUPA/Imperial_CUPA_APSA.cfm

5. Where can I learn more about California hazardous waste regulations?

The DTSC is the lead agency in California hazardous waste management. You can view the laws, regulations, policies, and fee summaries at http://www.dtsc.ca.gov/LawsRegsPolicies/index.cfm. California Code of Regulations (CCR) for hazardous waste can be found under 22 CCR.

6. Are there special considerations by county for hazardous waste planning and reporting?

The minimum requirements for hazardous waste management in California apply in all counties. However, some counties may have different reporting thresholds or stricter requirements that are typically enforced by the County CUPA. However, in some cases, such as Los Angeles and Oakland, the CUPA is the local Fire Department.

Depending on the amount of fuel, oil and hazardous materials you store, your course may be subject to California's Hazardous Materials Business Plan (HMBP) requirements. Once completed, HMBPs are uploaded to the California Environmental Reporting System (CERS) found here: https://cers.calepa.ca.gov/

7. I've never heard of an HMBP. What is that?

For purposes of an emergency response to any hazardous material mishap, an Hazardous Materials Business Plan (HMBP) is required to assist first responders like

the Fire Department. Specifically, if your course handles a hazardous material in quantities equal to or greater than 500 pounds of a solid substance, 55 gallons of a liquid, 200 cubic feet of a compressed gas calculated at standard temperature and pressure, or threshold planning quantities of an extremely hazardous material, an HMBP is required.

The HMBP is submitted electronically via California's Environmental Reporting System (CERS) website at http://cers.calepa.ca.gov/ for review by your local county CUPA or other agency. The HMBP consists of the following:

1. Inventory of Hazardous Materials and/or Extremely Hazardous Materials
2. Annotated Site Map
3. CERS Consolidated Emergency Response/Contingency Plan
4. Emergency Procedures

Submittal of the HMBP inventory shall meet the Emergency Planning & Community Right-to-Know Act (EPCRA) if the following are submitted with the inventory (Title 19 Section 2729.6):

- Business Activities page of the Unified Program Consolidated Form
- •Substantiation to Accompany Claims of Trade Secrecy" Form (40 CFR Section 350.27) if the business wishes to claim trade secrecy in accordance with 40 CFR Part 350, to USEPA.
- Chemical Description Page(s), for each extremely hazardous substance, containing an original signature, a photocopy of the original signature, or a signature stamp. This signature may be placed in the box for locally collected information.

8. Is my fleet of off-road diesel- powered vehicles subject to California Air Resources Board (CARB) reporting requirements?

All self-propelled off-road 25 horsepower (hp) or greater used in California are subject to reporting through the Diesel Off-Road Online Reporting System (DOORS). This includes vehicles that are leased.

The overall purpose of the Off-Road regulation is to reduce emissions of oxides of nitrogen (NOx) and particulate matter (PM) from off-road diesel vehicles operating within California.

The requirements and compliance dates of the Off-Road regulation vary by fleet size. Reporting can be completed using DOORS, which is ARB's free online reporting tool for the Off-Road regulation. Information as well as the online reporting tool is available at https://ssl.arb.ca.gov/ssldoors/doors_reporting/doors_login.html

More information on in-use off-road diesel fueled fleets regulation may be found in the Air Quality chapter and on the ARB website.

9. If I have a hazardous material or hazardous waste spill, what do I do?

First, protect yourself, your employees, and others around you. Depending on what was spilled and the volume and location, equipment available and the training your staff has had, you may be able to address this with in-house resources.

However, depending on any immediate threats to life and safety, the size, area, magnitude and volume of the spill and its proximity to water, the following agencies may need to be contacted:

Local Fire Department	911 or Area Dependent
Local County CUPA	Area Dependent. See v
Hazardous Materials Contractor (may be the same one used for hazmat pickup)	Area Dependent
California Governor's Office of Emergency Services (OES)	(800) 852-7550
California Regional Water Quality Control Board (RWQCB)	Area Dependent, See St https://www.waterboa
US EPA Regional Administrator	(415) 947-8000
National Response Center	(800) 424-8802
CHEMTREC (24/7 public service hotline for first responders)	(800) 424–9300

The above phone numbers, along with the superintendent's and general manager's phone numbers, should be posted in a conspicuous place in the maintenance facility in the event that this information is needed.

10. What sort of products are available for vehicle washing in maintenance operations?

As published by the Sacramento County Environmental Management Department, some products available for vehicle washing include:

- Vacu-Boom collection system information is available at: http://www.vacuboom.com/
- Portable wash pad information is available at: www.hydroblaster.com/HydropadPortableWashRack.htm
- Inflatable wash pad information is available at www.morclean.com (see inflatable wash pad)
- Temporary Storm drain cover information is available at www.carwashguys.com/stormdrainprot.shtml

- Shop/Industrial vacuum information is available at http://www.shopetsonline.com/default.asp
- Containment Dyke & Spill Containment Berm information is available at www.newpig.com/us/stormwater-management/containment/spill-containment-berms/
- Waterless car washing product information is available at www.waterless-wash.com/

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

California Air Resources Board (CARB). 2019. Diesel Off-Road Online Reporting System (DOORS). Available at https://ssl.arb.ca.gov/ssldoors/doors_reporting/doors_login.html

CAir Resources Board (CARB). 2019. Knowledge center for the un-use off-road diesel-fueled fleets regulation. Available at https://www.arb.ca.gov/msprog/ordiesel/knowcenter.htm

California Code of Regulations, Title 22, Division 4.5: Identification and Listing of Hazardous Waste. Available at: https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=IA168A950D4BA11DE8879F88E8B0DAAAE&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)

California Code of Regulations, Title 22, Section 66261.101: Non-RCRA Hazardous Waste. Available at https://govt.westlaw.com/calregs/Document/IA653F820D4BA11DE8879F88E8B0DAAAE?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

California Department of Toxic Substances Control (DTSC) Imperial CUPA Aboveground Petroleum Storage Act Program. Available at: https://www.dtsc.ca.gov/HazardousWaste/CUPA/Imperial_CUPA_APSA.cfm

California Department of Toxic Substances Control (DTSC): Laws, Regulations, and Policies. Available at: http://www.dtsc.ca.gov/LawsRegsPolicies/index.cfm.

California Environmental Protection Agency: California Environmental Reporting System (CERS). Available at: https://cers.calepa.ca.gov/

California Office of the State Fire Marshal: Aboveground Petroleum Storage Act. Available at http://osfm.fire.ca.gov/cupa/apsa

Cal/OSHA. 2019. Homepage. Department of Industrial Relations. Available at https://www.dir.ca.gov/dosh/dosh1.html

Sacramento County. 2008. Preventing Stormwater Pollution: Your Guide to BMPS for Pressure Washing and Surface Cleaning in the Greater Sacramento Area. Available at http://www.beriverfriendly.net/docs/files/File/Brochures/PressureWashing_BMPs_Dec08.pdf

State Water Resources Control Board (SWRCB). 2018. Construction Stormwater Program. Available at https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

Code of Federal Regulations Title 40, Section 261.33: Discarded commercial chemical products, off-specification species, container residues, and spill residues thereof. Available at https://www.law.cornell.edu/cfr/text/40/261.33

Code of Federal Regulations, Title 40, Section 261.31: Hazardous wastes from non-specific sources. Available at https://www.law.cornell.edu/cfr/text/40/261.31

Code of Federal Regulations, Title 40, Section 261.32: Hazardous wastes from specific sources. Available at https://www.law.cornell.edu/cfr/text/40/261.32

Department of Toxic Substances Control (DTSC): Hazardous Waste. Available at: https://www.dtsc.ca.gov/HazardousWaste/

Office of Environmental Health Hazard Assessment (OEHHA). 2018. The Proposition 65 List. Available at: https://oehha.ca.gov/proposition-65/proposition-65-list

Chapter 11: Landscape & Out of Play Areas

Overview of Landscape Management

Landscape and Out-of-Play areas are an essential part of the overall course design and provide many benefits including enhanced course aesthetics, wildlife habitat, flood plain, noise abatement and wind breaks.

All embedded hyperlinks below can be found in the References section of this guide.

Plant Species Selection and Size Considerations

Principles

- The fundamental principle for the environmentally sound management of landscapes is “right plant, right place.” The ideal plant from an environmental standpoint is a native plant that has adapted specifically to the soil, microclimate, rainfall, and light patterns, insects, and other pests, and endemic nutrient levels.
- Know the ultimate sizes and growth rates of trees, shrubs, and ground covers. This reduces the need for pruning and debris removal and lowers maintenance costs.

- Landscape areas should be designed to conserve water and require no to low nutritional input.
- Native vegetation in non-play areas should can enhanced through the supplemental planting of other native trees, shrubs, and herbaceous vegetation to provide wildlife habitat and buffers protect water resources.
- Leaving dead trees (snags) in areas adjacent to water where they do not pose a hazard combine with a well-developed understory (brush and young trees) and native grasses to support a diverse riparian habitat.

Best Management Practices

- When constructing or enhancing a non-play area, select plants adapted to the local ecosystem that are able to establish and grow in the soil, microclimate, rainfall, light patterns, insects and other pests, and endemic nutrient levels over many years.
- Select trees, plants, and grass species to attract birds seeking wild fruits, herbs, seeds, and insects.
- Know the ultimate sizes and growth rates of trees, shrubs, and ground covers.
- Select stress-tolerant species or cultivars to manage periodic dry/wet conditions.
- Choose the most stress-tolerant species or cultivar for a particular area.
- Refer to Chapter 6: Cultural Practices for guidance on plant selection.

Trees

Principals

- Trees provide shade, nesting habitat and aesthetics to a course. Keep in mind that shade cast by trees can change dramatically based on season.
- Tree maintenance, including trimming, correct irrigation, and pest control are critical to tree health and longevity.
- Trimming to maintain proper structure and balance, in addition to safety, is critical

Best Management Practices

- The purpose and/or function of any added tree must be defined prior to planting.
- Create an inventory of all primary trees in the golf course and evaluate them to help determine planting needs. Record information such as location, condition, appearance, site conditions and sun angles, and impacts on turf, design, play, and other nearby trees.
- Choose trees suitable to specific site conditions. Resources such as The National Arbor Day Foundation offers a tree database. Link: https://www.arborday.org/trees/ Nurseries can also provide specific plant information.

- Consider a tree species' mature size and growth before planting trees. Avoid tree species that are weakly branched or brittle-wooded which can be susceptible to storm damage and avoid trees that produce invasive roots or large quantities of surface roots. Avoid planting trees that are vulnerable to pests and biotic problems.
- Avoid trees with thorns, or limit planting them to out-of-play areas. Trees that frequently drop leaves, needles, and other debris should be avoided near play areas.
- If feasible, consider transplanting trees from one area to another instead of purchasing new trees.
- Invest in the right tree rather than saving money on the wrong tree.
- Plant deciduous trees in temperate climates in the early spring and late summer/fall seasons. Plant conifer species in early fall or late spring, and plant broadleaf evergreens as new growth begins in spring. Delay summer planting until new spring growth on the tree matures. In milder climates, trees can be planted during winter.
- Conifer species should be avoided from green sites or use them sparingly due to their dense shade, possible impacts on air circulation and needle drop that may be create a maintenance or soil acidity issue.
- Consider wind direction when selecting trees and planting sites.
- Space trees irregularly and leave wide gaps in between to recreate a natural landscape.
- Use the trees' potential mature canopy size when determining spacing and their location relative to design features.
- Avoid planting larger-sized trees in areas where the morning sun will be blocked.
- Establish a Nest Box Survey program for cavity nesting birds.
- Consult with arborists, landscape designers, and nurseries to help select the right plants.
- Management of tree roots near greens and golf cart paths is important. Tree root pruning can be done by cutting a 2-foot deep trench through the rooting area and then placing asphalt shingles in the trench with the rough side facing the roots. When they regrow and contact the shingle they will grow away from the rough surface.
- More information on trees on golf courses can be found here: http://www.usga.org/course-care/digitalcollections/trees-and-golf-courses.html https://asgca.org/design/existing-courses/course-renovation-articles/thoughtful-tree-planning/

Design and Function

Principles

- Aesthetic gardens, window boxes, and container gardens should include a variety of plants of different sizes and heights. Remember, “right plant, right place.”
- When integrating turf areas into the landscape around the clubhouse, entries, and other areas, design them for ease of maintenance and keep in mind that turfgrasses grow best in sunny areas.
- Consider the effect that tree canopy and other design features may have on the health and function of the turf.
- Garden plants, shrubbery, ground cover, integrated with native plants are aesthetically pleasing and can provide food, cover and habitat for a variety of native species.
- Trees and shrubs along streams are critical components of a riparian habitat and provide several benefits including food, shelter, bank stabilization to reduce erosion, and temperature moderation through shade, which lowers water temperature in summer, benefiting aquatic resources.

Best Management Practices

- Well-designed vegetated buffers should contain a mixture of fast- and slow-growing native trees, shrubs, and grasses to provide a diverse habitat for wildlife.
- Vegetated buffers provide numerous benefits that include:
- Trapping and removing upland sources of sediments, nutrients, and chemicals.
- Protecting fish and wildlife by supplying food, cover, and shade.

Planting Methods

Principles

- The ideal plant from an environmental standpoint is often a native plant that is adapted to site-specific soil, nutrient, microclimate, rainfall, pests, etc.
- The use of mulches in gardens and aesthetic areas increases the moisture-holding capacity of plantings and lessens weed growth when applied in sufficient depth. Mulch decomposed by soil microorganisms adds to soil tilth.
- Keep mulch 2 to 3 inches away from plants, to prevent fungal growth from excess dampness.
- Excess mulch or compacted mulch may be detrimental, causing water to shed away from the root zone and encourage overwatering. Compaction or excessive mulch buildup should be avoided, especially when annual re-mulching is performed.

Best Management Practices

- The plant palette and irrigation system should be appropriate for site conditions, considering that, in some cases, soil improvement can enhance water-use efficiency.
- Plants should be grouped together based on irrigation demand.
- The percentage of landscaped area in irrigated high-water-use zones should be minimized.
- In most instances, established, drought-tolerant landscape plants have a root system substantial enough to keep them alive with little or no supplemental irrigation.
- Pruning and fertilizing benefit landscape plants while they are becoming established.
- Add proper soil amendments in garden areas to improve the soil's physical and chemical properties, increase its water-holding capacity, and reduce the leaching of fertilizers.
- The following Chapters have useful supplemental information:
    - Chapter 2: Irrigation
    - Chapter 5: Nutrient Management
    - Chapter 6: Cultural Practices

Frequently Asked Questions (FAQs)

1. Where do I find more information on native plants?

There are several resources for locating information on California Native Plants, including:

The California Native Plant Society (CNPS) has a database that allows you to search for native plants that meet the desired plant characteristics for different California regions: https://www.cnps.org/

2. I need to do some brush removal in my out of play area. What resources should I check before I begin?

During your work, you don't want to inadvertently disrupt a threatened/endangered species, a nesting bird, or their habitat. Many resources are presented in Chapter 15: Threatened and Endangered Species.

3. I am concerned about the risk of fire and the potential for fuel build-up. Is there anyone I can call?

Contact your local and county fire department or the California Department of Forestry and Fire Protection (CalFire) for advice on allowable vegetation types, heights and

densities, and methods of removal. More information is available here: https://www.fire.ca.gov/

4. Players have reported seeing coyotes in the out of play area adjacent to #3 fairway and are concerned about being attacked. What should I do?

Refer to Chapter 7: Integrated Pest Management for vertebrate pest management and resources on who to contact in such circumstances.

5. I am considering creating habitat in my course's out of play areas. What resources can I use to get started?

Refer to:

- Chapter 15: Threatened and Endangered Species.
- Chapter 9: Pollinator Protection and Enhancement
- Chapter 1: Planning, Design, and Construction.

6. I've heard that some landscape plantings, particularly flowers, are sensitive to irrigation water quality, and in some cases, metals like boron. Where can I find more information?

Refer to Chapter 2: Irrigation for more about irrigation water quality. Also, be aware that certain fertilizers may contain metals. Refer to Chapter 5: Nutrient Management.

7. Roses around the club house are being attacked by aphids. I'm considering going down to the local hardware store and buying an insecticide. What rules apply to pesticide use?

All the same rules that apply to other pesticide use, including reading and following the label, use of appropriate PPE, and monthly reporting to your County Ag Commissioner. Refer to the following chapters for more information:

- Chapter 7: Integrated Pest Management
- Chapter 8: Pesticide Management

8. What other agencies are good resources?

The California Department of Fish and Wildlife offer additional information on native plants at https://www.wildlife.ca.gov/conservation/plants

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

California Native Plant Society. 2018. Calscape database. Available at: http://calscape.org/

The National Arbor Day Foundation: https://www.arborday.org/trees/

USGA. 2019. Trees and Golf Courses. Available at: http://www.usga.org/course-care/digitalcollections/trees-and-golf-courses.html

American Society of Golf Course Architects. 2019. Thoughtful Tree Planning. Available at: https://asgca.org/design/existing-courses/course-renovation-articles/thoughtful-tree-planning/

Chapter 12: Energy

Overview of Energy Management

According to the GCSAA Golf Course Environmental Profile, Vol. IV (GCSAA 2012), six major energy sources were identified for golf course use: electricity, gasoline, diesel, natural gas, propane, and heating oil. In addition, operational uses were segmented to meet irrigation, turf maintenance, buildings, clubhouse operations, swimming pools, and various amenity needs.

