BMP for the Continued Enhancement of Environmental Quality on Alabama Golf Courses

Best Management Practices

Alabama Golf Course Superintendent's Association

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*

Emergency Response

Response to Spills of Oil and Hazardous Material and Fish Kills

Spills and fish kills should be reported during normal office hours to the nearest ADEM Field Office or **24 hours per day by calling the Alabama Emergency Management Agency State Warning Point at 1-800-843-0699**. The ADEM response staff can be reached after hours in emergency situations through the Alabama Emergency Management Agency.

Each of the ADEM Field Offices has staff assigned on a rotating basis to response duties 24-hours per day and 7 days per week. Response activities include incidents involving spills of oil and hazardous materials and fish kills. In addition, ADEM supports local governments in response to actual or potential releases of oil and hazardous material resulting from natural, manmade or technological disasters. The ADEM response staff serve as State On Scene Coordinator for facility related releases of hazardous materials, including releases to State waters and oil releases to the State waters. ADEM also acts as the technical advisory agency in identifying and directing the containment, treatment, and removal of hazardous materials impacting or threatening the citizens and/or the environment of the State of Alabama. ADEM serves as the point of coordination between the state and federal response resources of the U.S. Environmental Protection Agency and the U.S. Coast Guard.

Useful Numbers and Links for Reporting Oil Spills and Hazardous Substance Releases

Alabama State Warning Point - 1-800-843-0699

National Response Center (NRC) - 1-800-424-8802

ADEM Montgomery Branch Field Office(334) 260-2700 Fax (334)272-8131

ADEM Birmingham Branch Field Office(205) 942-6168 Fax (205) 941-1603

ADEM Decatur Branch Field Office (256) 353-1713 Fax (256) 340-9359

ADEM Mobile Field Office (251) 450-3400 Fax (251) 479-2593

Coastal Section Office (251) 304-1176 Fax (251) 304-1189

ADEM - Central Office (334) 271-7700 Fax (334) 271-7950

ADEM Office of Emergency Response (General Information only) (334) 260-2717

ADEM Ombudsman (General Information)1-800-533-2336

CHEMTREC - 1-800-424-9300

EPA Atlanta Emergency Response (404) 562-8700

Can be reached after hours through the National Response Center listed above.

United States Coast Guard - Mobile (251) 441-5286

US National Response Team

US Region IV Regional Response Team

EPA Local Government Reimbursement Program

Links and Other Information

State Warning Point - (800) 843-0699

National Response Center - (800) 424-8802

Region 4 Regional Response Team

EPA Local Government Reimbursement Program

ADPH Emergency Preparedness Program

ADPH Radiation Program

Alabama EMA

Contact Information

ADEM Attn: Field Operations Division

Post Office Box 301463

Montgomery, Alabama 36130-1463

(334) 260-2700 (334) 272-8131 Fax

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Who We Are/ Acknowledgments

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.

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Mrs. Lee Ann Perry for layout, design, and presentation.

Introduction

Introduction

Welcome to the new Best Management Practice (BMP) for the state of Alabama.

The Alabama Golf Course Superintendent Association (AGCSA) has published this new live version that can be updated as laws and environmental needs change.

As a Golf Course Superintendent, no one is more aware of the impact that we have on the environment, not only on the golf course but on the surrounding areas as well. We all take great care to create an environmentally friendly place for golfers, workers, and wildlife to enjoy. We want to ensure the safety of our players and our personnel while creating habitats for the wildlife around us. We consider ourselves stewards of the environment while taking great pride in our work.

Johnny Perry

2019 AGCSA President

BMP Index

Golf Course Cultural Practices

Mowing

Cultivation practices are an important part of golf course turf management. Certain cultural practices such as mowing, grooming (light verticutting), and rolling are necessary to provide a high-quality playing surface, while others such as aerification are required to enhance plant health.

Heavily used areas such as putting greens often deteriorate because of compacted soil, thatch accumulation, and excessive use. Soil problems from active use are usually limited to the top 3 inches of the soil profile and should be actively managed to enhance turf health and improve nutrient and water uptake.

Unlike annual crops, which offer the opportunity for periodic tilling of the soil profile to correct problems like soil compaction that might develop over time, turfgrass does not offer opportunities for significant physical disturbance of the soil without destroying the playing surface.

Principle

- Mowing is the most basic yet most important cultural practice to consider when developing a management plan.
- The mowing practices implemented on a facility will have an impact on turf density, texture, color, root development, and wear tolerance.
- Mowing practices affect turfgrass growth. Frequent mowing will increase shoot density and tillering. 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, mower set up, equipment type, 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 physiologically. As a result, the plants will slough off the unneeded roots. Root growth is least affected when no more than 30% of leaf area is removed in a single mowing.
- Failure to mow properly will result in weakened turf with poor density and quality.

- Improper mower set up and adjustment can cause major problems especially during stressful conditions.

Best Management Practices

Mowing

- Mowing frequency should increase during periods of rapid growth and decrease during dry, stressful periods and in the off season.
- 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 the desired height of cut is achieved.
- Shade effects turfgrass growth by filtering out photosynthetically active radiation. 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 regulator 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.
- Use proper mowing equipment, with the proper set up and adjustments for the area to be mowed.