The overall conclusion of the study suggests that golf facility managers must take steps toward identifying options for conservation, efficiency, and cost savings.

To address current needs and future energy reduction opportunities, superintendents should evaluate current energy conservation performance practices based on the following categories:

- General energy conservation position statements on policy and planning.
- Facilities: Including parking lots, office, maintenance building(s), etc.
- Irrigation System: Including turf and landscape watering requirements, pump station and overall irrigation system.

All embedded hyperlinks below can be found in the References section of this guide.

Energy Conservation

Principles

- Determine goals and establish an energy policy as part of your overall environmental plan.
- Establish an energy management plan for the facility based on current energy use baselines to optimize efficiency.
- Communicate policy and train staff regarding use patterns and management practices to enhance buy-in.
- Relate the policy to the entire facility and your golfers.
- Incorporate quality management elements for continual improvement (plan, do, check, and act) to reduce environmental and economic impacts.
- Understand that the irrigation pump is the largest user of energy. A well-engineered pump station is critical to reducing energy consumption.

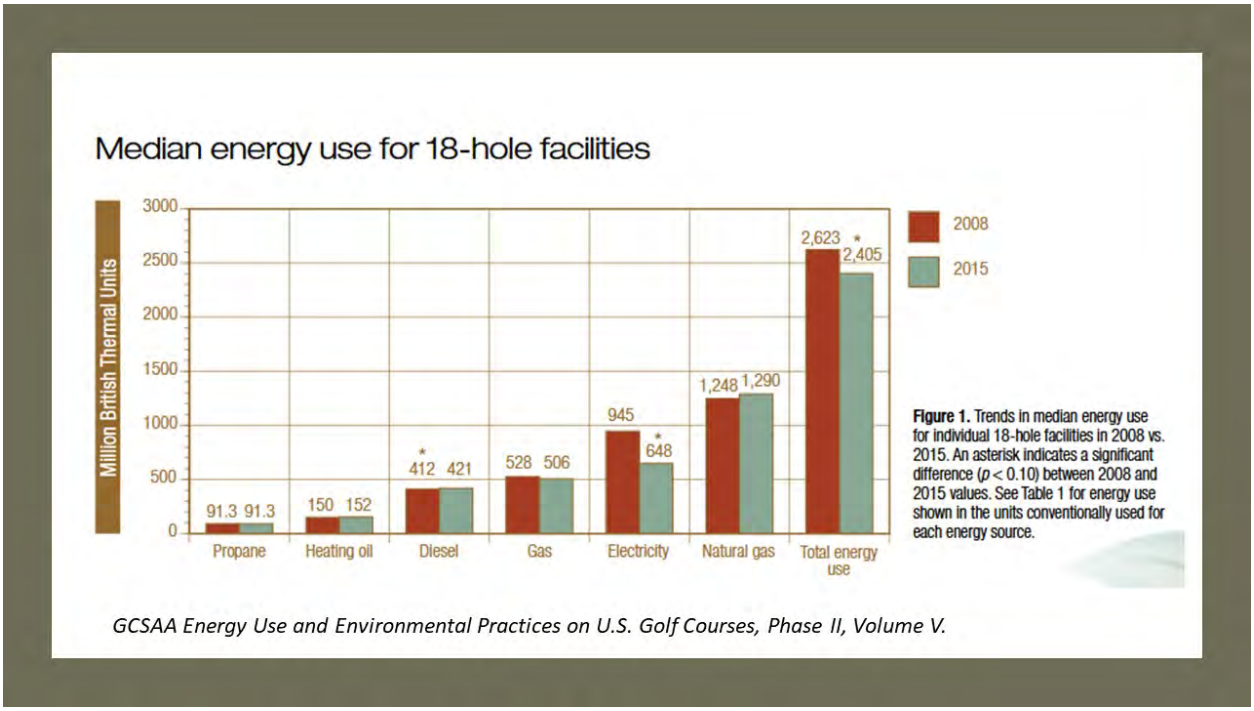
Best Management Practices

- Conduct energy and lighting audits to assess your energy use and identify opportunities for efficiency. Review the facilities last 12 months of energy bills.
- Conduct an irrigation audit and consider using a member of the American Society of Irrigation Consultants (ASIC). Find a member here.
- Determine when your utility provides off-peak power and use this time to run irrigation pumps, charge golf carts and maintenance equipment.
- Utilize vendor-supplied energy efficiency monitoring tools. Examples include:
    - John Deere
    - Toro
- Contact your local utility to obtain assistance with rebates on use of energy-efficient building materials and supplies (insulation, windows, lighting, etc.), audits, off-peak energy consumption and alternative energy sources such as solar energy.

    - PG&E
    - San Diego Gas & Electric
    - Los Angeles Department of Water and Power
    - Southern California Edison

If your utility is not listed above, you may be able to find yours here.

Facilities



Principles

- Using your utilities' webpage or reading your usage meters, continually track and measure energy use.
- Benchmark your use by comparing to other local golf facilities of similar size. GCSAA's Energy Use and Environmental Practices on U.S. Golf Courses, Phase II, Volume V, contains median use information: https://www.gcsaa.org/docs/default-source/Environment/phase-2-energy-survey-full-report.pdf?sfvrsn=9cedeb3e_2
- Consider benchmarking on categories such as irrigation pump(s), buildings, etc.
- If designing a new facility, consider U.S. Green Building Council's LEED (Leadership in Energy and Environmental Design) program.
- Evaluate use of alternative energy/fuels. For example, is compressed natural gas (CNG) or propane an alternative for heating and air conditioning at the maintenance facility?
- Consider solar panel installation.
- Incorporate natural landscape and trees for shading and site selection. This includes strategic placement of shade-bearing plants. See Chapter 11: Landscape & Out of Play Areas for more information.
- Install photo cells for lights where appropriate.
- Install LED lighting and/or retrofit devices.
- Install motion sensors for lights where appropriate.
- Install a programmable thermostat.
- Add insulation where needed.

Irrigation System

Principles

- Upgrade or install National Electrical Manufacturers Association's (NEMA) premium efficiency-rated pump motors.
- Contact your local utility or Resource Conservation District and perform an annual pump efficiency test. A list of RCDs can be found here.
- Consider the installation of a variable frequency drive (VFD) to your pump to save energy
- Integrate results of your irrigation audit.
- Ensure efficient design, selection, operation, and maintenance of irrigation pumps, irrigation controls, and other irrigation components.
- See Chapter 2: Irrigation for more information about system design and pumping systems that may result in reduced energy use.

Frequently Asked Questions (FAQs)

1. What is the Golf Course Energy Collective?

The Golf Course Energy Collective (http://www.golfenergycollective.com/) provides American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Level 2 energy efficiency audits to assess energy savings in areas including:

- Meter and rate classification Review to assess accurate and appropriate billing. For example, most utilities have a specific agriculture rate which should be used for irrigation pumping.
- Solar Energy Options to evaluate if renewable energy (e.g., solar) would be a good fit for a maintenance shop or clubhouse.

2. What is the Professional Golfers' Association (PGA) of America doing to help golf courses become more energy efficient?

PGA has partnered with Constellation Energy to provide audits and alternative energy options like solar and wind power. Learn more here.

References

NOTE: Links to webpages and PDFs were active as June 15, 2019. Access to those web resources and information presented therein are subject to change.

Constellation Energy 2019. PGA of America's Preferred Energy Choice. https://www.constellation.com/community/sponsorships/pga-of-america.html

GCSAA 2012. Golf Course Environmental Profile, Vol. IV. https://www.gcsaa.org/uploadedfiles/Environment/Environmental-Profile/Energy/Golf-Course-Environmental-Profile--Energy-Use-and-Conservation-Report.pdf.

California Department of Conservation 2019. Resource Conservation Districts. https://www.conservation.ca.gov/dlrp/RCD/Pages/CaliforniaRCDs.aspx

California Energy Commission 2019. Electric Load-Serving Entities (LSEs) in California. https://www.energy.ca.gov/almanac/electricity_data/utilities.html

GCSAA's Energy Use and Environmental Practices on U.S. Golf Courses, Phase II, Volume V: https://www.gcsaa.org/docs/default-source/Environment/phase-2-energy-survey-full-report.pdf?sfvrsn=9cedeb3e_2

Chapter 13: Groundwater Management

Overview of Groundwater Management

To irrigate golf course turf and landscape areas, golf courses sometimes require the use of groundwater when irrigation needs are unmet by rainfall and surface water supply. Golf course superintendents must play a role in protecting California water resources from overdraft and potential impacts to water quality.

Many locations in California use groundwater faster than the aquifer recharges. In 2014, California instated mandatory groundwater management law to address overdraft which previously had been voluntary. The goal of the Sustainable Groundwater Management Act (SGMA) is to establish a balance between use and recharge. The Department of Water Resources (DWR) is primarily responsible for issues that pertain to groundwater quantity.

Pesticide and fertilizer use in golf courses can be a potential source of groundwater pollution. The California Department of Pesticide Regulation (DPR) started to address groundwater contamination from pesticide use in the early 1980s. In 1985, the Pesticide Contamination Prevention Act (PCPA) was passed to prevent further pollution of ground water used for drinking water supplies from agricultural pesticides. The California Department of Pesticide Regulation (DPR) is primarily responsible for issues related to pesticides in groundwater. Aside from pesticides, groundwater contamination can include salt and nitrate infiltration; these topics are discussed in the Irrigation and Nutrient Management chapters of this guide.

All embedded hyperlinks below can be found in the References section of this guide.

Frequently Asked Questions (FAQs)

1. What are some of the biggest potential issues that pertain to overuse of groundwater?

- Overdraft occurs when the use of groundwater exceeds the aquifer recharge. When the water table falls below the point water is no longer accessible through existing pumps, a new well may need to be installed. The installation of a new well is costly, as well as the increase in energy required to pump water from deeper levels.
- Subsidence: The overuse of groundwater changes the water level, possibly causing the ground to sink or collapse. This change in elevation may result in sinkholes and/or damage infrastructure.
- Saltwater intrusion: Changes in the water table shape can result in a slope that funnels seawater into groundwater.

- Water quality impairment: When groundwater use exceeds the water recharge, the decreased volume for water can concentrate pollutants such as nitrate, pesticides, metals, and salts.

2. What is the role of the Department of Water Resources (DWR) in groundwater protection?

The DWR is responsible for:

- Implementing the Sustainable Groundwater Management Act (SGMA)
- Administering the California Statewide Groundwater Elevation Monitoring (CASGEM) Program
- Characterizing California's groundwater basins through updates to California's Groundwater, Bulletin 118
- They have a long-standing history of:
- Collecting and analyzing groundwater data
- Investigating and reporting groundwater conditions
- Encouraging integrated water management
- Providing the technical expertise needed to improve statewide groundwater management practices
- Implementing local groundwater assistance grants

3. How do I know if I can use the groundwater for my golf course?

The Department of Water Resources provides the public with a Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Agency portal with water supply/water management/land use notices within the groundwater basin(s) and contact information for responsible agencies. Contact the GSA in your area to find out more about groundwater usage at your golf course.

4. What is the Sustainable Groundwater Management Act (SGMA)?

SGMA provides framework for sustainable groundwater management in California. This includes a maintenance plan during project implementation that requires the local government and/or water agencies of vulnerable basins to prevent overdraft over approximately twenty years. Specific deadlines depend on the status of basin overdraft and should be discussed with local agencies. Under SGMA, the Groundwater Sustainability Agencies (GSAs) manage basins and establish Groundwater Sustainability Plans for medium- to high-priority groundwater basins in California.

Contact your local GSA, which can be located through the SGMA portal, for questions about basins in your region to determine if you have potential restrictions on your use of groundwater.

5. What are groundwater protection areas (GWPAs)? How do I verify if I am located in a GWPA?

DPR identifies and enforces regulations related to ground water protection areas (GWPAs). GWPAs are one-square mile sections of land that are vulnerable to pesticide movement to ground water. Permits must be obtained from your local county agricultural commissioner (CAC) if you wish to use a pesticide regulated as a ground water contaminant in a GWPA. These permits will specify enforceable management practices required in each GWPA. In addition, statewide restrictions apply to pesticides applied in recharge basins, canals, and ditches by chemigation.

There are over 3000 GWPAs in 31 counties. GWPAs are viewable through either a mapping or listing system. These references are preliminary; please check with your local County Agricultural Commissioner (CAC) for verification.

CAC contact information can be found in the Contacts section of this guide.

6. What is the California Statewide Groundwater Elevation Monitoring (CASGEM) Program?

CASGEM establishes long-term, locally-managed monitoring plans of groundwater basins in California, for the purposes of attaining goals established by the SGMA. The DWR and these local agencies collaborate to collect groundwater elevation data that is subsequently made available to the public. This information is intended to track seasonal and long-term groundwater elevation trends in California groundwater basins and can be accessed through the CASGEM Public Portal. If you are having irrigation pump performance issues, it may be due to falling groundwater elevations. If you intend to install a well on your course, one important step is to determine the depth to groundwater.

7. What is Bulletin 118?

The Bulletin 118 series are regional reports from the DWR about the occurrence and nature of groundwater in California. Bulletin 118 defines the boundaries and describes the hydrologic characteristics of the state's groundwater basins and provides information on groundwater management and recommendations for the future. Bulletin 118 serves an additional role by providing GSAs with three critical pieces of information regarding groundwater basins: Critical Conditions of Overdraft, Basin Boundaries, and Basin Priority.

In 2020 and every 5 years after, comprehensive updates to Bulletin 118 will be released. These bulletins can be found on the DWR website.

8. How do I determine depth to groundwater information at my golf course?

Check on the California Department of Water Resources Groundwater Information Center Interactive Map for depth below ground surface, groundwater elevation, and the groundwater change in elevation over time.

9. How can I get more information on the groundwater levels, elevations, and water quality of existing wells in my area?

Check the groundwater levels for stations in proximity to your golf course using the WDL station map. This interactive map also provides information about recent groundwater level data, historical groundwater levels, ground surface elevation, and water quality reports.

10. Can some groundwater be injurious to turf?

Yes, depending on your location, groundwater can contain salts and total dissolved solids (TDS) that may not be suitable for long term irrigation of turf. Another common groundwater constituent is Boron, which can be injurious to some landscape plants.

11. Does the quality of groundwater vary based on depth?

Yes. Different aquifers (underground bodies of water) are separated by aquitards that largely prevent movement between aquifers. These aquifers are in contact with different rock and soil types and are influenced by water moving in and out of the aquifer. Generally speaking, first encountered groundwater (i.e., the water closest to the ground surface) is more susceptible to influences from the ground surface. For example, depending on soil type and rainfall, certain soluble chemicals like nitrate, can migrate to groundwater.

12. If I want to install a well on my course, what do I do?

First, it is advisable to hire a knowledgeable hydrogeologist and engineer to assess things like your water quality and quantity needs, depth to water on your course, power requirements and compatibility with your irrigation system. Often, bid specifications are prepared and contractors are invited to estimate costs to install the well. You'll need to work with your local County Environmental Health Department who typically issues permits for the installation of groundwater wells. It is important to coordinate with your local utility provider to supply the necessary power to run either your turbine or submersible pump.

13. What is the role of State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board with respect to groundwater use?

The SWRCB/RWQCB are responsible for:

Managing water rights, in some cases groundwater, use falls under the same water right requirements as surface water. In select counties (particularly in Southern California), groundwater use needs to be granted and reported to the SWRCB or local GSA. Check with your local GSA. For more about water rights, see the Irrigation section of this BMP Guide. Some of the functions of the SWRCB include:

- Establishing water quality and implementation plans for groundwater
- Provides information about water quality through the Groundwater Ambient Monitoring and Assessment (GAMA) Program
- Enforcement of laws and regulations related to violation of groundwater laws
- Provide financial assistance for constructing water recycling facilities and remediation for underground storage tank leaks

14. What regulations do I need to know about GWPAs? What is the Groundwater Protection List (GWPL)?

Established under 3 CCR Section 6800, the GWPL dictates that certain pesticides labeled for agricultural, outdoor institutional, or outdoor industrial are designated as having the potential to pollute ground water. Certain 3 CCR 6800(a) chemicals are prohibited from leaching into GWPAs unless certain criteria are met, as described under 3 CCR Section 6487.5. Leaching Ground Water Protection Areas. Additionally, 3 CCR 6800(a) chemicals are prohibited from being used in engineered right-of-ways unless the criteria found under 3CCR Section 6487.3. Engineered Rights-of-Way Within Ground Water Protection Areas are met.

15. What BMPs can I take to prevent contamination of ground water at my golf course?

Mitigation measure efficiency should be decided based on the primary mechanism through which potential impacts are expected. For example, course -textured soils are more prone to leaching while hardpan layers/fine-texture soils promote runoff.