Mower Types

- 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. Dull blades will result in the shredding of leaf tissue, increasing water loss and the potential for disease development.
- Flail mowers are most often used to maintain utility turf areas that are mowed infrequently and do not have a high aesthetic requirement.
- Mowing patterns influence both the aesthetic and functional characteristics of a turf surface.

Clippings

- 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.
- Nutrients contained in clippings can be sources of pollution and should be handled properly.
- 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.
- Collected clippings should be disposed of properly to prevent undesirable odors near play areas and to prevent fire hazards that can occur when clippings accumulate. Consider composting clippings or dispersing them evenly in natural areas where they can decompose naturally without accumulating in piles.

Cultivation

Principles

- Cultivation involves disturbing the soil or thatch through the use of various implements to achieve important agronomic goals that include relief of soil compaction, thatch/organic matter reduction, and improved water and air exchange.
- Cultivation techniques will result in disturbance of the playing surface that can require significant time for recovery.
- Frequency of cultivation should be based on traffic intensity and level of soil compaction.
- Core aerification is effective at managing soil compaction and aiding in the improvement of soil drainage.
- Accumulation of excessive thatch and organic matter will reduce root growth, encourage disease, and create undesirable playing conditions.
- Light and frequent applications of sand 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 the removal of small cores or plugs from the soil profile. Cores are usually 0.25 to 0.75 inch in diameter. 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 the development of compacted layers in the soil profile as a result of cultivation.
- 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 the 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.

Slicing and Spiking

- Slicing and spiking reduce surface compaction and promote water infiltration with minimal surface damage.
- Slicing is faster than core aerification but is less effective. Slicing 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

- 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.
- 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.
- Initiate vertical mowing when the 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.

Grooming

- Groomers, or miniature vertical mowers attached to the front of reels, are effective at improving management of grain and improving plant density through the cutting of stolons.

Topdressing

- Topdress the playing surface with sand following core aerification and heavy vertical mowing to aid in the 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.

Rolling

- Daily rolling of putting surfaces following mowing can increase putting speeds by roughly 10%, allowing for improved ball roll without lowering the height of cut.
- To minimize the potential for compaction caused by rolling, use lightweight rollers.
- Rolling is a way to decrease mowing stress and help in keeping the surface smooth.
- Rolling is often followed up the next day after a light topdressing to decrease the wear and tear on a mowers blades by allowing the sand to work its way down into the canopy.

Overseeding Warm-Season Turfgrass

Principles

- The fundamental 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.
- Overseeding increases the need for irrigation and routine mowing and may result in significant thinning of the base grass during the 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 the health of the warm-season turfgrass while allowing the successful establishment of the overseeded cool-season grass species.

Best Management Practices

Overseeding Practices

- Thatch depth greater than 0.5 inches 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.
- Some herbicides may be applied as early as 4 weeks prior to seeding to decrease the populations of winter weeds germinating during the overseed period.
- Core-aerify the soil four to six weeks before the planned overseeding date to open turf canopy and aid in the uniform establishment of overseeded grass.

Seeded turf

- Select grass species/cultivars that are adapted to the desired use, taking note of disease resistance and spring transition traits. Cultivars with improved heat tolerance can delay spring transition and create increased competition for water, nutrients, and light with the warm-season turfgrass base.
- 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 the establishment of overseeding 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 the 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.
- Some pre-emergent may be applied once overseed is established. This will help decrease weed infestation of the overseeded area.

Removal of Overseeding

- Mechanical removal of winter grass is an old school way but still effective.
- Chemical removal is more common. We have several options for removing winter turf from summer turf. The appropriate time for this depends on your weather and growth of summer turf - too early, you can look bad and in transition; too late, you can create too much competition and the summer turf may have difficulty getting established early on.

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.

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Trees, Location and Use

- Trees can be and integral part of the design of a course or a hindrance.
- Prune tree limbs and roots as needed to reduce competition 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.

Nutrient Management

Regulatory Considerations

Proper nutrient management plays a key role in the reduction of environmental risk and increases course profitability. Among other benefits, applied nutrients inflate the available pool of nutrients and allow turfgrass to recover from damage, increase its resistance to stress, and increase its playability. However, the increase in available nutrients also increases the potential risk of environmental impact. Nutrients may move beyond the turfgrass via leaching or runoff, which may directly impact our environment. Other organisms also respond to increases in nutrients and, in some cases, these organisms may deleteriously alter our ecosystem. The goal of a proper nutrient management plan should be to apply the minimum necessary nutrients to achieve an acceptable playing surface and apply these nutrients in a manner that maximizes their plant uptake.

Regulatory Considerations

Principles

- Local and state regulations are in place to better manage nutrient risks based on the unique conditions that exist in your location. Designing a nutrient management plan within these regulations addresses local concerns and minimizes risk within your unique ecosystem and keeps you in compliance with local and state regulations.
- Depending on your location, regulatory agencies may include federal, state, or local policies.
- In general, if your location is regulated by nutrient policies (such as nutrient management plans), all of your nutrient BMP will be designed according to these policies.
- Understand the importance of nutrient licensing.

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Licensing

- Usually the Superintendent will be licensed with an OTPC state license.
- This type of license allows for employees under the direct supervision of the licensed superintendent to be properly trained in the application of pesticides and work under the supervision of the license holder.
- 30 points of continuing education must be received in a 3 year period to maintain the license.
- Contact local and state organizations for regulatory restrictions, CE points and licensing restrictions.

- http://www.agi.alabama.gov/

Plant Tissue Analysis

Principles

- Because of the mobility and conversion of elements within the 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 existing turf health.
- Tissue testing can allow you to tailor your fertility program specifically to your microenvironment, water management, and fungicide program.
- Where soil testing gives you broader look at the potential health of the plant tissue testing allows you to customize your program to your specific needs.
- Taking the time to implement a plan in detail will save you time, money and problems down the road. Environmentally it will allow you to be site specific and apply only what is needed and help decrease the leaching out or the over use of fertilizers and pesticides.

Best Management Practices

Tissues samples

- Tissue samples may 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.

Tracking your progress

- Set up a plan and track where samples are taken for example greens, tees and fairways, rough. Isolate areas based on terrain, high ground or low area, soil type, plant type.
- Poor-quality turfgrass that is 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.

Utilize the information

- 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.
- Testing can allow you to optimize your nutrient plan for the plant's health and sustainability.

Tips for collecting samples:

- Plant part to sample - leaf blade. Most turf samples are collected from mower clippings.
- Keep in mind that soil and fertilizer material can also be picked up by the mower and can contaminate the sample. For best results, wait at least a week (if possible) from the last top-dress application (fertilizer or fungicide app).
- Samples should be collected on actively growing turf.
- Do not sample drought or severely diseased areas, unless you feel these areas are nutrient deficient and that could be the cause of the stress.
- Sample actively growing areas of the green, when looking for what is working for you.
- Collect approximately one cup of fresh clippings.
- Because of the moist nature of turf clippings, molding and degradation are a concern. Samples should be shipped in paper or cloth bags and loosely packed in the shipping box. If possible, let samples dry overnight to remove excess moisture.

Soil pH

Principle

Identifying pH levels may be the most important soil test result for turfgrass managers. In most cases, a pH of 6.3 is ideal because it provides the greatest probability of micronutrient availability. Soil pH adjustments may occur slowly and are temporary.

Soil samples can be used to give you a base line of the soils health and the ability to monitor its health year to year, such as organic composition and Ph levels.

Recommendations from the testing facility are broad ranged recommendations. Its important to know your soil types and the characteristics of your soil. A low result most likely will not be a bad thing. where optimal may be excessive.Moral of this story, Know your turf and soil characteristics to get the result you want.

Best Management Practices

Increase soil pH

- To increase soil pH, apply a liming material.
- Calcium carbonate
- Calcium oxide
- Dolomitic limestone, that contains Ca^{2+} and neutralizes acidity.

Lower soil pH

- Elemental sulfur
- Products containing elemental sulfur.

- If choosing Elemental sulfur, less is more. Take great care in not over applying this product.

Methods used to deliver chosen products.

- Injection pumps into irrigation water to address pH can be beneficial.
- Fertigation systems allow micro amounts of products to be distributed through the irrigation system to specifically target an area.
- Products such as fertilizers, micronutrients, and wetting agents can be applied via fertigation.
- Granular products
- Water-soluble sprayable products as well.
- Liquid products

Things to consider

- When adjusting your PH, understand your soils and how these products react with your soil.
- Make a long-range plan to correct these levels.
- Check your PH as often as every 90 days until you reach your desired number.

Knowing your soil type, you can put together a long and short-range plan for keeping your soil in an optimum range.

Doing this keeps from having to make corrections which can lead to having heavier applications subject to runoff. Runoff can be hazardous to the environment and costly.

Applying smaller more frequent applications can be more beneficial for you and the environment.

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.

Terminology

- Grade or analysis is the percent by weight of Nitrogen (N), Phosphorous fertilizer (P_2O_5) and Potassium fertilizer (K_2O) that is guaranteed to be in the fertilizer.
- A complete fertilizer contains N, P_2O_5, and K_2O.
- For Alabama laws governing the labeling of fertilizer see "The Alabama fertilizer law of 1969"

Label

- The label is intended to inform the user about the contents of the fertilizer which, if understood and followed, will result in little to no environmental risk.
- The fertilizer label may contain:
    - Brand
    - Grade
    - Manufacturer's name and address
    - Guaranteed analysis
    - "Derived from" statement
    - Net weight

Macronutrients

Macronutrients are required in the greatest quantities and include nitrogen (N), phosphorus (P), and potassium (K).

Understanding the role of each macronutrient within the plant should provide you with a greater understanding of why these nutrients play such a key role in proper turfgrass management.

The role of nitrogen (N)

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.

- *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 leads to an increase in course profitability and a reduction in environmental risk.
- *Nitrogen processes*
    - *Mineralization:* the microbial-mediated conversion of organic N into plant-available NH_4
    - *Nitrification:* the microbial-mediated conversion of NH_4 to NO_3
    - *Denitrification:* the microbial-mediated conversion of NO_3 to N gas; this primarily occurs in low-oxygen environments and is enhanced by high soil pH
    - *Volatilization:* the conversion of NH_4 to NH_3 gas
    - *Leaching:* the downward movement of an element below the root zone
    - *Runoff:* the lateral movement of an element 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 applied without regard to their release characteristics. This is an improper practice and increases the risk of negative environmental impact. 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, 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
    - 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.