- Efficient irrigation, especially in course soils, significantly reduces downward movement of pesticides and fertilizers and allows time for these materials to be taken up by plants or degraded.
- Always apply pesticides and fertilizers according to label directions.
- Obtain the advice of an agronomist to gain information on turf health and nutrition so that appropriate fertilizers are applied correctly and at the right time to minimize or reduce potential impact to groundwater.
- As necessary, obtain the advice of a DPR-licensed Pest Control Advisor and get written recommendations on your use of pesticides so that they are appropriate

and are applied correctly and at the right time to minimize or reduce potential impact to groundwater

- For those applying pesticides, have them obtain their DPR Qualified Applicator Certificate (QAC) or Qualified Applicator (QAL) license. Individuals with these licenses are trained on the proper application of pesticides and play an important role in carefully following the PCA recommendations.
- Use backflow prevention devices on wells used to mix fertilizer with water (fertigate) or pesticides with water (chemigate).
- Construct and maintain groundwater wells consistent with County guidelines. This includes the installation of a seal at the well surface to prevent the well from being a conduit to groundwater.
- Do not mix, load or handle pesticides or fertilizers near your well

For more information about nutrient and pesticide management, see the Nutrient Management and Pesticide Management sections of this BMP Guide.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

California Code of Regulations, Section 6487.3: Engineered Rights-of-Way Within Groundwater Protection Areas: http://www.cdpr.ca.gov/docs/legbills/calcode/020404.htm#a64873

California Code of Regulations, Section 6487.4: Runoff Ground Water Protection Areas: https://www.cdpr.ca.gov/docs/legbills/calcode/020404.htm#a64874.

California Code of Regulations, Section 6487.5: Leaching Groundwater Protection Areas: http://www.cdpr.ca.gov/docs/legbills/calcode/020404.htm#a64875

California Department of Pesticide Regulation (DPR) Groundwater Protection Areas:

https://www.cdpr.ca.gov/docs/emon/grndwtr/gwpa_locations.htm

California Department of Pesticide Regulation (DPR) Groundwater Protection List:

http://www.cdpr.ca.gov/docs/legbills/calcode/040101.htm

California Department of Water Resources (DWR). Groundwater Information Center Interactive Map:

https://gis.water.ca.gov/app/gicima/

California Department of Water Resources (DWR). Water Data Library Station Map:

http://wdl.water.ca.gov/waterdatalibrary/

California Department of Water Resources (DWR) Sustainable Groundwater Management Act (SGMA) Groundwater Sustainability Agency portal: https://sgma.water.ca.gov/portal/#intro

California Department of Water Resources (DWR) CASGEM Online System:

https://water.ca.gov/Programs/Groundwater-Management/Groundwater-Elevation-Monitoring--CASGEM

California Department of Water Resources (DWR) Bulletin 118:

https://www.water.ca.gov/LegacyFiles/groundwater/bulletin118/docs/Bulletin_118_Interim_Update_2016.pdf

Chapter 14: Air Quality

Overview of Air Quality

This chapter covers some of the general areas in which golf course operations must consider potential impacts to air quality.

In addition to aesthetic impacts, air pollution can cause a variety of adverse health impacts that include eye irritation and creating or exacerbating respiratory ailments. Information on potential health impacts by pollutant type can be found here.

Air Quality is measured relative to Ambient Air Quality Standards (AAQS). An AAQS defines the maximum amount of a pollutant averaged over a specified period of time that can be present in outdoor air without any harmful effects on people or the environment. California has AAQS for the following pollutants:

- Particulate Matter (PM10 and PM2.5)
- Ozone (O3)
- Nitrogen Dioxide (NO2)
- Sulfate
- Carbon Monoxide (CO)
- Sulfur Dioxide (SO2)
- Visibility-Reducing Particles
- Lead
- Hydrogen Sulfide (H2S)
- Vinyl Chloride

The California Air Resources Board (CARB) designates air basins based on their attainment of the AAQSs. Learn more about air basin attainment here and learn more about these pollutants here.

The primary areas that a golf course may potentially impact air quality are:

- Engine and maintenance facility operations (particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide)
- Dust generation from roads: (particulate matter, visibility-reducing particles, lead)

Carbon dioxide is a greenhouse gas (GHG) and an essential building block needed for the growth of plants through photosynthesis. However, over-production of carbon dioxide contributes to global warming and ocean acidification. The role golf courses play in reducing GHGs has been investigated by a number of researchers including Selhorst and Bartlett.

All embedded hyperlinks below can be found in the References section of this guide.

Regulatory Considerations

California Air Resources Board (CARB)

The California Air Resources Board (CARB) is responsible for overall state policy to protect the public from air pollution and to address climate change and has duties that include:

- Setting air quality standards to protect the public
- Identifying pollutants that pose the health risks
- Measuring air quality pollution using an extensive air monitoring network
- Verifying motor vehicle emissions compliance
- Researching causes, effects, and potential solutions of air pollution problems
- Studying the costs and benefits of pollution controls
- Addressing climate-changing emissions by promoting energy efficiency

From guiding the activities of 35 local air pollution control districts, to leading our states efforts to address global climate change, the CARB has pioneered many of the approaches now used worldwide to address air quality problems.

Local Air Pollution Control Districts (APCD)

There are 35 air pollution control districts (APCDs) throughout California. APCDs are sometimes called Air Quality Management Districts (AQMDs). Each District adopts rules to address local air quality issues in its region.

The local air district directory and district rules directory may be accessed by using the links below:

Amador	Antelope Valley	Bay Area	Butte	Calaveras
Colusa	Eastern Kern	El Dorado	Feather River	Glenn
Great Basin	Imperial	Lake	Lassen	Mariposa
Mendocino	Modoc	Mojave Desert	Monterey Bay	North Coast
Northern Sierra	Northern Sonoma	Placer	Sacramento	San Diego

San Joaquin	San Luis Obispo	Santa Barbara	Shasta	Siskiyou
South Coast	Tehama	Tuolumne	Ventura	Yolo-Solano

County Environmental Health Departments

Local county environmental health departments take on the role of the Certified Unified Program Agency (CUPA). The CUPA is designated by the California Environmental Protection Agency (CalEPA) to address a variety of local issues related to fuel storage, hazardous materials and waste, Spill Prevention Control and Countermeasure (SPCC) Plans, and Hazardous Materials Business Plans (HMBPs). In some cases, CUPAs have the responsibility to issue permits for construction of fuel storage facilities, including approval of plans for fill, vent, and vapor recovery piping.

More information about CUPAs can be found in Chapter 10: Maintenance Operations.

Best Management Practices (BMPs)

- Know what AQMD or APCD you are in and be familiar with their rules.

Potential Sources of Air Pollution

Diesel Irrigation and Groundwater Pumps

Diesel engines, including those that run irrigation and well pumps, are a source of nitrogen oxides (NOx) and particulate matter. Contact your local AQMD or APCD for requirements for operation, permitting, and reporting.

Fuel Storage

Depending on how your above or below ground fuel storage tank is vented, you may need to contact your local CUPA, AQMD, or APCD requirements.

Pesticide Drift and Volatility

Based on their characteristics, including vapor pressure, some pesticides may be capable of volatilizing. Volatilization results in a liquid pesticide becoming a gas and may result in impacts to air quality. The pesticide product label and Safety Data Sheet (SDS) has information that warns users about the potential for volatilization and presents mitigation measures or prohibitions for use.

Pesticides that exhibit volatility may impact air quality due to drift. Both liquid and gas phase pesticides may be subject to drift which involves the movement of the pesticide off the intended target area of application. Pesticide drift may be a result of incorrect application technique, incorrect nozzle size, high application pressure, wind, temperature, or other factors.

Additional information on these topics can be found in Chapter 8: Pesticide Management.

Small (< 25 HP) Engines

According to CARB, small gasoline engines found in lawn mowers, leaf blowers, and other power equipment pollute at a higher rate than other equipment and vehicles. For example, 1 hour of a typical lawn mower use emits the same amount of smog-forming air pollution that a mid-size sedan emits traveling 300 miles. In 2020, CARB will consider new standards for small engines to help California meet its goal of reducing smog-forming pollutant emissions from mobile sources.

Equipment of this type is often in the small off-road engine (SORE) category and consists of off-road spark-ignition engines. Learn more about the SORE program here.

In some AQMDs, incentive programs exist to replace SORE category equipment. For example, the South Coast Air Quality Management District (SCAQMD) has a Commercial Electric Lawn and Garden Equipment Incentive & Exchange Program where an operable gasoline or diesel-powered piece of lawn or garden equipment is scrapped and replaced by new battery-electric equipment. Eligible equipment includes handheld trimmers, chainsaws, pruners, backpack and handheld blowers, and ride-on, stand-on, walk-behind, and robotic lawn mowers. Learn more here.

Large Engines (>25 HP)

In-Use Off-Road Diesel-Fueled Fleets consisting of vehicles using engines greater than 25 HP must report use via the Diesel Off-Road Online Reporting System (DOORS) to demonstrate compliance with emission requirements. All fleets are required to complete their annual reporting and submit a Responsible Official Affirmation of Reporting (ROAR) form or e-ROAR. Learn more here.

Overseeding

Limiting irrigation to start fall dormancy and then scalping and verticutting Bermuda grass to allow winter grass seed contact with the soil during overseeding can generate significant dust. The Coachella Valley Association of Governments has addressed this issue with a video found here.

Best Management Practices

- Be sure equipment is properly fueled, lubricated, maintained, and operated.
- Know the air quality index (AQI) in your area using sources such as this USEPA webpage.
- Consult your local APCD, AQMD, or equipment vendor for compliance assistance.
- Know the types of equipment you have on your golf course and the regulations that pertain to this equipment.
- Be familiar with CARB reporting requirements through the DOORS program.
- The following BMPs are suggested to reduce dust generation during fall overseeding:
    - Seed after October 15 or when nighttime temperatures drop below 60 F
    - Reduce irrigation, don't eliminate it
    - Gradually lower grass height to ½ inch
    - Manage dust by syringing with irrigation water.

Frequently Asked Questions (FAQs)

1. What reporting requirements are my off-road diesel-powered vehicles subject to? (From the Maintenance Operations Chapter)

To reduce emissions of oxides of nitrogen (NOx) and particulate matter (PM), all self-propelled off-road vehicles of 25 horsepower (hp) or greater must report through the Diesel Off-Road Online Reporting System (DOORS) found here.

2. What certifications must my electric golf carts have?

Certification of electric golf carts as a Zero Emission Vehicle (ZEV) is required for use in all non-attainment areas. To determine if your course is in a non-attainment area, contact your local AQMD or APCD using the links presented earlier.

A brief summary of ZEV Regulations may be found at the CARB website here: https://www.arb.ca.gov/msprog/zevprog/factsheets/zev_regulation_factsheet_082418.pdf

3. Are there fines associated with non-reporting?

Yes. In 2016, a prominent golf course maintenance firm paid $13,350. for failing to report changes in its off-road fleet according to the In-Use Off-Road Diesel Vehicle Regulation.

4. What rules pertain to diesel vehicles that are > 25 HP?

Several rules are relevant to this type of vehicle. Learn more by clicking here and here. In addition to reporting and labeling requirements, the following apply:

- Limits on idling, requires a written idling policy, and requires a disclosure when selling vehicles
- Restricts the adding of older vehicles into fleets
- Reduce emissions by retiring, replacing, or repowering older engines, or installing Verified Diesel Emission Control Strategies (VDECS) (e.g., exhaust retrofits).

References

NOTE: Links to webpages and PDFs were active as of June 14, 2019. Access to those web resources and information presented therein are subject to change.

Bartlett et al, 2011. Are golf courses a source or sink of atmospheric carbon dioxide? A modelling approach. Found here: https://journals.sagepub.com/doi/abs/10.1177/1754337110396014

CARB. 2019. Knowledge center for the un-use off-road diesel-fueled fleets regulation. Available at https://www.arb.ca.gov/msprog/ordiesel/knowcenter.htm

CARB. 2019. Diesel Off-Road Online Reporting System (DOORS). https://ssl.arb.ca.gov/ssldoors/doors_reporting/doors_login.html

CARB 2019. Small Off-Road Engines (SORE) Program. https://ww2.arb.ca.gov/our-work/programs/small-off-road-engines-sore/about

CARB 2018 Zero Emission Vehicle (ZEV) Regulation Factsheet: https://www.arb.ca.gov/msprog/zevprog/factsheets/zev_regulation_factsheet_082418.pdf

SCAQMD 2019. Lawn and Garden Equipment Incentive Program. http://www.aqmd.gov/home/programs/community/community-detail?title=lawn-equipment

CARB 2019. Large Spark Ignition Engine Program. https://ww2.arb.ca.gov/large-spark-ignition-engine-regulatory-and-certification-documents

CARB 2019. Off Road Diesel Fleet-Fueled Regulations. https://www.arb.ca.gov/msprog/ordiesel/faq/overview_fact_sheet_dec_2010-final.pdf and https://www.arb.ca.gov/msprog/ordiesel/documents/post_2010_hearing_fact_sheet.pdf

CARB 2019. Air Basin Attainment Maps. https://www.arb.ca.gov/desig/adm/adm.htm

CARB 2019. In-Use Off-Road Diesel-Fueled Fleets Regulation. Low-Use Provisions. https://ww2.arb.ca.gov/resources/fact-sheets/use-road-diesel-vehicle-regulation

CARB 2019. Pollutant Types. https://ww2.arb.ca.gov/resources/california-ambient-air-quality-standards

California Air Pollution Control Officers Association 2019. Health Impact Summary. http://www.capcoa.org/health-effects/

College of the Desert 2019. Overseeding Certification Training. http://www.collegeofthedesert.edu/community/pace/Pages/clc.aspx (Accessed July 2, 2023)

Selhorst 2011. Carbon Sequestration in Golf Course Turfgrass Systems and Recommendations for the Enhancement of Climate Change Mitigation Potential. Found here. https://link.springer.com/chapter/10.1007/978-94-007-2366-5_13

USEPA 2019. Air Quality Index Mapping. https://www.airnow.gov/index.cfm?action=airnow.local_state&stateid=5&mapcenter=0&tabs=0

Chapter 15: Threatened and Endangered Species

Overview of Threatened and Endangered Species

Threatened and endangered (T/E) species, sometimes referred to as “special status” or “listed” species, have been identified as being in danger of extinction now or are likely to become endangered within in the foreseeable future. Maintenance, renovation or construction on a golf course needs to take T/E species into account so as not to directly harass or harm them, disrupt their behavior, or adversely alter their habitat.

California has more T/E species than anywhere in the United States. The protection of T/E species is addressed by the California Endangered Species Act (CESA), California Environmental Quality Act (CEQA), the Federal Endangered Species Act (FESA). An excellent side by side comparison of CESA and FESA is presented here: https://www.wildlife.ca.gov/Conservation/CESA/FESA

CESA states that all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved.

The California Environmental Quality Act (CEQA) is California's broadest environmental law. CEQA helps to guide the CDFW during issuance of permits and

approval of projects. CEQA applies to all discretionary projects proposed to be conducted or approved by a California public agency, including private projects requiring discretionary government approval.

Note that some pollinator species are T/E and are discussed separately in Chapter 9.

Migratory waterfowl and nesting birds are protected in California by various regulations including theMigratory Bird Treaty Act, FESA, Bald and Golden Eagle Protection Act, CESA, and Fish and Game Code sections including 3503, 3503.5, and 3511. Nesting bird season in California is generally considered to begin on February 1 and end on August 31; actual nesting dates vary by species and location. All nesting bird species except pigeons (rock doves), English sparrows and starling are protected. Golf courses with nesting bird habitat can best avoid potential impacts by scheduling maintenance and projects outside of the nesting bird season, when feasible.

Maintenance activities like brush or tree trimming can directly remove/destroy nests or lead to nest abandonment. If an active nest is encountered, it should be left undisturbed and a buffer area around the nest should be established. Typical buffer areas for songbirds and similar species is 50 feet, while buffers for raptors may be 250 to 500 feet. If the bird species using a nest in a maintenance or project area is identified, CDFW or a qualified biologist can make a recommendation on the appropriate buffer size. Buffer distances vary with the type of project or maintenance activity, duration, sensitivity of the bird species to disturbance and stage of the nesting cycle. Nests should be left undisturbed until the nest has been abandoned or the young have left the nest on their own.

All embedded hyperlinks below can be found in the References section of this guide.

Frequently Asked Questions (FAQs)

1. What exactly is a “special-status species”?

Special-status species are plants and animals that are considered rare, threatened, or endangered under Sections 15380 (2005) and 15125 (2018) of the CEQA Guidelines. Special-status species include those species protected under the Endangered Species Act (ESA), California Endangered Species Act (CESA), the California Fish and Game Code, the California Native Plant Protection Act, the Migratory Bird Treaty Act, and the Bald and Golden Eagle Protection Act. Specifically, species considered as special-status include those which are:

- Federal Endangered

- Federal Threatened
- Federal Proposed
- State Endangered
- State Threatened
- State Candidate
- State Species of Special Concern
- State Fully Protected
- California Native Plant Society (CNPS) Rank 1 and 2

2. How do I know if T/E species are on my course?

Several good sources exist as follows:

CDFW's California Natural Diversity Database (CNDDB) is found here: https://www.wildlife.ca.gov/Data/CNDDB

This on-line software can be used in the free (BIOS) or subscription (Rarefind) mode. Use the QuickView Tool in BIOS to view data by species and location: https://map.dfg.ca.gov/bios/?tool=cnddbQuick

If you are looking for Spotted Owl data, use the Spotted Owl Observations Database in BIOS.