The role of phosphorus (P)

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.

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 phosphorus 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 sufficiency ranges*

    Consult your land-grant university for sufficiency ranges in your location.

- *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 potassium is over-utilized, which can be quite common. Generally, potassium concentrations in turfgrass tissue are about 1/3 to ½ that of nitrogen.

Potassium is not a component of an 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 sufficiency ranges*

Consult your land-grant university for sufficiency ranges in your location.

- *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)

- Primarily a component of cell walls and structure
- Consult your land-grant university for sufficiency ranges in your location
- Found in gypsum, limestone, and calcium chloride

The role of magnesium (Mg)

- Central ion in the chlorophyll molecule and chlorophyll synthesis
- Consult your land-grant university for sufficiency ranges in your location
- 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
- Consult your land-grant university for sufficiency ranges in your location
- Found in ammonium sulfate, elemental sulfur, gypsum, potassium sulfate

Micronutrients

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

Micronutrients are just as essential for proper turfgrass health as macronutrients, 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).

Consult your land-grant university for micronutrient sufficiency ranges in your location.

The role of iron (Fe)

- Is part of the catalytic enzymes and is required for chlorophyll synthesis
- Affects photosynthesis, nitrogen fixation, and respiration
- Consult your land-grant university for sufficiency ranges in your location

The role of manganese (Mn)

- Involved in photosynthesis
- Required as a cofactor for ~35 enzymes
- Lignin biosynthesis depends on Mn

The role of boron (B)

- Found in the cell wall; probably required for the structural integrity of the cell wall

The role of copper (Cu)

- Cu-protein plastocyanin is involved in photosynthesis
- Cofactor for a variety of oxidative enzymes

The role of zinc (Zn)

- Structural component of enzymes
- Protein synthesis requires Zn
- Carbohydrate metabolism affected by Zn

The role of molybdenum (Mo)

- Primarily related to nitrogen metabolism
- Structural and catalytical functions of enzymes

The role of chlorine (Cl)

- Required for the oxygen-evolving reactions of photosynthesis
- Also appears to be required for cell division in both leaves and shoots

Nutrient Management

Principles

- Within each state, environmental conditions vary greatly including differences among soils, topography, rainfall, and temperature. These differences require that a nutrient management plan be flexible enough to allow turfgrass managers to address their unique needs.
- Understand the importance of application timing for effective use of applied nutrients.
- Know and understand your micro climate and different soil types on the property.

Best Management Practices

Why we add Nutrients.

- Growth
- Stress, either or both environmental or mechanical
- Color
- Density
- Health

The objective of all nutrient applications is plant uptake and the corresponding desirable response.

When applying products, things to consider:

- Apply nutrients when environmental conditions are suitable for actively growing turfgrass.
- With Granular products, typically its good practice to apply to dry foliage only.
- When applying sprayable products, environmental factors are very important to observe. Temperature, wind, and burn potential of said products.
- Microfeeding allows more control of the products and less chance of run off, apply only what the plant can take up.

Product types and considerations:

- When looking for a fertilizer there are many things to consider. quick release, slow release, organic, liquid and dry products. Its important to find the product that will best suit your needs based off of your assessment and needs.
- 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.
- Follow N application rate recommendations based off your soil reports and desired results. Check with your local land-grant university for tips, timing and rates if your unsure of the area.
- N application rates from slow-release materials should take into consideration the release rate of the chosen material. If insufficient material is applied, the desired response may not be observed.
- Consult your local land-grant university for efficient N: K in your location.
- The reduced height of cut and excessive traffic damage on putting greens results in an increased need for growth leading to an increase in nutrition.

- Tees and landing areas often have higher fertility requirements than fairways and roughs because they suffer constant divot damage.
- Fairways and roughs often require fewer nutrient inputs than other locations because of their increased height of cut, less damage, and clipping return.
- Exercise caution when applying nutrient applications during turfgrass establishment as these applications are particularly susceptible to loss via leaching and runoff.
- Provide appropriate rates and products to minimize N loss without reducing turfgrass establishment.
    - Increased water applications
    - Increased nutrients to hasten the establishment
    - Reduced root mass

Micronutrients

- Micronutrients play a vital role in the health and growth of all plants.
    - Soil reports can expose deficiency and or overages in the plant.
    - Micronutrients such as Boron, Copper, Molybdenum, Manganese, Zinc, Iron, Chlorine.
    - Understand how these micronutrients are utilized in the plants.