The California Native Plant Society (CNPS)'s webpage is found here: http://rareplants.cnps.org/advanced.html

Simple and advanced searches allow you to look for rare and T/E plants. The advanced search option allows searches down to the county and quadrangle level. Pictures and information on life-form, blooming period and habitat are available.

Additional pictures are available at the CalPhotos webpage found here: https://calphotos.berkeley.edu/

The CalFlora web page is found here: https://www.calflora.org/

This page is similar to the CNPS page and is a good source of information on T/E and other plants. This site contains excellent pictures and allows searching by a variety of characteristics including affinity for serpentine soil, lifeform (grass, shrub, etc.), community (coastal prairie, wetland-riparian, etc.) and category (monocot, dicot, etc.).

The US Fish and Wildlife Services (USFWS) Information for Planning and Consultation (IPaC) is a useful tool to assess T/E species near your course: https://ecos.fws.gov/ipac/location/index

3. Who are some of the regulatory agencies that deal with threatened and endangered species?

California Department of Fish and Wildlife (CDFW)

CDFW is the primary agency in California with T/E responsibilities. CDFW has a Sacramento headquarters and seven (7) regional offices. In addition to dealing with identification and protection of T/E species and nesting birds, they are also responsible for other duties including the issuance of permits. These permits include Streambed Alteration Agreements (often referred to as "1600" or "1602" permits) and is discussed in more detail in Chapter 1, Plan, Design and Construction.

https://www.wildlife.ca.gov

National Marine Fisheries Service (NMFS)

NMFS is often referred to as "NOAA Fisheries" and is a part of the National Oceanic and Atmospheric Administration (NOAA), an agency within the United States Department of Commerce (DOC). They have a West Coast office in Sacramento and is responsible for protecting marine and coastal resources under several regulations including FESA.

https://www.westcoast.fisheries.noaa.gov/about_us/california_central_valley_area_office.html

U.S. Fish and Wildlife Service (USFWS)

The USFWS is an agency in the Department of the Interior (DOI) and shares responsibility with NOAA Fisheries for implementing the ESA. The Pacific Southwest Region office is in Sacramento and 7 smaller offices exist throughout the state. USFWS issues critical habitat reports and biological opinions (BOs) related other federal agency actions that may result in impacts to T/E species.

https://www.fws.gov/endangered/ and https://www.fws.gov/sacramento/es/overview/

A useful tool to identify critical habitat for FESA T/E species can be found here:

https://fws.maps.arcgis.com/home/webmap/viewer.html?webmap=9d8de5e265ad4fe09893cf75b8dbfb77

4. I have heard the word "take" used. What does it mean?

The listing of a species as threatened/endangered makes it i**llegal to "take" them without a permit and approved mitigation measures**. Similar prohibitions often extend to threatened species. The term “take” is broadly defined as follows:

CESA: hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill.

FESA: harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.

Note that a disruption in habitat of common golf course activities (mowing, digging, tree work, etc.) may not be considered a take under CESA, but may be considered “harass” under FESA because it creates the likelihood of injury due to disruption of normal behavioral patterns such as breeding, feeding, or sheltering.

Penalties for unauthorized takes range from $25,000 to $50,000 for each violation, one-year imprisonment, or both fine and imprisonment (Fish & G. Code, § 12008.1)

CDFW has the following programs to authorize “takes”:

Incidental Take Permit (ITP) Allows an exception to CESA take prohibitions if certain conditions are met.

Safe Harbor Agreement (SHA) - Encourages landowners to manage lands to benefit T/E species and does not subject them to future additional regulatory restrictions because of their conservation efforts.

Habitat Conservation Plans (HCPs) - Natural Community Conservation Planning (NCCP) addresses cumulative impact concerns and promotes coordination and conservation of unfragmented habitat areas and provides an option for identifying and ensuring appropriate mitigation that is roughly proportional to impacts on fish and wildlife.

When golf course activities may disrupt or impact a species or its habitat, a qualified professional should be retained to determine if the species is endangered, threatened, or listed, and if so, what steps must be taken to prevent a take.

Note: NMFS, USFWS, and CDFW are the primary agencies that address “takes”. Because their definitions differ slightly, they may view “takes” differently. When in doubt, contact them as needed.

5. What do I do if I think there might be an endangered or threatened species on my golf course?

Learn about them. Use some of the many resources that exist on the pages listed above. Use all necessary steps to avoid "taking" these species.

If you plan to make any modifications to your golf course that may influence the habitat of a T/E species, consider contacting a knowledgeable consultant to assess the situation. For example, use caution when considering modifying the perimeter of a pond by removing cattails and tules (examples include Common Tule (Scirpus acutus) and Hardstem bulrush (Schoenoplectus actus)) that may be habitat for a variety of T/E species such as tricolored blackbird or giant garter snake. A pre-work survey by a qualified professional may be advisable so that you don't inadvertently "take" one of these species and be subject to fines and penalties. Pre-work surveys are good tool to create record of lack of species and demonstrate good-faith efforts to avoid impacts to T/E species so that in the event that you are alleged to have committed a "take", you have data to protect yourself.

6. Should I attempt to promote or create T/E habitat?

It Depends. Promoting or creating habitat on the course is a great way to demonstrate your environmental stewardship and allows for outreach and education opportunities that showcase golf in general and your course in particular.

However, there are several caveats to consider:

- The habitat you promote or create shouldn't create a safety, operational or aesthetic issue.
- Maintenance of the habitat you create may be needed and if so, it's important to check for nesting birds and avoid a "take", as described above.
- Creation of habitat or food sources, although with the best of intentions, may have the opposite effect. For example, planting milkweed, an important food source for Monarch butterflies, is not recommended in certain locations. This is because if the plant was never there, introduction may unintentionally disrupt overwintering, reproduction, or migration behavior. Refer to Chapter 9, 'Pollinator Protection and Enhancement' for more information.

7. Are there are any rules regarding pesticide applications to protect T/E species?

Yes. Here are five (5) that you should know about:

California Department of Pesticide Regulation (DPR) Endangered Species Custom Realtime Internet Bulletin Engine (PRESCRIBE).

The PRESCRIBE database tool allows the selection of a location and pesticide intended for use and then returns applicable use limits, if any, and protective measures and

protected species. PRESCRIBE uses a combination of its own pesticide registration database with the CDFW CNDDB database to present this data.

https://www.cdpr.ca.gov/docs/endspec/prescint.htm

United States Environmental Protection Agency Endangered Species Protection Program - Bulletins Live! Two

Bulletins Live! Two is the web-based application to access Endangered Species Protection Bulletins (Bulletins). These Bulletins contain enforceable pesticide use limitations that are necessary to ensure a pesticide's use will not harm a species listed as threatened or endangered (listed) under the Endangered Species Act or their designated critical habitat.

https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

Salmonid Injunction:

As a result of lawsuits by environmental groups such as the Northwest Center for Alternatives to Pesticides and Washington Toxics Coalition, no-spray buffer zones have been established to protect 26 species of listed salmon and steelhead from 54 pesticide active ingredients. To determine whether Court-ordered limitations apply to Caltrans' proposed uses of specific herbicide active ingredients, visit: https://www.epa.gov/endangered-species/salmon-mapper.

Red-legged Frog Injunction

As a result of a lawsuit by the Center for Biological Diversity (CBD) against the USEPA, establishment of buffers may be required to protect the California Red-Legged Frog (RLF) from potential impacts due to 66 pesticides in 33 counties. A large number of these pesticides are unlikely or are prohibited from use on a golf course and so the actual pesticide list is much smaller. This injunction applies to select active ingredient usage in designated geographical areas. To learn more about if this injunction applies to your golf course and the exceptions, please see the link below.

https://www.epa.gov/endangered-species/how-comply-requirements-protect-california-red-legged-frog-pesticides

Goby-11 Injunction

Similar to the RLF Injunction discussed above, CBD sued the USEPA resulting in the potential requirement for buffers around habitat for 11 San Francisco Bay Area species, including the Tidewater Goby.

https://www.epa.gov/endangered-species/san-francisco-bay-area-map-tool-identify-interim-pesticide-use-limitations

Additional Resources

In addition to PRESCRIBE and awareness of the RLF and Goby-11 injunctions, a good local resource when dealing with T/E species and potential pesticide impacts is your local county Agricultural Commissioner's office. Additionally, the local county Resource Conservation District (RCD) or US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) are resources for information about T/E species.

8. What additional steps can I take to be aware and protective sensitive of T/E species on or around my course?

Proactively use the tools mentioned above and enlist the assistance of local advocacy organizations such as the Audubon Society, UC Cooperative Extension, watershed and creek protection groups, and the Nature Conservancy.

9. How do I know what to look for when searching for nesting birds before starting a project?

Nesting bird surveys should be conducted prior to projects or maintenance activities that occur in or near nesting habitat during the nesting season. A golf cart makes a good platform for looking for bird activity. If an area with bird activity is encountered in or around a project or maintenance area, stop and observe trees, shrubs, other potential nesting habitat, particularly early in the morning, with binoculars and look for nesting activity. Birds will fly with food in their beaks or feet, or nesting material in their beaks to their nest. However, while eggs are being incubated, very little obvious activity will occur.

See an example description of different types of nests here:

https://goldengateaudubon.org/conservation/make-the-city-safe-for-wildlife/tree-care-and-bird-safety/types-of-bird-nests/

10. n times of natural disasters (particularly fires), does CEQA waive certain permit requirements in order to speed up recovery? For example, if there are burned or flooded out areas, would a golf course superintendent be able to do clean-up work in areas that might contain T&E species without getting the permits?

It depends on a variety of factors including, but not limited to the type of natural disaster, extent of damage, specific species and quality of habitat that is being “restored”. The CEQA emergency exemptions are pretty narrow – basically emergency repairs to facilities to prevent loss of life or property, or for certain facilities if there is a state of emergency declared by the governor. CDFW permits and the Army Corps of Engineers allow for emergency projects, but they typically have to be true emergencies, and “take” is generally not going to be authorized. You should consider reviewing your project with a knowledgeable consultant or the appropriate regulating agencies prior to commencing work.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Calflora: information on wild California plants: https://www.calflora.org//

California Department of Fish and Wildlife (CDFW). California Natural Diversity Database (CNDBB): https://www.wildlife.ca.gov/Data/CNDDB

California Department of Fish and Wildlife (CDFW). CESA to the Federal Endangered Species Act: https://www.wildlife.ca.gov/Conservation/CESA/FESA

California Department of Fish and Wildlife homepage. https://www.wildlife.ca.gov

Department of Fish and Game Biogeographical Information and Observation System (BIOS): https://map.dfg.ca.gov/bios/?tool=cnddbQuick

Department of Fish and Wildlife Services (USFWS) Information for Planning and Consultation: https://ecos.fws.gov/ipac/location/index

Department of Pesticide Regulation (DPR) Pesticide Regulation’s Endangered Species Custom Realtime Internet Bulletin Engine (PRESCRIBE): https://www.cdpr.ca.gov/docs/endspec/prescint.htm

Golden Gate Audubon Society: type of bird nests: https://goldengateaudubon.org/conservation/make-the-city-safe-for-wildlife/tree-care-and-bird-safety/types-of-bird-nests/

National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS), west coast region: https://www.westcoast.fisheries.noaa.gov/about_us/california_central_valley_area_office.html

The California Native Plant Society (CNPS) Inventory of Rare and Endangered Plants of California: http://rareplants.cnps.org/advanced.html

U.S. Environmental Protection Agency (USEPA) Endangered Species Bulletins Live! Two: https://www.epa.gov/endangered-species/bulletins-live-two-view-bulletins

U.S. Environmental Protection Agency (USEPA) Endangered Species Protection Bulletins: https://www.epa.gov/endangered-species/endangered-species-protection-bulletins

U.S. Environmental Protection Agency (USEPA) How to Comply with Requirements to Protect California Red-legged Frog from Pesticides: https://www.epa.gov/endangered-species/how-comply-requirements-protect-california-red-legged-frog-pesticides

U.S. Environmental Protection Agency (USEPA) Salmon Mapper: https://www.epa.gov/endangered-species/salmon-mapper

U.S. Environmental Protection Agency (USEPA) San Francisco Bay Area Map Tool to Identify Interim Pesticide Use Limitations (Goby-11): https://www.epa.gov/endangered-species/san-francisco-bay-area-map-tool-identify-interim-pesticide-use-limitations

U.S. Fish and Wildlife Services Critical Habitat for Threatened and Endangered Species AcrGIS Online: https://fws.maps.arcgis.com/home/webmap/viewer.html?webmap=9d8de5e265ad4fe09893cf75b8dbfb77

U.S. Fish and Wildlife Services Endangered Species: https://www.fws.gov/endangered/

U.S. Fish and Wildlife Services Sacramento Fish and Wildlife Office: https://www.fws.gov/sacramento/es/overview/

University of California, Berkeley. CalPhotos: https://calphotos.berkeley.edu/

Chapter 16: Urban Golf

Overview of Urban Golf

Golf courses in urban settings experience specific challenges. These may stem from the proximity of the course to non-golfing residents, a lack of understanding of golf and golf course maintenance, and heavy course usage. Specific areas of concern may arise from a lack of understanding with specific aspects of golf course maintenance, including irrigation, pest management and the maintenance facility operations.

Developing and implementing a public relations strategy that includes outreach and education are critical to addressing these issues.

All embedded hyperlinks below can be found in the References section of this guide.

Public Messaging

Certain issues are “hot topics” and may draw special attention in urban environments, although they are applicable to any course. Some of these areas of interest may include:

- Water: Have irrigation water use data available and be able to describe how you irrigate, what evapotranspiration is, how you monitor soil moisture, etc. If you use

reclaimed water or you planted drought-tolerant species, make this part of the story of the course being a good environmental steward.

- Species and Habitat: Describe the habitat on your course, the species that live there and the enhancements you've made to accommodate them. For example, do you have bat or owl boxes, raptor perches, or plantings that are helpful to Monarch Butterflies? Do you use native plants?
- Pesticide Usage/IPM: Be conscientious not only of what pesticides and methods of IPM you're using, but also the perception associated with those methods. If there are particular environmentally aware activities or practices your golf course partakes in, feel free to plant signs that let bystanders know what actions you're taking.
- Agronomy: Can you describe the type(s) of grass you grow, what its nutrient and water needs are, and why it was, or became, a good selection for your course?
- Flood Protection: Does your course provide a valuable community service by receiving stormwater from the surrounding impervious areas and dissipating and infiltrating that stormwater so that the community and infrastructure downstream is not damaged?

Target Audiences

Depending on your location and particular message(s), there are a variety of entities that you may consider reaching out to.

- County Agricultural Commissioner (CAC): It's important to develop a rapport with the CAC because they're the ones doing your pesticide storage inspections and can inspect your application crew at any time. If anyone complains about an "odd smell" or drift issue, it's often the CAC that gets the call and has to investigate. Having a good working relationship with the CAC can make these issues less onerous. In addition, you may be able to have the CAC assist you with other outreach entities that his/her office has familiarity with, such as the Future Farmers of America (FFA) and 4H.
- Audubon Society: This and other groups may be interested in better understanding the habitat on your course and may even have suggestions on how to enhance it. A good working relationship with Audubon can be helpful when groups unfamiliar with golf challenge your environmental stewardship.
- Local Schools: Whether it's the local high school golf team or the junior high science teacher, developing relationships and providing messages to this group can go a long way to building your brand as an environmental steward. For example, consider hosting a field trip and let them cut some practice cups, hand water a green, and give them a ride in a cart. This first positive experience with a golf course may pay dividends down the road.
- Youth Programs: For example, the Oakland Turfgrass Education Initiative, based at Metropolitan Golf Links, teaches environmental science to inner-city Oakland high school students and introduces them to the game of golf through free study tours on the golf course. Learn more here: https://www.oaklandturf.org/. GCSAA's First Green, an innovative environmental and STEM (Science, Technology, Engineering and Math) education outreach program, uses golf courses as environmental learning labs. Learn more here: http://www.thefirstgreen.org/
- The First Tee Program: Introduces golf to kids and teens in after-school and in-school programs. Learn more here: https://thefirsttee.org/about/
- Audubon Sanctuary Program (ACSP) is not related to the Audubon Society and is a fee-based environmental education and certification program that addresses the following six environmental components:
    - Environmental Planning
    - Wildlife and Habitat Management
    - Chemical Use Reduction and Safety
    - Water Conservation
    - Water Quality Management
    - Outreach and Education

Educational materials, flyers, posters, signage, etc. are available to assist the course in communicating their environmental stewardship. Learn more here: https://audubboninternational.org/acsp-for-golf/

Steps to Being a Good Neighbor

Some steps you can take to be a good neighbor and embrace public relations include, but are not limited to:

- Manage the perception and visual impact of pesticide and fertilizer applications. For example, staff PPE doesn't have to be a white Tyvek, but can be a green or camouflage color.
- Be sure that off-site pesticide and fertilizer drift do not become issues. Select materials that have little or no odor. Be aware of nearby walking paths that may be occupied by bystanders.
- Carefully maintain irrigation heads so they do not leak or irrigate off turf. This presents you as waterwise and a good water conservationist.
- Use good housekeeping at the maintenance facility. Clean up spills and leaks promptly. Minimize debris on the washpad and inoperable equipment in view.
- Train your staff to clearly communicate with golfers and your non-golfing neighbors. Share with them some brief explanations for the above issues so that they aren't stumped when asked. Coach them in communicating in a clear and concise manner and supply them with a bailout: "I don't know, but I can find out and get back to you or give you my Superintendent's contact information and (s)he'd be happy to talk with you."

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Audubon Sanctuary Program (ACSP) for Golf Program. Audubon International. Information available at https://auduboninternational.org/acsp-for-golf/ (Accessed: May 28, 2019)

Oakland Turfgrass Education Initiative (OTEI). Information available at https://auduboninternational.org/acsp-for-golf/ (Accessed: May 28, 2019)

The First Green. Golf Course Superintendent Association of America. Information available at http://www.thefirstgreen.org/ (Accessed: May 28, 2019)

The First Tee. Information available at http://www.thefirstgreen.org/ (Accessed: May 28, 2019)

Chapter 17: Seaside Golf

Overview of Seaside Golf

Coastal golf courses experience specific challenges, including a unique regulatory environment and limitations on fertilizer and pesticide use.

All embedded hyperlinks below can be found in the References section of this guide.

Coastal Regulatory Environment

The California Coastal Management Program is comprised of the following:

- The California Coastal Commission (CCC) manages development along the California coast except for San Francisco Bay. Learn more here: https://www.coastal.ca.gov/

- San Francisco Bay Conservation and Development Commission (BCDC) manages development in San Francisco Bay. Learn more here: http://www.bcdc.ca.gov/

- California Coastal Conservancy purchases, protects, restores, and enhances coastal resources, and provides access to the shore. Learn more here: http://scc.ca.gov/about/

Limitations on Pesticide and Fertilizer Use

The CCC is responsible for issuing responses to coastal permit applications. For example, in 2014, the CCC issued an addendum to a Coastal Commission Permit Application that required the applicant to prepare a Turf and Pest Management Plan "that favors non-chemical strategies over chemical strategies" and calls for "state-of-the-art environmental methods to minimize water use, fertilizer and herbicide application, and chemical pest control to the maximum extent feasible." (San Diego Public Works, 2014).

In another case, the CCC prohibited the use of "pesticides and rodenticides." (City of San Diego, 2017).

Resource Assessment and Protection Measures

Similar to pesticide and fertilizer use, the CCC may require applicants to prepare resource assessment and protection. Example of cases include:

- The CCC required the applicant to prepare landscape plans to ensure all new landscaping is drought-tolerant and native or non-invasive (City of San Diego, 2017).
- The CCC required the applicant to prepare a Restoration Plan that specified removal of invasive species and woody riparian vegetation (Laguna Beach Golf, 2017).
- The CCC negotiated with the applicant to set aside and not develop 635 acres of Monterey Pine forest (Pebble Beach, 2012).
- The CCC required habitat restoration/revegetation activities as part of an approved coastal sage scrub mitigation plan and dedicated an open space and conservation easement to the California Department of Fish and Game (Carlsbad, 2017).
- The CCC required the applicant to prepare a BMP for a complete bunker renovation project (City of San Diego, 2017)

Salinity and Coastal Courses

Golf courses near the seaside may be at risk of experiencing adverse impacts from irrigation salinity and saltwater intrusion into groundwater. Excess salts may come from windborne ocean spray, sedimentary deposits from dune sand, fossil salt in marine sediments, and rock weathering.

For more information about groundwater quality, see Chapter 5: Nutrient Management.

For more about BMPs related to sodic water and irrigation, see Chapter 2: Irrigation.

Sea Level Rise and Flooding

View sea level rise and potential coastal flooding impact areas and relative tide depth using the Sea Level Rise Viewer from the National Oceanic and Atmospheric Administration (NOAA). Link: https://coast.noaa.gov/slr/

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

California Coastal Commission, City of Carlsbad. 2011. Addendum to Item Th14c, Coastal Commission Permit Application #A-6-CII-00-087-A2 (Carlsbad golf course emergency access), for the Commission Meeting of July 14, 2011. Available at https://documents.coastal.ca.gov/reports/2011/7/Th14c-7-2011.pdf (Accessed: April 26, 2019).

California Coastal Commission, City of San Diego. 2017. Staff Report TH5a: Consent Calendar. Available at https://documents.coastal.ca.gov/reports/2017/10/th5a/th5a-10-2017-report.pdf (Accessed: April 26, 2019).

California Coastal Commission, Laguna Beach Golf. 2017. Staff Report W14a: Consent Calendar. Available at https://documents.coastal.ca.gov/reports/2017/8/w14a/w14a-8-2017-report.pdf (Accessed: April 26, 2019).

California Coastal Commission, Pebble Beach. 2012. Staff Report Addendum for W26a: Monterey County Major Amendment Number 1-12 Part 1 (Del Monte Forest Update and Pebble Beach Company Concept Plan). Available at https://www.coastal.ca.gov/sc/pr-pebble-beach-5-2012.pdf (Accessed: April 26, 2019).

California Coastal Commission, San Diego Public Works. 2014. Addendum to Item F20b, Coastal Commission Permit Application #6-14-1607 (City of San Diego Public Works Department), for the Commission Meeting of November 14, 2014. Available at https://documents.coastal.ca.gov/reports/2014/11/F20b-11-2014.pdf (Accessed: April 26, 2019).

California Coastal Commission. 2018. Description of California's Coastal Management Program. Available at https://www.coastal.ca.gov/fedcd/ccmp_description.pdf (Accessed: May 1, 2019).

National Oceanic and Atmospheric Administration (NOAA). 2019. Sea Level Rise Viewer. Available at: https://coast.noaa.gov/slr/ (Accessed: May 6, 2019).

Podmore, C. 2009. "Irrigation Salinity – causes and impacts." NSW Government Dept. of Industry. Available at https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0018/310365/Irrigation-salinity-causes-and-impacts.pdf (Accessed: February 22, 2018).

Chapter 18: Golf Courses on Landfills

Overview

Operating a golf course on a closed municipal solid waste landfill (MSWL) presents an opportunity to transform a degraded site into an active recreational amenity. By using the closed MSWL as a golf course, the potential exists to build and maintain features that are more protective of the environment than an undeveloped closed MSWL. However, there are challenges with operation of a golf course on a closed MSWL that include:

- Maintenance of integrity and effectiveness of the MSWL's cover
- Maintenance and operation of a leachate collection system
- Maintenance and operation of a gas monitoring system
- Maintenance and operation of a surfacewater, groundwater and building monitoring system

Reference: CalRecycle, 2016. Deegan, 2017. USEPA, 2014.

Regulatory Considerations

The primarily agencies with responsibility for municipal solid waste MSWLs are:

- California Department of Resources Recycling and Recovery, also known as "CalRecycle"
- State Water Resources Control Board (SWRCB)

Both are part of the California Environmental Protection Agency (CalEPA). CalRecycle was established in 2010 to replace the California Integrated Waste Management Board.

In addition to CalRecycle and the SWRCB, several other agencies play a local role in MSWL management and include:

- Regional Water Quality Control Board (RWQCB)
- Local Air Quality Management District (AQMD)

- Local Certifying Unified Program Agency (CUPA) (typically referred to as the County Department of Environmental Health)

- Local County Department of Public Works

Principles

- CalRecycle has requirements under 40 Code of Federal Regulations (CFR) Part 258, Subpart F - Closure and Post-Closure Care for closure plans for final cover systems, and closure plans for MSWLs to be converted into a golf course (CalRecycle, 2018b).
- 27 California Code of Regulations (CCR) contains CalRecycle's and the SWRCB's joint regulations pertaining to waste disposal on land.
- The SWRCB requires that the final closure and post-closure plans for MSWLs are reviewed and approved by the RWQCB per 27 CCR 21090.

- A MSWL that ceases to operate must be closed and maintained according to 27 CCR 20950 and has the following requirements:

    - Maintain the integrity and effectiveness of the final cover system, leachate collection, groundwater and methane monitoring systems.
    - The owner/operator of a closed MSWL must prepare a post-closure plan that includes:
        - A description of all required monitoring and maintenance activities, including the frequency of monitoring
        - The name, address, and phone number of the person to contact during the post-closure care period,
        - And a description of the planned uses of the land during the post-closure care period (USEPA, 2018b)
    - Any land use activities must not disturb the integrity or operation of any of the waste containment systems or the monitoring systems (CalRecycle, 2016).

Best Management Practices

- Read and understand the MSWL's post closure maintenance plan.

- Consult with representatives of your local Air Quality Management District (AQMD), CalRecycle, the SWRCB, RWQCB and local County authorities, including the CUPA, before altering features of the MSWL.

What is MSWL

The SWRCB and CalRecycle define the following in 27 CCR 20164:

- "MSWL" means a "waste management unit" at which waste is discharged in or on land for disposal. It does not include surface impoundment, waste pile, land treatment unit, injection well, or soil amendments (27 CCR *20090).*
- "Waste Management Unit" means an area of land, or a portion of a "waste management facility", at which waste is discharged. The term includes containment features and ancillary features for precipitation and drainage control and for monitoring.
- "Waste management facility" or "facility" means the entire parcel of property at which waste discharge operations are conducted. Such a facility may include one or more waste management units.

The materials that a MSWL can take are varied. For example, some MSWLs are restricted to municipal household waste, while others can only accept construction debris, and others can only take hazardous waste.

Only previously closed municipal solid waste MSWLs (MSWL) for which a post closure plan has been prepared will be considered in this chapter.

How does a MSWL work?

MSWLs accept waste from commercial collection and transportation companies servicing communities and residents of these communities (USEPA, 2014). MSWLs often try to segregate and recycle metal, glass and electronic waste to keep these materials out of the MSWL to limit sources of contamination and reduce volume (USEPA, 2014; CalRecycle, 2019b). Although MSWLs are typically covered once refuse is brought to them, covering doesn't happen immediately. As the waste mixes with rain water and is then covered, it begins to decompose (USEPA, 2014). This decomposition process is typically devoid of oxygen and is referred to as anaerobic decomposition. As a result of anaerobic decomposition, a variety of gases are formed including methane and numerous odiferous sulfur-containing compounds including hydrogen sulfide and its analogs (Glanton, 2003; USEPA, 2014). It is these sulfur containing gases that are responsible for the rotten egg smell common to MSWLs. Methane gas is flammable and must be either flared off. More commonly, methane is collected and used as a fuel to operated turbines that generate electricity (USEPA, 2014). In most cases, the amount and location of methane generation at a MSWL must be monitored, recorded and reported to regulatory agencies like CalRecycle or the local County responsible agency.

As MSWL content mixes with rainwater, it generates leachate which is often contaminated with the contents of the waste in the MSWL (USEPA, 2014). Depending on the depth to groundwater beneath the MSWL, or proximity to surfacewater adjacent to the MSWL, leachate may pose a risk to water quality. Like methane, leachate must be sampled on a regular basis and reported. In some cases, leachate generation is significant enough to require its collection and disposal (USEPA, 2014). Methods to limit leachate generation include the use of a liner under the MSWL and the placement of a water-tight cap on the top of the MSWL (USEPA, 2014). Depending on the liner and cap type, quality and method of installation, either the cap and/or the liner may not remain fully functional over the life of the MSWL.

As waste decomposes, it settles (Young, 2010). The waste type and the degree of decomposition and other factors like leachate pumping, moisture and cover type determine the rate at which settlement occurs. Because factors that influence settlement are so varied, differential settlement of the MSWL cover or cap over time is common.

The following chapters explore characteristics of a MSWL and how they relate to golf courses.

MSWL Gas

Principles

- Landfills containing organic matter and typically will produce a variety of organic gases, including methane and hydrogen sulfide in a largely anaerobic environment (Young, 2010)**.**
- Typically, once a MSWL is closed and is no longer accepting waste, it is capped with an impermeable layer of clay, polyethylene, or other material to prevent rainwater from entering the MSWL, and for preventing methane from uncontrolled escape (University of Florida, 2015).
- MSWL gas can be either flared off or captured and used to generate electricity (USEPA, 2014).
- MSWL gas monitoring requirements are outlined in 27 CCR 20920-20929. In general, a gas monitoring plan identifies the equipment used, and the location duration and frequency of monitoring. For example, this inside of buildings on the MSWL may require monitoring.
- The concentration of methane gas must not exceed 1.25 percent by volume in air within any portion of any on-site structures. This value is often referred to as the Lower Explosive Limit (LEL). (27 CCR 20921.1)

Best Management Practices

- Before altering the surface of the MSWL and its cap, it is critical to understand what impacts this may have to the MSWL and its gas and leachate generation.
- Read and understand the MSWL's post closure maintenance plan.

Consult with representatives of your local Air Quality Management District (AQMD), CalRecycle, the SWRCB, Regional Water Quality

Surfacewater

Principles

- Surface water quality can be affected by MSWL leachate. In order to prevent this from happening, the MSWL must be designed to capture, collect and dispose of leachate (USEPA, 2014).
- Leachate must be regularly sampled and analyzed (USEPA, 2014).
- The frequency and location of sampling, sampling methods and analytical techniques are commonly specified in a Sampling and Analysis Plan (SAP) as part of the MSWL's post closure documentation. The requirements of the SAP are typically specified by the SWRCB, RWQCB, CalRecycle or the local County agency and can be found in the post closure maintenance plan (Young, 2010).
- The MSWL cap must be designed and maintained in such a way as to protect it against damage from stormwater so that it is not damaged (University of Florida, 2015). Protective Best Management Practices (BMPs) often include the use of a vegetated cover, and other erosion control tools such as benching, limitations on slope and use of other hydraulic controls to limit the speed and energy of water contacting the cap (27 CCR 21090).
- If leachate is collected, it must be managed in an on-site facility like a pond, or trucked off site. Discharge of leachate, gas condensate, or other waste liquids to any final-covered portion of a municipal solid waste MSWL is subject to the restrictions under 27 CCR 20200(d).

Best Management Practices

- Understand the post closure requirements of MSWL so that adverse impacts to water quality can be avoided. Before altering the surface of the MSWL and its cap, it is critical to understand what impacts this may have to the MSWL and surfacewater quality. For example, the creation of a drainage swale or bunker may damage or interfere with the cap or flow of water off of the cap, resulting in impacts to stormwater water flow and surfacewater quality.
- Read and understand the MSWL's post closure maintenance plan.

- Consult with representatives of CalRecycle, the SWRCB, RWQCB and local County authorities before altering the MSWL cap and cover.

Groundwater

Principles

- Groundwater exists beneath the MSWL (CalRecycle, 2016). The vertical distance separating the first encountered groundwater from the waste in the MSWL varies by location.
- Depending on this separation distance and the characteristics of the local geology, leachate may migrate to groundwater and cause adverse impacts to water quality (Young, 2010).
- Monitoring the groundwater elevation (i.e., the vertical distance to first encountered groundwater) may assist in assessing its proximity to the waste in the MSWL (27 CCR 22920).
- Monitoring the quality of the groundwater up, cross downgradient of the MSWL is required to assess impacts, if any, of the MSWL leachate to groundwater quality. Requirements for monitoring are described in 27 CCR 20925.
- Groundwater elevation and sampling is commonly done by installing monitoring wells that typically consist of 2-inch PVC pipe inside of a 6-inch steel casing. This casing often protrudes 3 or more feet from the ground surface. In some cases, a groundwater monitoring well may be completed flush with the ground surface (27 CCR 21760).
- The number, spacing and depth of wells is assessed on a site-specific basis based on a number of factors including depth to water, aquifer thickness, groundwater flow rate and direction, and the other geologic and hydrogeologic characteristics of the site (USEPA, 2018).
- Samples collected from up gradient wells show the background concentrations of constituents in the groundwater, while the down and cross gradient wells show the extent of groundwater impacts due to leachate (USEPA, 2018b).
- The frequency and location of sampling, sampling methods and analytical techniques are commonly specified in a Sampling and Analysis Plan (SAP) as part of the MSWL's post closure documentation. The requirements of the SAP are typically specified by the SWRCB, RWQCB, CalRecycle or the local County agency (Young, 2010).

Best Management Practices

- Understand the post closure requirements of MSWL so that adverse impacts to groundwater water quality can be avoided. Before altering the surface of the MSWL and its cap, it is critical to understand what impacts this may have to the groundwater quality.
- Read and understand the MSWL's post closure maintenance plan.
- Consult with representatives of CalRecycle, the SWRCB, RWQCB and local County authorities before altering the MSWL cap and cover.

- Be aware of the presence of groundwater monitoring wells during earth moving so that they are not damaged. A damaged monitoring well can be a direct conduit for contaminants to reach groundwater.