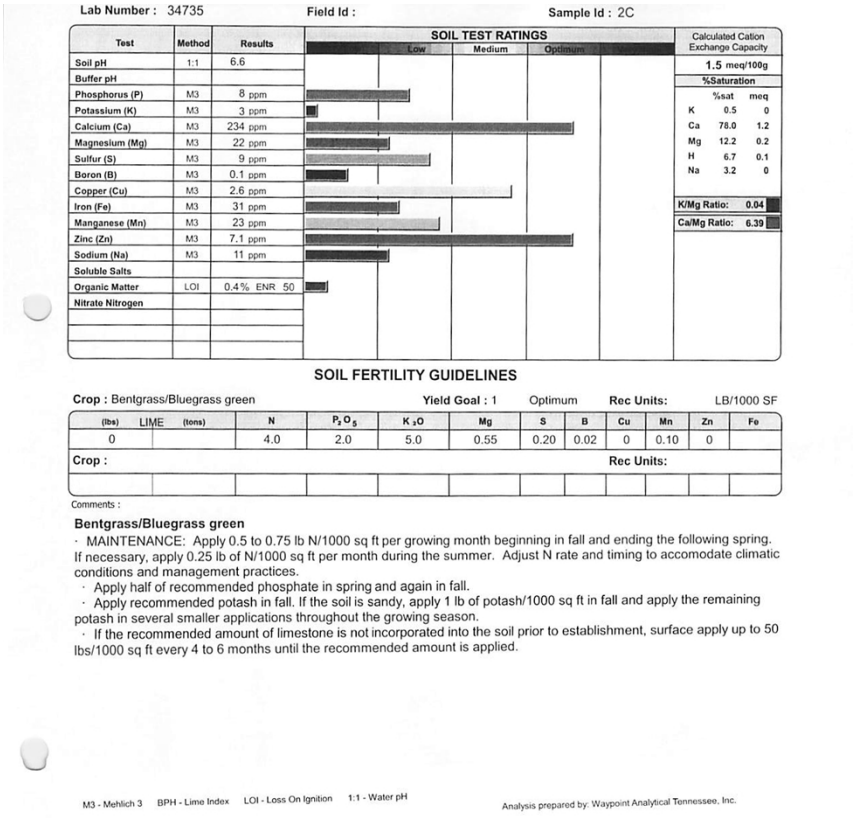
Spreaders:

- 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.
    - Walk-behind rotary
    - Drop spreader
    - Bulk rotary
    - Spray

Calibration

- Calibration reduces environmental risk and increases profitability.
- Proper fertilizer storage, loading, and clean-up reduce environmental risk.
- Avoid applying fertilizer to soils that are at, or near, field capacity or following rain events that leave the soils wet.
- Do not apply fertilizer when the National Weather Service has issued a flood, tropical storm, or hurricane water or warning, or if heavy rains are likely.

Soil Test



Lab Number : 34735 Field Id : Sample Id : 2C

Test	Method	Results
Soil pH	1:1	6.6
Buffer pH		
Phosphorus (P)	M3	8 ppm
Potassium (K)	M3	3 ppm
Calcium (Ca)	M3	234 ppm
Magnesium (Mg)	M3	22 ppm
Sulfur (S)	M3	9 ppm
Boron (B)	M3	0.1 ppm
Copper (Cu)	M3	2.6 ppm
Iron (Fe)	M3	31 ppm
Manganese (Mn)	M3	23 ppm
Zinc (Zn)	M3	7.1 ppm
Sodium (Na)	M3	11 ppm
Soluble Salts		
Organic Matter	LOI	0.4% ENR 50
Nitrate Nitrogen		

SOIL TEST RATINGS: Low | Medium | Optimum

Calculated Cation Exchange Capacity: 1.5 meq/100g

%Saturation

	%sat	meq
K	0.5	0
Ca	78.0	1.2
Mg	12.2	0.2
H	6.7	0.1
Na	3.2	0

K/Mg Ratio: 0.04

Ca/Mg Ratio: 6.39

SOIL FERTILITY GUIDELINES

Crop : Bentgrass/Bluegrass green Yield Goal : 1 Optimum Rec Units: LB/1000 SF

(lbs) LIME (tons)	N	P_2O_5	K_2O	Mg	S	B	Cu	Mn	Zn	Fe
0	4.0	2.0	5.0	0.55	0.20	0.02	0	0.10	0	

Crop : Rec Units:

Comments :

Bentgrass/Bluegrass green

· MAINTENANCE: Apply 0.5 to 0.75 lb N/1000 sq ft per growing month beginning in fall and ending the following spring. If necessary, apply 0.25 lb of N/1000 sq ft per month during the summer. Adjust N rate and timing to accomodate climatic conditions and management practices.

· Apply half of recommended phosphate in spring and again in fall.

· Apply recommended potash in fall. If the soil is sandy, apply 1 lb of potash/1000 sq ft in fall and apply the remaining potash in several smaller applications throughout the growing season.

· If the recommended amount of limestone is not incorporated into the soil prior to establishment, surface apply up to 50 lbs/1000 sq ft every 4 to 6 months until the recommended amount is applied.

M3 - Mehlich 3 BPH - Lime Index LOI - Loss On Ignition 1:1 - Water pH

Analysis prepared by: Waypoint Analytical Tennessee, Inc.

Soil Testing

Principles

- Soil testing may or may not provide the appropriate answers to your nutrient management questions. It will give you a broad picture of your soil. Consult with your local land-grant university and get the most current information and to better understand which soil test values are relevant in your location.
- Through proper sampling, laboratory analysis, interpretation of results, recommendations, and record keeping, soil testing can be used to manage nutrients more efficiently.
- Soil samples can be used to give you a base line of the soils health and the ability to monitor its health year to year, such as organic composition and Ph levels.
- There are various soil tests that can be taken. Choose what best fits your needs.

Best Management Practices

Why soil Test?

- Accurate and consistent sampling is essential to providing useful soil test information over time.
- Helps you determine potential problem areas.
- A tool to help you diagnose problem areas.
- The purpose of a soil test is to provide the grower with a prediction of a plant's response to an applied nutrient.
- If the location has correlation data between a given nutrient applied to the soil and a response to that nutrient by turfgrass, then recommendations may provide expected results.
- If your location does not have correlation data, then soil test recommendations may be of little value.
- Keeping soil tests from prior years will allow you to observe changes over time.
- This practice can provide good evidence of the impact of your nutrient management plan.

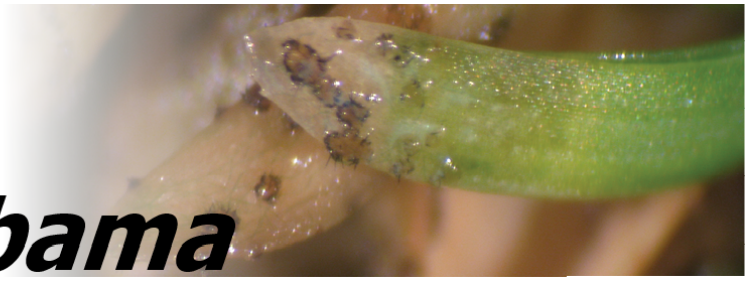
How to take soil samples:

- Divide the course into logical components such as greens, fairways, tees, roughs, etc., for each hole.
- Ten to 15 soil samples should be randomly taken from each section and blended together to provide a representative, uniform soil sample.
- example: Back, middle, top then left middle right.
- Each soil sample should be taken from the same depth.

- Use an appropriate tool that works for extraction is your soils.
- The same tool must be used for each test in order to compare soil test results over time.
- Have a firm procedure in pulling samples so your replicating the process best as possible.
- Consistency is key.

Pesticide Management

Regulatory Considerations



BMP GCSAA USGA. Alabama

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

Regulatory Considerations

Principle

Pesticides contain active ingredients (the component 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 legally registered at all levels of jurisdiction.
- Only apply pesticides 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).
- Apply according to manufacturer recommendations as seen on the label.

Human Health Risks

Principle

Pesticides belong to numerous chemical classes that vary greatly in their toxicity. The human health risk associated with pesticide use is related to both pesticide toxicity and the level of exposure. The risk of a very highly toxic pesticide may be very low if the exposure is sufficiently small.

Best Management Practices

Know the products

- Know the products and health risks they may cause.
- Know the Personal Protective Equipment they require.
- Know steps to take in a worst-case scenario.
- Select the least toxic pesticide with the lowest exposure potential.
- Follow all manufactures application guidelines.
- Safety first and foremost when applying any and all pesticides. Safety for you, the applicator, your customers and the environment.

Environmental Fate and Transport

Principle

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 user of the potential hazards to the environment from the use of the product. The environmental hazards generally fall into three categories: (1) general environmental hazards, (2) non-target toxicity, and (3) endangered species protection.

Best Management Practices

Selecting what pesticide you need:

- Select pesticides that have low runoff and leaching potential.
- Before applying a pesticide, evaluate the impact of site-specific characteristics (for example, proximity to surface water, water table, and well-heads; soil type; prevailing wind; etc.) and pesticide-specific characteristics (for example, half-lives and partition coefficients)
- Select pesticides with reduced impact on pollinators.
- Select pesticides that, when applied according to the label, have no known effect on endangered species present on the facility.

Considerations:

- Can you do split applications with effective results?
- Split applications are rates at 1/2 or 1/3 per application.
- This can drastically decrease the impact on the environment by decreasing the run off potential.
- Not all products can be effective with split applications.
- Some products are time sensitive and must be applied when needed.

Pesticide Transportation, Storage, and Handling

Principle

Storage and handling of pesticides in their concentrated form pose the highest potential risk to ground or surface waters. For this reason, it is essential that facilities for storing and handling these products be properly sited, designed, constructed, and operated.

Best Management Practices

Receiving and storing the Pesticides at your facility:

- Check all packages for leaks, broken bags, that are already outside their container.
- Refuse to take any products damaged, once you accept them the clean up is your responsibility.
- Contact supplier immediately if there is any problem with your delivery.
- Proceed with cation.
- Immediately store products in their desired secure location.
- Check them into inventory.
- Store, mix and load pesticides away from sites that directly link to surface water or groundwater.
- Store pesticides in a lockable concrete or metal building that is separate from other buildings.
- Locate pesticide storage facilities from other types of structure to allow fire department access.
- Storage facility floors should be impervious and sealed with chemical-resistant paint.
- Floors should have a continuous sill to retain spilled materials and no drains, although a sump may be included.
- Sloped ramps should be provided at the entrance to allow the use of wheeled handcarts for moving material in and out of the storage area safely.
- Shelving should be made of sturdy plastic or reinforced metal.
- Metal shelving should be kept painted to avoid corrosion. Wood shelving should never be used, because it may absorb spilled pesticides.
- Automatic exhaust fans and an emergency wash area should be provided. Explosion-proof lighting may be required. Light and fan switches should be located outside the building so that both can be turned on before staff enter the building and turned off after they leave the building.
- Avoid temperature extremes inside the pesticide storage facility.
- Personal protective equipment (PPE) should be easily accessible and stored immediately outside the pesticide storage area.
- 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.