Buildings

Principles

- Gas escaping from MSWL may enter and accumulate in a building (Young, 2010).
- If the concentration of gas in the structure exceeds the LEL of 1.25%, a dangerous explosive condition may exist (Young, 2009).

Best Management Practices

- Automatic methane gas sensors, designed to trigger an audible alarm when methane concentrations are detected, should be installed in all buildings consistent with 27 CCR 20931.
- Enclosed basement construction should be prohibited (27 CCR 21190).
- Buildings should be constructed to mitigate gas accumulation which may include an active gas collection or passive vent systems. For example, a geomembrane or equivalent system with low permeability to MSWL gas should be used between the concrete floor slab of the building and subgrade (USEPA, 2014; 27 CCR 21190).
- Buildings should be constructed to mitigate the effects of differential settlement. For example, utility connections should be designed with flexible connections (27 CCR 21090).
- Building foundations should not interfere with the cap. For example, pilings or piers should not be installed in or through the cap, unless the design has been reviewed and approved by the RWQCB, CalRecycle and the local county agency (USEPA, 2014).
- Methane gas monitoring should be conducted inside all buildings and underground utilities in accordance with 27 CCR 20933.
- Unauthorized personnel or visitors should be kept away from buildings known to accumulate methane (27 CCR 21600; USEPA, 2014).
- Authorized personnel should be provided sufficient re-occurring training and access to service and monitor the gas sensors and alarms (27 CCR 21600; USEPA, 2014).

Frequently Asked Questions

What are some of the things that an Inspector looks for during a post closure MSWL inspection?

Inspections are done by a local enforcement agency, typically associated with the county the course and MSWL are located in. Inspections are done to meet requirements of applicable sections of Division 30 of the Public Resources Code and 14 CCR and 27 CCR. The inspector will often check for one or more of the following:

- Evidence of differential settlement.
- Operation of the MSWL gas collection system.
- Presence of ponded water.
- Operation of the irrigation system in a manner to avoid flooding/ponding of water in all areas of the golf course to prevent infiltration of water into the buried waste.
- Review of records of methane gas monitoring probes, equipment used, condition of the probe vault, etc.
- Presence of construction projects that are moving earth or occurring below grade.
- Monitor structures that release or are suspected of releasing methane gas.
- Inspect methane gas monitoring devices.

Is MSWL methane injurious to turfgrass?

Yes. Sanctuary Lake Golf Course in Troy, MI encountered methane migration that killed grass in several fairways. Trenching in these areas and placement of perforated drainage pipe allowed gas to escape before reaching turfgrass roots (BCDN, 2019). Whether or not a technique like this would be allowed in California is uncertain. Approvals from the local Air Quality Management District, the County and CalRecycle would be needed at a minimum.

References

NOTE: Links to webpages and PDFs were active as of the listed access date. Access to those web resources and information presented therein are subject to change.

Billy Casper Digital Network (BCDN) Staff, Undated. The perils of building a golf course on a former landfill. Billy Casper Digital Network. Retrieved from: http://www.billycasperdigitalnetwork.com/courses/the-perils-of-building-a-golf-course-on-a-former-landfill (Accessed: September 10, 2019).

California Certified Unified Program Agency (CUPA). Undated. Laws and Regulations. Retrieved from: https://calepa.ca.gov/cupa/lawsregs/ (Accessed: September 17, 2019).

CalRecycle. 2016. Final Closure and Post Closure Maintenance Plan. CalRecycle 177. (Accessed: September 19, 2019).

CalRecycle. 2018. Landfill Gas Monitoring and Control. Retrieved from: https://www.calrecycle.ca.gov/swfacilities/landfills/gas/monitoring (Accessed: July 18, 2019).

CalRecycle. 2019a. Title 27, Environmental Protection – Division 2, Solid Waste. Retrieved from: https://www.calrecycle.ca.gov/laws/regulations/title27 (Accessed September 19, 2019)

CalRecycle. 2019b. Title 27, Full Regulations. Department of Resources Recycling and Recovery. Waste Permitting, Compliance, and Mitigation Division. Retrieved from: https://www.calrecycle.ca.gov/docs/cr/laws/regulations/title27/jan2019title27full.pdf (Accessed: July 26, 2019).

Deegan, 2017. Grass over garbage: Golf courses give landfill sites a second life. Golf Advisor. Retrieved from: https://www.golfadvisor.com/articles/grass-over-garbage-golf-courses-give-landfill-sites-a-second-life (Accessed: September 17, 2019).

Glanton, Dahleen. 2003. Changing Course of Landfills. Chicago Tribune. Sandy Springs, GA. Retrieved from: https://www.chicagotribune.com/news/ct-xpm-2003-07-06-0307060360-story.html (Accessed: September 17, 2019)

United States Environmental Protection Agency (USEPA). 2014. Closed Waste Sites as Community Assets: A Guide for Municipalities, Landfill Owners, and Regulators. EPA/600/R-14/349. Available Retrieved from: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P100LHOS.TXT (Accessed: July 23, 2019).

United States Environmental Protection Agency (USEPA). 2016. Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills. Retrieved from: https://www.federalregister.gov/documents/2016/08/29/2016-17700/emission-guidelines-and-compliance-times-for-municipal-solid-waste-landfills (Accessed: September 10, 2019)

United States Environmental Protection Agency (USEPA). 2018a. Municipal Solid Waste Landfills. Retrieved from: https://www.epa.gov/landfills/municipal-solid-waste-landfills (Accessed: September 10, 2019).

United States Environmental Protection Agency (USEPA). 2018b. Requirements for Municipal Solid Waste Landfillss. Available at: https://www.epa.gov/landfills/requirements-municipal-solid-waste-landfills-mswlfs (Accessed: September 17, 2019).

University of Florida. 2015. Landfill Sites and Trees. Retrieved from: https://hort.ifas.ufl.edu/woody/land-fills.shtml (Accessed: July 18, 2019).

Young, Glenn. 2009. Continuous Monitoring of Structures for Landfill Intrusion. Closed, Illegal and Abandoned Site Program. California Integrated Waste Management Board. Publication # IWMB-2009-014 (Accessed July 22, 2019).

Young, Glenn. 2010. Former Landfill and Disposal Site Investigations. CalRecycle. (Accessed: July 22, 2019).

References

Selected References

(Note: URLs are as of September 2016)

Aerts, M.O., N. Nesheim, and F. M. Fishel. April 1998; revised September 2015. *Pesticide recordkeeping.* PI-20. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI012.

Aquatic Ecosystem Restoration Foundation. 2014. Biology and Control of Aquatic Plants: A Best Management Practices Handbook: 3rd Ed. Gettys, L.A., W. T. Haller, and D. G. Petty, editors.http://www.aquatics.org/bmp%203rd%20edition.pdf

ASCE, January 2005. *The ASCE standardized reference evapotranspiration equation.* Final report of the Task Committee on Standardization of Reference Evapotranspiration, Environmental and Water Resourses Institute of the American Society of Civil Engineers. 1801 Alexander Bell Drive, Reston, VA 20191 Available: http://www.kimberly.uidaho.edu/water/asceewri/ascestzdetmain2005.pdf

Bohmont, B. 1981. *The new pesticide users guide.* Fort Collins, Colorado: B & K Enterprises.

Brecke, B.J., and J.B. Unruh. May 1991; revised February 25, 2003. *Spray additives and pesticide formulations.* Fact Sheet ENH-82. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/LH061.

Broder, M.F., and D.T. Nguyen. 1995. *Coating concrete secondary containment structures exposed to agrichemicals.* Circular Z-361. Muscle Shoals, Alabama: Tennessee Valley Authority, Environmental Research Center. Tel. (205) 386–2714.

Broder, M.F., and T. Samples. 2002. *Tennessee handbook for golf course environmental management.* Tennessee Department of Agriculture.

Buss, E.A. January 2002; revised July 2003. *Insect pest management on golf courses.* ENY-351. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/IN410.

Butler, T., W. Martinkovic, and O.N. Nesheim. June 1993; revised April 1998. *Factors influencing pesticide movement to groundwater.* PI2. Gainesville, Florida: Institute of

Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI002.

California Fertilizer Association. 1985. *Western fertilizer handbook*, 7th ed. Sacramento, California.

Carrow, R.N., R. Duncan, and C. Waltz. 2007. Best Management Practices (BMPs) Water-Use Efficiency/Conservation Plan for Golf Courses. Available: https://www.gcsaa.org/uploadedfiles/Environment/Get-Started/BMPs/Water-use-efficiency-and-conservation-best-management-practices-(Georgia).pdf

Carrow, R.N., R.R. Duncan, and D. Wienecke. 2005. BMPs: Critical for the golf industry. *Golf Course Management*. 73(6):81-84.

Center for Resource Management. 1996. *Environmental principles for golf courses in the United States.* 1104 East Ashton Avenue, Suite 210, Salt Lake City, Utah 84106. Tel: (801) 466-3600, Fax: (801) 466-3600.

Clark, G.A. July 1994. *Microirrigation in the landscape.* Fact Sheet AE254. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/AE076.

Clark, Mark and Acomb, Glenn; Florida Field Guide to Low Impact Development: Stormwater Reuse. Univ. Florida 2008. http://buildgreen.ufl.edu/Fact_sheet_Stormwater_Reuse.pdf

Colorado Nonpoint Source Task Force. 1996. Guideslines for Water Quality Enahncement at Golf Courses Through the Use of Best Management Practices. Available: http://www.wrightwater.com/assets/7-golf-course-bmps.pdf

Connecticut Department of Environmental Protection. 2006. Best Management Practices for Golf Course Water Use. Available: http://www.ct.gov/deep/lib/deep/water_inland/diversions/golfcoursewaterusebmp.pdf

Cromwell, R.P. June 1993; reviewed December 2005. *Agricultural chemical drift and its control.* CIR1105. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/AE043.

Crow, W.T. February 2001; revised November 2005. *Nematode management for golf courses in Florida.* ENY-008 (IN124). Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/IN124.

Daum, D.R., and T.F. Reed. n.d. *Sprayer nozzles.* Ithaca, New York: Cornell Cooperative Extension. Available http://psep.cce.cornell.edu/facts-slides-self/facts/gen-peapp-spray-nozz.aspx.

Dean, T.W. February 2003. *Pesticide applicator update: Choosing suitable personal protective equipment.* PI-28. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI061.

———. April 2004; revised November 2004. *Secure pesticide storage: Facility size and location.* Fact Sheet PI-29. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI064.

———. April 2004; revised November 2004. *Secure pesticide storage: Essential structural features of a storage building.* Fact Sheet PI-30. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI065.

Dean, T.W., O.N. Nesheim, and F. Fishel. Revised May 2005. *Pesticide container rinsing.* PI-3. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI003.

Delaware Nutrient Management Commission. 2006. Water Quality Best Management Practices: Nutrients, Irrigation and Pesticides for Golf Course, Athletic Turf, Lawn Care and Landscape Industries. Available: http://dda.delaware.gov/nutrients/forms/BMPnonagforprinter.pdf

Dodson, R.G. 2000. Managing wildlife habitat on golf courses. Sleeping Bear Press. Chelsea, MI.

Elliott, M.L., and G.W. Simone. July 1991; revised April 2001. *Turfgrass disease management.* SS-PLP-14. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/LH040.

Fishel, F.M. March 2005. *Interpreting pesticide label wording.* Gainesville, Florida: Institute of Food and Agricultural Sciences. Available: http://edis.ifas.ufl.edu/PI071.

Fishel, F.M., and Nesheim, O.N. November 2006. *Pesticide safety.* FS11. Gainesville, Florida: Institute of Food and Agricultural Sciences. Available: http://edis.ifas.ufl.edu/pdffiles/CV/CV10800.pdf.

Florida Department of Agriculture and Consumer Services. n.d. *Pesticide recordkeeping—benefits and requirements.* Available: http://www.flaes.org/pdf/Pesticide%20Recordkeeping%20Pamphlet%205-05.pdf.

Florida Department of Agriculture and Consumer Services. Division of Agricultural Environmental Services. *Suggested pesticide recordkeeping form.* Available: https://www.freshfromflorida.com/content/download/2990/18861/Suggested%20Pesticide%20Recordkeeping%20Form.pdf

———. Division of Agricultural Environmental Services. *Suggested pesticide recordkeeping form for organo-auxin herbicides.* Available: http://forms.freshfromflorida.com/13328.pdf.

Florida Department of Agriculture and Consumer Services and Florida Department of Environmental Protection. 1998. *Best management practices for agrichemical handling and farm equipment maintenance.* Available: http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/agbmp3p.pdf

Florida Department of Environmental Protection. 2008. *Florida stormwater, erosion, and sedimentation control inspector's manual.* Tallahassee, Florida: Nonpoint Source Management Section, MS 3570, 3900 Commonwealth Blvd.., Tallahassee, Florida 32399-3000. Available: http://www.dep.state.fl.us/water/nonpoint/docs/erosion/erosion-inspectors-manual.pdf.

———. December 27, 2002. *Environmental risks from use of organic arsenical herbicides at south Florida golf courses.* FDEP white paper. Available: http://fdep.ifas.ufl.edu/msma.htm.

———. April 2002. *Florida water conservation initiative.* Available: http://www.dep.state.fl.us/water/waterpolicy/docs/WCI_2002_Final_Report.pdf.

_____. 2015. "Florida-friendly Best Management Practices for Protection of Water Resources by the Green Industries", Florida Department of Environmental Protection. Revised December 2008, 3rd printing 2015. https://fyn.ifas.ufl.edu/pdf/grn-ind-bmp-en-12-2008.pdf

———. 2012. Best Management Practices for The Enhancement of Environmental Quality on Florida Golf Courses. Florida Department of Environmental Protection. 3rd printing, September 2012. http://www.dep.state.fl.us/water/nonpoint/docs/nonpoint/glfbmp07.pdf

———. Revised August 2009. *A guide on hazardous waste management for Florida's auto repair shops.* Available: http://www.dep.state.fl.us/waste/quick_topics/publications/shw/hazardous/business/Paint_and_Body8_09.pdf.

———. October 2005. *Checklist guide for 100% closed loop recycle systems at vehicle and other equipment wash facilities.* Available:

http://www.dep.state.fl.us/water/wastewater/docs/ChecklistGuideClosed-LoopRecycleSystems.pdf.

———. October 2005. *Guide to best management practices for 100% closed-loop recycle systems at vehicle and other equipment wash facilities.* Pollution Prevention Program and Industrial Wastewater Section. Available: http://www.dep.state.fl.us/water/wastewater/docs/GuideBMPClosed-LoopRecycleSystems.pdf.

———. 2006. *State of Florida erosion and sediment control designer and reviewer manual.* Nonpoint Source Management Section. Available: http://www.dep.state.fl.us/water/nonpoint/erosion.htm.

———. 2016. Operation Cleansweep for Pesticides Web site. Available: http://www.dep.state.fl.us/waste/categories/cleansweep-pesticides.

———. December 1, 2005. *Standards and specifications for turf and landscape irrigation systems,* 5th Ed. Available: http://ufdc.ufl.edu/UF00076845/00001.

———. December 2006. *Landscape Irrigation & Florida-Friendly Design Standards.* Florida Department of Environmental Protection, Office of Water Policy, 3900 Commonwealth Blvd., MS 46, Tallahassee, FL 32399-3000. Available: http://www.dep.state.fl.us/water/waterpolicy/docs/LandscapeIrrigationFloridaFriendlyDesign.pdf

Gilman, E. 2006. *Pruning shade trees in landscapes.* Available: http://hort.ufl.edu/woody/pruning/index.htm.

Golf Course Superintendents Association of America. 2012. Golf Course Environmental Profile; Volume IV; Energy Use and Energy Conservation Practices on U.S. Golf Courses. Available: https://www.gcsaa.org/Uploadedfiles/Environment/Environmental-Profile/Energy/Golf-Course-Environmental-Profile--Energy-Use-and-Conservation-Report.pdf

Golf Course Water Resources Handbook of Best Management Practices (Pennsylvania). 2009. Available: http://pecpa.org/wp-content/uploads/Golf-Course-Water-Resources-Handbook-of-Best-Management-Practices.pdf

Havlin, J.L., et al. 2004. *Soil fertility and fertilizers*, 7th Ed. Prentice Hall.

Haydu, J.J., and A.W. Hodges. 2002. *Economic impacts of the Florida golf course industry.* UF–IFAS Report EIR 02-4. Available: http://economicimpact.ifas.ufl.edu/publications/EIR02-4r.pdf.

Helfrich, L.A., et al. June 1996. *Pesticides and aquatic animals: A guide to reducing impacts on aquatic systems.* Virginia Cooperative Extension Service. Publication Number 420-013. Available: http://www.ext.vt.edu/pubs/waterquality/420-013/420-013.html.

Hornsby, A.G., T.M. Buttler, L.B. McCarty, D.E. Short, R.A. Dunn, G.W. Simone. Revised September 1995. *Managing pesticides for sod production and water quality protection.* Circular 1012. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/SS053.

Insecticide Resistance Action Committee Web site. Available: http://www.irac-online.org/.

King, K.W., and J.C. Balogh. 2001. Water quality impacts associated with converting farmland and forests to turfgrass. In: *Transactions if the ASAE, Vol. 44(3): 569-576.*

Lehtola, C.J., C.M. Brown, and W.J. Becker. November 2001. *Personal protective equipment. OSHA Standards 1910.132-137.* AE271. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/OA034.