Emergency Preparedness and Spill Response

Principle

Accidents happen. Advance preparation on what to do when an accident occurs is essential to mitigate the human health effects and the impact on the environment.

Best Management Practices

Where to start:

- Know your medical provider, policy and procedures for sending an employee for emergency medical needs.
- Develop a golf course facility emergency response plan which includes procedures to control, contain, collect, and store spilled materials.

- Prominently post "Important Telephone Numbers" (see glossary) including CHEMTREC, for emergency information on hazards or actions to take in the event of a spill.
- Ensure an adequately sized spill containment kit is readily available.
- Designate a spokesperson who will speak on behalf of the facility should an emergency occur.
- Meet with your local fire department and EMT service to seek advice on ways to improve your plan for handling such issues.

Pesticide Record Keeping

Principle

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

Best Management Practices

State regulations:

- Keep and maintain records of all pesticides used to meet legal (federal, state, and local) reporting requirements.
- Use records to monitor pest control efforts and to plan future management actions.
- Use electronic or hard-copy forms and software tools to properly track pesticide inventory and use.
- Develop and implement a pesticide drift management plan.
- Keep a backup set of records in a safe, but separate storage area.

Why Keep records?

State and federal laws require yo to do so.

Next to managing employees managing your pesticide use and tracking it is crucial to your success as a Golf course superintendent.

- Knowing what products work for you and don't work for you.
- Understanding timing of such products can mean successes or failure.
- Having a record to show that you are actively working in the best interest of the course.
- Managing the environment is not an exact science.
- Mother nature does not always cooperate with your plan.
- Being a few weeks late or to early applying products can be the difference between success or failure.
- Tracking these applications can help you to identify potential problems.

Sprayer Calibration

Principle

Properly calibrated and operation of application equipment is paramount to mitigating environmental and human health concerns.

Best Management Practices

Training and Calibration:

- Personally ensure spray technician is experienced, licensed, and properly trained.
- Minimize off-target movement by using properly configured application equipment.
- Properly calibrate all application equipment at the beginning of each season (at a minimum) or after equipment modifications.
- Check equipment daily when in use.
- Use recommended spray volumes for the targeted pest to maximize efficacy.
- Calibration of walk-behind applicators should be conducted for each person making the application to take into consideration their walking speed, etc.
- Addition of ground speed sensors helps to minimize varying differences in stride and walk speed.

Sprayer Operation:

- Make sure nozzles and spray patterns are correct.
- Proper agitation of product.
- No leaks
- Proper pressure is maintained.
- All controls work as they should.
- Measure each nozzle for volume and pressure.

Types of Sprayers

Principle

Various types and sizes of application equipment are readily available. The size of the equipment (tank size, boom width, etc.) should be matched to the scale of the facility.

Best Management Practices

Equipment too large in size requires greater volumes to prime the system. This can result in significant waste that must be properly handled.

Use an appropriately sized applicator for the size of the area being treated.

Sprayer types:

- Ride on sprayers.
- Pull behind sprayers.
- GPS guided sprayers are becoming popular.

- Walk boom sprayers. " Spray Hawk "
- Back pack sprayers.
- Piggy back tank sprayers similar to a back pack sprayer generally with a 10,15 or 25 gallon tank attached with a 12v motor.

Controllers:

- Manual spraying systems where ground speed and flow rate are manually adjusted with toggle switches.
- Automatic controllers where ground speed and flow rate are automatically adjusted as the sprayer is moving and spraying.
- GPS controlled sprayers allow for direct control over certain areas and makes overlap of ares sprayed a minimal issue.these sprayers save time, money and products.
- Handheld controllers are subject to manual calibration and manual control of said products.
- Spray Hawk uses a manual or automatic controller with ground speed sensor and manual control of boom to deliver products with low impact to the area being sprayed.

Inventory

Principle

Do not store large quantities of pesticides for long periods. Adopt the "first in–first out" principle, using the oldest products first to ensure that the product shelf life does not expire.

Best Management Practices

An inventory of the pesticides kept in the storage building and the Safety Data Sheets (SDS) for the chemicals used in the operation should be accessible on the premises, but not kept in the pesticide storage room itself.

Tips on storing pesticides.

- Always separate your products.
- Fungicide
- Herbicide
- Insecticide
- Micronutrients
- Fertilizer
- Wetting agents
- Keep off the floor when possible

- Keep locked up and limited access to only those trained in the use of said products.
- Have separate measuring devices for each class of pesticides.
- Keep in a ventilated storage area.
- Have each room or area clearly marked.
- Keep an inventory of all products when they arrive and when they are used.

Shelf Life

Principle

- Pesticides degrade over time. Do not store large quantities of pesticides for long periods.
- Utilize computer software systems to record inventory and use.

Best Management Practices

Be Mindful

- Avoid purchasing large quantities of pesticides that require storage for greater than six months. Early ordering makes this difficult to do, you can decide on the deliver dates of said orders.
- Adopt the "first in–first out" principle, using the oldest products first to ensure that the product shelf life does not expire.
- Many states offer "amnesty" days in order to eliminate potential public health and environmental hazards from canceled, suspended, and unusable pesticides that are being stored.
- Ensure labels are on every package and container.
- Consult inventory when planning and before making purchases.
- Ensure that labels remain properly affixed to their containers.
- Avoid over ordering know your numbers and when and where each product will be applied.
- Run a tight ship when it comes to your Pesticide orders and programs.