McCarty, L.B., and D.L. Colvin. 1990. *Weeds of southern turfgrasses.* Gainesville, Florida: University of Florida.

Midwest Plan Service. Revised 1995. *Designing facilities for pesticide and fertilizer containment.* MWPS-37. Midwest Plan Service, 122 Davidson Hall, Iowa State University, Ames, IA 50011-3080. Tel.: (515) 294-4337. Available: http://infohouse.p2ric.org/ref/50/49471.pdf.

Mitra, S. 2006. *Effects of recycled water on turfgrass quality maintained under golf course fairway conditions.* WateReuse Foundation, 1199 North Fairfax Street, Suite 410, Alexandria, VA 22314. Available: http://www.watereuse.org/Foundation/documents/wrf-04-002.pdf.

National Pesticide Telecommunications Network. December 1999. *Signal words.* Fact Sheet. Available: http://npic.orst.edu/factsheets/signalwords.pdf.

Nesheim, O.N., and F.M. Fishel September 2007, reviewed August 2013.*Interpreting PPE statements on pesticide labels.* P116. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: https://edis.ifas.ufl.edu/pdffiles/CV/CV28500.pdf.

Nesheim, O.N., and F.M. Fishel. March 1989; revised November 2005. *Proper disposal of pesticide waste.* PI-18. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/PI010.

Nesheim, O.N., F.M. Fishel, and M. Mossler. July 1993. *Toxicity of pesticides.* PI-13. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/pdffiles/PI/PI00800.pdf..

O'Brien, P. July/August 1996. Optimizing the turfgrass canopy environment with fans. *USGA Green Section Record, Vol. 34(4), 9-12* Available: http://gsrpdf.lib.msu.edu/ticpdf.py?file=/1990s/1996/960709.pdf.

O'Brien, P., and C. Hartwiger. March/April 2003. Aerification and sand topdressing for the 21st century. *USGA Green Section Record, Vol. 41(2), 1-7.* Available: http://turf.lib.msu.edu/2000s/2003/030301.pdf.

Olexa, M.T., A. Leviten, and K. Samek. December 2008, revised December 2013. *Florida solid and hazardous waste regulation handbook: Table of contents.* FE758. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/fe758.

Otterbine Barebo, Inc. 2003. *Pond and lake management.* 3840 Main Road East, Emmaus, PA 18049. Available: http://www.otterbine.com/assets/base/resources/PondAndLakeManual.pdf.

Peterson, A. 2000. *Protocols for an IPM system on golf courses.* University of Massachusetts Extension Turf Program.

Pennsylvania Department of Environmental Protection, LandStudies, Inc., The Pennsylvania Environmental Council. Golf Course Water Resources Handbook of Best Management Practices. June 2009. http://pecpa.org/wp-content/uploads/Golf-Course-Water-Resources-Handbook-of-Best-Management-Practices.pdf

Pettinger, N.A. 1935. Useful chart for teaching the relation of soil reaction to availability of plant nutrients to crops. *Virginia Agri. Ext. Bul. 136, 1-19.*

Portness, R.E., J.A. Grant, B. Jordan, A.M. Petrovic, and F.S. Rossi. 2014. Best Management Practices for New York State Golf Courses. Cornell Univ. Available: http://nysgolfbmp.cals.cornell.edu/ny_bmp_feb2014.pdf

Rao, P.S.C., and A.G. Hornsby. May 1993; revised December 2001. *Behavior of pesticides in soils and water.* Fact Sheet SL40. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/SS111.

Rao, P.S.C., R.S. Mansell, L.B. Baldwin, and M.F. Laurent. n.d. *Pesticides and their behavior in soil and water.* Ithaca, New York: Cornell Cooperative Extension. Available: http://psep.cce.cornell.edu/facts-slides-self/facts/gen-pubre-soil-water.aspx.

Rodgers, J. n.d. *Plants for lakefront revegetation.* Invasive Plant Management, Florida Department of Environmental Protection, 3900 Commonwealth Blvd., MS 705, Tallahassee, FL 32399. Available: http://myfwc.com/media/2518526/LakefrontRevegetation.pdf .

Sartain, J.B. 2000. *General recommendations for fertilization of turfgrasses on Florida soils.* Fact Sheet SL-21. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/LH014.

———. 2001. *Soil testing and interpretation for Florida turfgrasses.* SL-181. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/SS317.

———. 2002. revised October 2006. *Recommendations for N, P, K, and Mg for golf course and athletic field fertilization based on Mehlich-I extractant.* SL-191. Available: http://edis.ifas.ufl.edu/SS404. Gainesville, Florida.

Sartain, J.B., and W.R. Cox. 1998. *The Florida fertilizer label.* SL-3. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/SS170.

Sartain, J.B., G.L. Miller, G.H. Snyder, and J.L. Cisar. 1999a. Plant nutrition and turf fertilizers. In: J.B. Unruh and M. Elliott (Eds.). *Best management practices for Florida golf courses.* SP-141 2nd ed. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida.

———. 1999b. Liquid fertilization and foliar feeding. In: J.B. Unruh and M. Elliott (Eds.), *Best management practices for Florida golf courses.* SP-141 2nd ed. Gainesville , Florida: Institute of Food and Agricultural Sciences, University of Florida.

Sartain, J.B., G.L. Miller, G.H. Snyder, J.L. Cisar, and J.B. Unruh. 1999. Fertilization programs. In: J.B. Unruh and M. Elliott (Eds.). *Best management practices for Florida golf courses.* SP-141 2nd ed. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida.

Schueler, T.R. 2000. Minimizing the impact of golf courses on streams. Article 134 in: *The practice of watershed protection.* T. R. Schueler and H. K. Holland (Eds.). Ellicott City, Maryland: Center for Watershed Protection. Available: http://www.stormwatercenter.net/.

Schumann, G.L., et al. January 1998. *IPM handbook for golf courses.* Indianapolis, Indiana: Wiley Publishing, Inc.

Seelig, B. July 1996. *Improved pesticide applicationBMP for groundwater protecton from pesticides.* AE-1113. Fargo, North Dakota: North Dakota State University Extension Service. Available: http://www.ext.nodak.edu/extpubs/h2oqual/watgrnd/ae1113w.htm.

Smajstrla, A.G., and B.J. Boman. April 2000. *Flushing procedures for microirrigation systems.* Bulletin 333. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/WI013.

Staples, A.J. 2. Golf Course Energy Use Part 2: Pump Stations. Golf Course Management, July 2009. https://www.gcsaa.org/Uploadedfiles/Environment/Resources/Energy-Conservation/Golf-course-energy-use-Part-2-Pump-stations.pdf

Tennessee Department of Agriculture. Tennessee Handbook for Golf Course Environmental Management. Available: http://tennesseeturf.utk.edu/pdffiles/golfcourseenvironmgmt.pdf

Thostenson, A., C. Ogg, K. Schaefer, M. Wiesbrook, J. Stone, and D. Herzfeld. 2016. Laundering pesticide-contaminated work clothes. PS 1778. Fargo, ND. North Dakota State Univ. Cooperative Extension. https://www.ag.ndsu.edu/pubs/plantsci/pests/ps1778.pdf

Trautmann, N.M., K.S. Porter, and R.J. Wagenet. n.d. *Pesticides and groundwater: A guide for the pesticide user.* Fact Sheet. Ithaca, New York: Cornell Cooperative Extension. Available: http://psep.cce.cornell.edu/facts-slides-self/facts/pest-gr-gud-grw89.aspx

University of Florida—Institute of Food and Agricultural Sciences. Center for Aquatic and Invasive Plants Web site. Available: http://plants.ifas.ufl.edu/.

———. Insect Identification Service Web site. Available: http://edis.ifas.ufl.edu/SR010.

———. Nematode Assay Laboratory Web site. Available: http://edis.ifas.ufl.edu/SR011.

———. Pesticide Information Office Web site. Available: http://pested.ifas.ufl.edu/

———. Plant Disease Clinic Web site. Available: http://plantpath.ifas.ufl.edu/extension/plant-diagnostic-center/

———. Rapid Turfgrass Diagnostic Service Web site. Available: http://turfpath.ifas.ufl.edu/rapiddiag.shtml.

Unruh, J.B. November 1993. *Pesticide calibration formulas and information.* Fact Sheet ENH-90. Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://edis.ifas.ufl.edu/WG067.

Unruh, J.B. 2006. *2006 University of Florida's pest control guide for turfgrass managers.* Gainesville, Florida: Institute of Food and Agricultural Sciences, University of Florida. Available: http://turf.ufl.edu.

Unruh, J.B., and B.J. Brecke. Revised January 1998. *Response of turfgrass and turfgrass weeds to herbicides.* ENH-100. Gainesville, Florida: Department of Environmental Horticulture, University of Florida. Available: http://edis.ifas.ufl.edu/WG071.

Unruh, J.B., and M. Elliot. 1999. *Best management practices for Florida golf courses,* 2nd ed. UF–IFAS Publication SP-141. Gainesville, Florida.

Unruh, J.B., J.L. Cisar, and G.L. Miller. 1999. Mowing. In: J.B. Unruh and M.L. Elliot (Eds.). *Best management practices for Florida golf courses,* 2nd ed. Gainesville, Florida: University of Florida Institute of Food and Agricultural Sciences.

Unruh, J.B., A.E. Dudeck, J.L. Cisar, and G.L. Miller. 1999. Turfgrass cultivation practices. In: J.B. Unruh and M.L. Elliot (Eds.). *Best management practices for Florida golf courses,* 2nd ed. Gainesville, Florida: University of Florida Institute of Food and Agricultural Sciences.

U.S. Environmental Protection Agency. 2005. *GreenScapes: Environmentally beneficial landscaping*; Washington, D.C. Office of Solid Waste and Emergency Response. Available: https://archive.epa.gov/greenbuilding/web/pdf/brochure.pdf

United States Golf Association. 2004. *Recommendations for a method of putting green construction.* Available: http://www.usga.org/content/dam/usga/images/course-care/2004%20USGA%20Recommendations%20For%20a%20Method%20of%20Putting%20Green%20Cons.pdf.

van Es., H.M. October 1990. *Pesticide management for water quality: Principles and practices.* October 1990. Ithaca, New York: Cornell Cooperative Extension. Available: http://psep.cce.cornell.edu/facts-slides-self/facts/pestmgt-water-qual-90.aspx.

Virginia Golf Course Superintendents Association. 2012. Environmental Best Management Practices for Virginia's Golf Courses. https://pubs.ext.vt.edu/ANR/ANR-48/ANR-48_pdf.pdf

White, C.B. 2000. Turfgrass manager's handbook for golf course construction, renovation, and grow-in. Sleeping Bear Press. Chelsea, MI.

Witt, J.M. n.d. *Agricultural spray adjuvants.* Ithaca, New York: Cornell Cooperative Extension. Available: http://pmep.cce.cornell.edu/facts-slides-self/facts/gen-peapp-adjuvants.html.

Yergert, M.B. Austin, and R. Waskom. June 1993. *Best management practices for turfgrass production.* Turf BMP Fact Sheet. Colorado Department of Agriculture. Agricultural Chemicals and Groundwater Protection Program. Available: http://hermes.cde.state.co.us/drupal/islandora/object/co%3A3063/datastream/OBJ/download/Best_management_practices_for_turfgrass_production.pdf.

Glossary

Term	Definition
401 Water Quality Certificate	Section 401 of the Clean Water Act requires that any person applying for a federal permit or license, which may result in a discharge of pollutants into waters of the United States, must obtain a state water quality certification that the activity complies with all applicable water quality standards, limitations, and restrictions.
Aerification	Core aerification involves removal of small (0.25- 0.75 inch diameter) cores or plugs from the soil profile.
Air Quality Index (AQI)	Measurement of air quality used by government agencies to communicate to the public the current conditions of air quality. This numeric representation may trigger health alerts or warn sensitive groups if above a certain index for a particular pollutant (e.g., ozone).
Ambient Air Quality Standards (AAQS)	Standards that define clean air and are established to protect the health of the most sensitive groups in our communities. There are ambient air quality standards established on both a national level as well as those in California.
APCD	Air Pollution Control Districts, along with the California Air Resources Board, typically have jurisdiction over issues pertaining to air quality (e.g., diesel emissions).
APSA	The Aboveground Petroleum Storage Act (APSA) is a California statute that addresses storage of certain petroleum tanks in above- and underground area. It is implemented, enforced, and administered by the California Fire Office of the State Fire Marshal, but from a practical standpoint, the local county CUPA or fire department often takes a lead role in assessing compliance. See the Maintenance Operations chapter for more details.
Aquifer	A saturated bed, formation, or group of formations which yields water in sufficient quantity to be economically useful.
Benchmarking	Comparing or assessing to a standard or point of reference, such as to evaluate energy efficiency.
Best Management Practices	Methods or techniques found to be the most effective and practical means of achieving an objective, such as preventing water quality impacts or reducing pesticide usage.
Biological Control	The use of living organisms, such as bacteria, to reduce populations of pests.
Bulletin 118	The Bulletin 118 series are regional reports from the DWR about the occurrence and nature of groundwater in California. Bulletin 118 defines the boundaries and describes the hydrologic characteristics of the state’s

Term	Definition
	groundwater basins and provides information on groundwater management and recommendations for the future. Bulletin 118 serves an additional role by providing GSAs with three critical pieces of information regarding groundwater basins: Critical Conditions of Overdraft, Basin Boundaries, and Basin Priority.
Carbamates	A class of insecticide, including carbaryl and aldicarb, that act on the nervous system. They are toxic to a wide range of mammals, insects, aquatic life and birds.
CASGEM	California Statewide Groundwater Elevation Monitoring (CASGEM) establishes long-term, locally-managed monitoring plans of groundwater basins in California, for the purposes of attaining goals established by the SGMA.
California Air Resources Board (CARB)	The California agency responsible for overall state policy to protect human health from air pollution and address climate change.
CDFW	California agency responsible for management and protection of fish, wildlife, plant and native habitats.
California Environmental Quality Act (CEQA)	California's broadest environmental law that addresses the protection of threatened and endangered species and helps guide the CDFW during issuance of permits and approval of projects.
California Environmental Reporting System (CERS)	Electronic reporting system through the Cal/EPA that is used for reporting California's Hazardous Materials Business Plans (HMBPs), among other things.
CERS	California Environmental Reporting System. This CalEPA reporting system allows users to report their HMBP, APSA, and UST Program submittals.
CESA	The California Endangered Species Act (CESA) states that all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved.
CNDBB	The California Natural Diversity Database is a searchable online tool maintained by the California Department of Fish & Wildlife (CDFW) that allows for location estimates of a variety of species.
California Coastal Commission (CCC)	Approved by the National Oceanic and Atmospheric Administration (NOAA), the California Coastal Commission manages development along the California coast except for San Francisco Bay.
California Coastal Conservancy	The Coastal Conservancy is a non-regulatory agency that supports projects to protect coastal resources by providing technical assistance and granting funds to local communities, non-profit organizations, private

Term	Definition
	landowners, and others.
Colony Collapse Disorder	Colony Collapse Disorder is a phenomenon generally described by worker bee abandonment of healthy hives, leaving a helpless queen, nurse bees, and larvae to die without access to nectar and pollen.
Construction General Permit (CGP)	The SWRCB Construction General Permit (CGP) requires development of a Stormwater Pollution Prevention Plan (SWPPP) to prevent erosion and sedimentation that may impact surfacewater.
Corrective Maintenance	Corrective maintenance (CM) is simply the act of fixing what is broken (e.g., cleaning a clogged orifice or a complete renovation of an irrigation system). As opposed to preventative maintenance.
CUPA	The Certified Unified Program Agencies (CUPA) are local agencies that implement the Cal/EPA Unified Program, which ensures consistency throughout California with regard to administrative requirements, permits, inspections, and enforcement of hazardous waste and materials.
Department of Water Resources (DWR)	The California Department of Water Resources is responsible for a wide range of water resource management responsibilities in CA. These responsibilities are shared with other agencies like the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards and the California Department of Fish and Wildlife.
Dethatching	The procedure of removing an excessive thatch accumulation either mechanically, by practices such as vertical mowing, or biologically, such as by topdressing with soil.
Dissipation	Relates to the reduction in concentration over time of a pesticide or other compound which has been applied to plants, soil, water, etc. This may be due to a number of factors including dilution and degradation.
Distribution Uniformity	A measurement of how evenly water is applied across turf during irrigation.
Drift	The physical movement of pesticide droplets or particles through the air at the time of pesticide application or soon thereafter from the target site to any non- or off-target site.
DOORs	The California Air Resources Control Board (CARB) online reporting tool for the regulations of Off-Road vehicles.
Endangered, Threatened or Listed Species	Species that have been identified as being in danger of extinction now or are likely to become endangered within in the foreseeable future.
Environmental Fate and Transport	The movement and distribution of chemicals in the environment.
EPCRA Tier II	Tier II reports are forms that organizations and businesses in the United States with hazardous chemicals above certain quantities, are required to fill out by the EPA. Known officially as Emergency and Hazardous

Term	Definition
	Chemical Inventory Forms, Tier II Reports are submitted annually to local fire departments, Local Emergency Planning Committees (LEPC) and State Emergency Response Commissions (SERCs) to help those agencies plan for and respond to chemical emergencies. Mandated by Section 312 of the Emergency Planning and Community Right-To-Know Act (EPCRA) – also known as SARA Title III – the Tier II form captures information about the types, quantities and locations of hazardous chemicals at a given facility. The form also lists contact information for the facility's designated emergency point-of-contact.
Evapotranspiration	The combination of soil evaporation and transpiration from a plant; total water loss from plant and soil.
FESA	Federal law that provides a program for the conservation of threatened and endangered plants and animals and the habitats in which they are found.
The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	The basic U.S. system for the regulation of pesticides to protect applicators, consumers, and the environment. Under FIFRA, the USEPA sets the minimum standards concerning the distribution, use, and disposal of pesticides and their containers. California standards are typically as or more stringent.
GAMA Program	The Groundwater Ambient Monitoring and Assessment Program (GAMA) is a statewide, comprehensive assessment of groundwater quality designed to help better understand and identify risks to groundwater resources. GAMA is being implemented by the California Water Board.
Goby-11 Injunction	Injunction that sets pesticide use limitations around habitat for 11 San Francisco Bay Area species, including the Tidewater goby.
Greenhouse Gas (GHG)	Gases that contribute to the greenhouse effect and include carbon dioxide, methane, nitrous oxide, HFCs, and PFCs.
Greenhouse Effect	The process that causes the earth's atmosphere to warm the planet surface due to trapping of the sun's heat.
Groundwater Sustainability Agencies (GSA)	Under SGMA, the Groundwater Sustainability Agencies (GSAs) manage basins and establish Groundwater Sustainability Plans for medium- to high-priority groundwater basins in California.
GWPA	A Groundwater Protection Area (GWPA) is a one-square mile section of land that is sensitive to the movement of pesticides and, as such, pesticide use is restricted in that area.
GWPL	A list of pesticides that have high potential to pollute groundwater in California, either determined from previous detections or chemical properties. The list is found under 3 CCR 6800 (a) and (b).
Half-Life	A measurement of how long it takes for half the concentration of a chemical or pesticide to dissipate.
HMBP	A Hazardous Materials Business Plan (HMBP) is a document intended to

Term	Definition
	provide information for use by first responders to prevent/mitigate damage to the public health and environment from release or a hazardous material. It contains an inventory of hazardous materials at a facility, an emergency response plan in the event of a release, training materials for employees, and a site map to aid in this objective.
Industrial General Permit (IGP)	The Industrial General Permit regulates industrial storm water discharges and authorized non-storm water discharges from industrial facilities in California and is regulated/enforced by the State Water Resources Control Board.
Infiltrate	See percolate.
Insect growth regulators	A chemical that interferes with the life cycle of an insect to control their populations.
Invasive Plants	Plants that are not native to an environment, and once introduced, they establish, quickly reproduce and spread, and cause harm to the environment, economy, or human health (Cal/IPC)
IPM	IPM is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and nontarget organisms, and the environment.
Leaching	The downward movement of a chemical or nutrient (e.g. pesticide or nitrogen from fertilizer) through the soil and potentially into groundwater.
Littoral Zone	Shallow areas within the near shore area of a lake or pond. Littoral shelves provide emergent aquatic vegetation the appropriate water depth necessary to thrive
Maximum Contaminant Level (MCL)	The legal water standard allowed of a particular chemical set by the United States Environmental Protection Agency in drinking water.
Microclimate	Local set of environmental conditions (e.g., atmospheric temperature) that are limited to a relatively small range.
Milkweed	A plant that is host to monarch butterfly caterpillars and considered important to monarch survival.
Minimum Risk Pesticides	Certain "minimum risk pesticides" pose little to no risk to human health or the environment. Because of this, the USEPA has exempted them from the requirement that they be registered under the Federal Insecticide, Fungicide, and Rodenticide Act. This exemption provision is located in 40

Term	Definition
	CFR 152.25(f).
Native Plants	A plant that is a part of the balance of nature that has developed over hundreds or thousands of years in a particular region or ecosystem (USDA).
NEMA	National Electrical Manufacturers Association. NEMA premium efficiency-rated pump motors can be used to improve the energy efficiency for pump motors.
Nematodes	A small, round worm, usually microscopic and colorless, that lives free in moist soil, water or decaying or living organic matter. Parasitic forms puncture plant tissues and live by sucking the juice of the plant.
Neonicotinoids	A class of neuroactive insecticides chemically similar to nicotine that are absorbed by plants and can be present in pollen and nectar, resulting in potential adverse effects to bees.
NMFS	The National Marine Fisheries Service is a part of the National Oceanic and Atmospheric Administration (NOAA) that is responsible for protecting marine and coastal resources under several regulations including FESA.
Nitrates	Nitrogen-oxygen species that are found in fertilizers that may make their way into surfacewater and groundwater/wells. At high concentrations, nitrates can have adverse human effects.
Nitrogen Management Plans (NMPs)	A report completed by crop growers that inventories nitrogen use on irrigated lands as a means to assist in diminishing nitrate contamination in groundwater. It is regulated and enforced by the Regional Water Quality Control Board (RWQCB). Note that golf courses are not currently required to fill out NMPs at this time.
Non-Point Source	Pollution which originates from many different sources and locations.
Non-RCRA Waste	Hazardous waste regulated under the State of California that meets conditions described under 22 CCR § 66261.101.
NOx	Pollutants (oxides of nitrogen) associated with smoggy air in California that damage human respiratory tracts, generated from high-temperature combustion products (such as vehicles). Please see the CARB for current ambient air quality standards for NOx.
NPDES	Created in 1972 by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program is authorized to state governments by USEPA to address water pollution by regulating point sources that discharge pollutants, such as pesticides, to Waters of the United States (WOTUS).
Overdraft	Use of groundwater that exceeds the aquifer recharge.
Overseeding	To sow seed over an area that is sparsely covered or to plant cool-season grasses into dormant warm-season turfgrass swards for a temporary, green winter cover.
Particulate Matter	Aerodynamic particles associated with respiratory illnesses that contribute

Term	Definition
(PM)	to smoggy air in California. They are regulated by the California Air Resources Control Board and generated from a variety of sources, including vehicles. Please see the CARB for current ambient air quality standards for PM.
PCA	Licensed professional who specializes in pest management in California by providing written recommendations and holds self as an authority on any agricultural use.
Percolate	Pertains to the movement of a liquid or gas as it moves through a porous media like soil.
Pest Threshold	The pest threshold is the point at which the damage caused by the pest is equal to or greater than whatever threshold you establish. This may be an economic, aesthetic and/or operational threshold.
Pesticide Resistance	The repeated use of herbicides, insecticides, and fungicides with the same mode of action that can result in the selection of insensitive pest.
Pesticide Signal Word	Wording on the pesticide label that describe the short-term toxicity of the product. From least-to-most toxic: "Caution", "Warning", and "Danger".
Pesticide Use Enforcement Program Standards Compendium, Volume 8	DPR manual with a plethora of information about interpreting pesticide laws and labeling. Publicly available on the DPR website.
Point Source	Any single identifiable source of pollution from which pollutants are discharged, such as a pipe, ditch, ship or factory smokestack
Pollinators	Pollinators include native bees, honey bees, butterflies, birds, and bats. Important pollinators in California include the western honey bee (Apis mellifera), carpenter bees, digger bees, mining bees, mason bees, sweat bees, leafcutting bees, cuckoo bees, and the Monarch butterfly.
Preventative Maintenance	Preventative maintenance (PM) is maintenance that is performed on equipment to prevent it from breaking or malfunctioning in the future. As opposed to corrective maintenance (CM).
Proposition 65	Chemicals on the Prop 65 list are known to the state to cause cancer, birth defects, or other reproductive harm. It is required by California law that businesses post warnings if citizens may be exposed to significant levels of a Proposition 65 chemical.
PSIS	The Pesticide Safety Information Series (PSIS) is a DPR leaflet that contains readable safety rules associated with pesticide applications in agricultural ("A" Series) and non-agricultural ("N" Series) settings.
PUR	California requires that applications of pesticides to golf courses and associated landscape submit monthly Pesticide Use Reports (PURs) to their CAC, who report this data to DPR.

Term	Definition
Pyrethroids	A class of synthetic insecticides that mimic the action of pyrethrins, which are organic compounds derived from chrysanthemum. Pyrethroids are generally toxic to insects and aquatic invertebrates and less toxic to humans.
QAL	As described by DPR, a Qualified Applicator License (QAL) is required to, "Supervise the pesticide application (restricted use and/or general use pesticide) made by a licensed Pest Control Business and is responsible for the safe and legal operation of the pest control business," or, "Use or supervises the use of a federally restricted use pesticide or state restricted material for any purpose or on any property other than that provided by the definition of private applicator under 3 CCR section 6000."
QAC	As described by DPR, a Qualified Applicator Certificate (QAC) is required to, "Apply or supervise the application of federally restricted use pesticides or state restricted materials for any purpose or on any property other than that provided by the definition of a private applicator1 (Title 3 of California Code of Regulations [3 CCR], section 6000)." Additionally, this certificate is also required by anyone who is is the business of landscape maintenance and performs pest control that is incidental to such business.
RCRA Waste	A RCRA waste is a hazardous waste that falls under one of three lists created by the U.S. EPA, known as the “F” List, “K” List, or “P/U” List, found under 40 CFR 261.31, 40 CFR 261.32, and 40 CFR 261.33.
Reclaimed Water	Water which, as a result of treatment of waste, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable resource.
Residual Toxicity	Residual Toxicity (RT) time is that period of time after completing a pesticide application until there is minimal toxic effect to bees.
Restricted Use Pesticide (RUPs)	Federally restricted use pesticides are pesticides that are not available to the general public and have the potential to cause unreasonable adverse effects to the environment and injury to applicators or bystanders without additional restrictions.
Restricted Material	California restricted materials include all federally restricted use pesticides (RUPS) as well as chemicals described under 3 CCR 6400.
Risk	Risk is the potential for adverse effects to occur given exposure to a particular chemical. It is a function of the extent of exposure and the toxicity of the chemical substance.
RLF Injunction	An injunction effective in certain California counties designed to protect the California Red-Legged Frog (RLF) from potential impacts due to pesticide use.
Responsible Official Affirmations of	Affirmation signed by an official or designee that indicates information reported for Off-Road Regulation is accurate and the fleet is in compliance with the Off-Road Regulation.

Term	Definition
Reporting (ROAR)	
Runoff	Water flow along the ground's surface that can pick up contaminants, such as fertilizers and pesticides. Runoff occurs when the soil is saturated, compacted, high in clay particles, or has lost soil structure (large pores).
RWQCB	Regional Water Quality Control Board (RWQCB)
Salmonid Injunction	An injunction that establishes no-spray buffer zones in certain areas of the West Coast to protect listed species of salmon and steelhead.
Saltwater intrusion	Changes in the water table shape can result in a slope that funnels seawater into groundwater.
San Francisco Bay Conservation and Development Commission (BCDC)	The San Francisco Bay Conservation and Development Commission (BCDC) is a California state planning and regulatory agency with regional authority over the San Francisco Bay, the Bay's shoreline band, and the Suisun Marsh.
Sand Applications	Topdressing the playing surface with sand following core aerification and heavy vertical mowing to aid in recovery of turf.
Scalping	Cutting into or below the crown of the grass plant while mowing. Continued scalping will weaken or kill the turf.
SDS	Safety Data Sheet (formally referred to as a Material Safety Datasheet or MSDS
Section 404 Permit	Permit required by the US Army Corps of Engineers when dredge and fill are proposed in a Water of the United States (WOTUS).
Sedimentation	The transport of soil particles (sediment) in runoff that are deposited into surfacewaters.
SGAR	Second Generation Anticoagulant Rodenticides (SGARs) are a class of pesticides aimed toward controlling rodent pests. Because of their tendency to accumulate in target rodents prior to lethality, they may result in exposure and adverse effects in non-target wildlife.
Sodic Water	Water high in salts, including sodium, that can adversely impact turf quality and have long-term impacts to soil and its ability to sustain a viable root zone.
Soil Binding Constant	A property of a pesticide that describes its tendency for soil retention. The actual tendency of the chemical to stick will depend on both the chemical as well as the properties of the soil.
SOx	Pollutants (oxides of sulfur) associated with smoggy air in California that damage human respiratory tracts, generated from a variety of sources (such as vehicles). Please see the CARB for current ambient air quality standards for SOx.
SPCC Program	A Spill Prevention Control and Countermeasures (SPCC) plan helps facilities prevent, control, and provide adequate countermeasures to the

Term	Definition
	discharge of petroleum, animal, and vegetable-derived oils. Not all facilities are required to develop this plan. See chapter for details.
Stormwater	Water that originates from precipitation events. Stormwater may soak into the ground or, when faced with impervious surfaces, result in runoff.
Lake and Streambed Alternation Agreement (LSA)	Permit issued by the CDFW that may be required if the structure or components of a waterbody is altered.
Structural Pest Control Board	Staff members of the Structural Pest Control Board (SPCB) license and regulate structural pest control businesses and professionals to ensure that licensees meet minimum qualifications and levels of competency to provide safe and effective services to the public.
Surfacewater	Surfacewater is are water bodies that reside on the surface of the Earth, such as lakes, reservoirs, and ponds. It is distinct from groundwater.
Subsidence	The overuse of groundwater changes the water level, possibly causing the ground to sink or collapse. This change in elevation may result in sinkholes and/or damage infrastructure.
Stormwater Pollution Prevention Plan (SWPPP)	A SWPP is a plan developed to demonstrate sediment and erosion control. SWPPPs include identifying potential pollution sources that may impact stormwater discharge and listing measures that will be taken to reduce or eliminate erosion and sediment movement.
Sustainable Groundwater Management Act (SGMA)	The goal of the Sustainable Groundwater Management Act (SGMA) is to establish a balance between groundwater use and recharge. The Department of Water Resources (DWR) is primarily responsible for issues that pertain to groundwater quantity.
SWRCB	State Water Resources Control Board (SWRCB)
Take	The term "take" has different meaning under different environmental laws. CESA: The hunt, pursue, catch, capture, or kill, or attempt to perform these actions. FESA: The harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in such conduct of an endangered species.It is illegal to "take" at threatened/endangered species without proper authorization and permitting.
TMDL	The Total Maximum Daily Load (TMDL) is a calculation of the maximum amount of a pollutant that a waterbody can receive and still safely meet water quality standards. TMDLs are established for water bodies on the 303(d) list.
Topdressing	The act of adding a material to a turfgrass surface to enhance its quality and appearance such as a fertilizer spread thinly on the surface of soil or a lawn.
Total Dissolved Solids (TDS)	Total dissolved solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in

Term	Definition
	molecular, ionized or micro-granular (colloidal sol) suspended form.
Toxicity	The degree to which a chemical can cause adverse effects in an organism, considering the dose, route of exposure, and duration of exposure.
UC Statewide IPM Program	The University of California Statewide IPM Program (UC IPM) helps residents, growers, land managers, community leaders, and other professional pest managers prevent and solve pest problems with the least unintended impacts on people and their surroundings.
USACE	The United States Army Corp of Engineers is a U.S. federal agency under the Department of Defense made up of civilians and military that review Section 404 permits.
Vapor Pressure	A measurement of how prone a chemical is to partition in the air.
Variable Frequency Drive (VFD) pumping systems	An adjustable-speed drive that controls pump motor's speed to deliver only what your operation needs to function at optimal efficiency.
Vertical Cutting (Verticutting)	The thinning of turfgrass grasses by blades or wire tines, which cut perpendicular to the soil surface.
Visibility-reducing particles	Pollution that impacts the environment by decreasing visibility (i.e., haze).
Water Budget	A water budget is a foundational tool used to compile water inflows (supplies) and outflows (demands). It is an accounting of the total groundwater and surface water entering and leaving a basin or user-defined area.
Water Rights	Governed by the State Water Resources Control Board (SWRCB), a water right is legal permission to use a reasonable amount of water for a beneficial purpose such as swimming, fishing, farming or industry.
Water Solubility	The tendency of a chemical to dissolve in water. Chemicals with high water solubility may be more inclined to be mobile if they come into contact with water.
West Nile Virus	A virus, commonly carried by mosquitos, which can cause West Nile Fever. There are no vaccines or medications to prevent and treat WNV. It can be fatal. The CDC recommends using insect repellent and wearing long-sleeved shirts/pants to prevent bites.
Winterization	Preparation of an irrigation system to protect the system and reduce equipment failures resulting from freezing.
WOTUS	The regulatory definition of Waters of the United States (WOTUS) is found under 40 CFR 230.3 and is still applicable as of February 2019. Be aware that the definition for WOTUS may change. Please confirm definition is still most recent. If you are discharging to a WOTUS, you are subject to the Clean Water Act Section 404 Permit Program.
WSP	Water-soluble packaging (WSP) is a special pesticide container or

Term	Definition
	package in which the packaging and pesticide itself dissolve when put in water.