Leaching Potentials

Principle

Weakly sorbed pesticides (compounds with small Koc values) are more likely to leach through the soil and reach groundwater. Conversely, strongly sorbed pesticides (compounds with large Koc values) are likely to remain near the soil surface, reducing the likelihood of leaching, but increasing the chances of being carried to surface water via runoff or soil erosion.

Best Management Practices

Understanding the Environmental impact:

- Understand pesticide sorption principles so that appropriate decisions can be made.

- Understand site characteristics that are prone to leaching losses (for example, sand-based putting greens, coarse-textured soils, shallow water tables).
- Identify label restrictions that may pertain to your facility.
- Avoid using highly water-soluble pesticides.
- Exercise caution when using spray adjuvants that may facilitate off-target movement.

Mixing/Washing Station

Principle

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 water bodies. One of the best containment methods is the use of a properly designed and constructed chemical mixing center (CMC).

Best Management Practices

Safety First:

- Always use proper PPE when handling any pesticides.
- Loading pesticides and mixing them with water or oil diluents should be done over an impermeable surface (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 waste.
- Sweep up solid materials and use as intended.

Disposal

Principle

Wash water from pesticide application equipment must be managed properly since it contains pesticide residues.

Packaging must be properly discarded as well.

Best Management Practices

Rinse tank:

- Collect wash water (from both inside and outside the application equipment) and use it as a pesticide in accordance with the label instructions.

- The rinsate may be applied as a pesticide (preferred) or stored for use as makeup water for the next compatible application.
- Have a few pre chosen sights that minimize run off and have minimal exposure to people.

Personal Protective Equipment

Principle

Exposure to pesticides can be mitigated by practicing good work habits and adopting modern pesticide mix/load equipment (for example, closed-loading) that reduce potential exposure. Personal Protective Equipment (PPE) statements on pesticide labels provide the applicator with important information on protecting himself/herself.

Best Management Practices

PPE Personal Protective Equipment:

- Provide adequate PPE for all employees who work with pesticides (including equipment technicians who service pesticide application equipment).
- Ensure that PPE is sized appropriately for each person using it.
- Make certain that PPE is appropriate for the chemicals used.
- Ensure that PPE meets rigorous testing standards and is not just the least expensive.
- Store PPE where it is easily accessible but not in the pesticide storage area.
- Forbid employees who apply pesticides from wearing facility uniforms home where they may come into contact with children.
- Provide laundering facilities or uniform service for employee uniforms.
- The federal Occupational Safety and Health Administration (OSHA) requires employers to fit test workers who must wear tight-fitting respirators.
- Meet requirements for OSHA 1910.134 Respiratory Protection Program.

Pesticide Container Management

Principle

The containers of some commonly used pesticides are classified as hazardous wastes 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 very high 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

Packaging and Container removal:

- Triple Rinse pesticide containers immediately over the mix tank in order to remove the most residue and not waste any product.
- Rinse containers during the mixing and loading process and add rinsate water to the finished spray mix.
- Rinse emptied pesticide containers by either triple rinsing or pressure rinsing.
- Puncture empty and rinsed pesticide containers and dispose of according to the label. Puncturing ensures they can not be used for anything else.
- Empty all bags completely and discard of Immediately.

Integrated Pest Management

Regulatory Considerations

BMP Alabama

GCSAA USGA

The philosophy of integrated pest management (IPM) was developed in the 1950s because of concerns over increased pesticide use, environmental contamination, and the development of pesticide resistance. The objectives of IPM include reducing pest management expenses, conserving energy, and reducing the risk of pesticide exposure to people, animals, and the environment. Its main goal, however, is to reduce pesticide use by using a combination of tactics to control pests, including cultural, biological, genetic, and chemical controls.

Pest management on golf courses results in significant inputs of time, labor, and financial resources. To grow healthy turfgrass, it is important for golf course superintendents to know what IPM is and how to implement it for each pest group (arthropods, nematodes, diseases, and weeds). They must be well-versed in pest identification, understanding pest life cycles and/or conditions that favor pests, and know about all possible methods of controlling pests.

Regulatory Considerations

Principles

Some federal or state regulations cover practically anyone who manufactures, formulates, markets, and uses pesticides.

- Record keeping of pesticide use may be required by law. IPM principles suggest that you keep records of all pest control activity so that you may refer to information on past infestations or other problems to select the best course of action in the future.

Best Management Practices

Proper records of all pesticide applications should be kept according to local, state, or federal requirements.

Use records to establish proof of use and follow-up investigation of standard protocols regarding:

Format for record keeping:

- Date and time of application.
- Name of applicator.

- The person directing or authorizing the application.
- Weather conditions at the time of and end of application. If rainfall happened 24 hours prior to or after application it should be noted along with quantity.
- What pest or pest was targeted or prevention.
- The pesticide used (trade name, active ingredient, amount of formulation.)
- Adjuvant/surfactant and amount applied, if used.
- Area treated (acres or square feet) and location.
- The total amount of pesticide used.
- Water per acre rate of application.
- Application equipment.
- Additional remarks, such as the severity of the infestation or life stage of the pest.
- A follow-up to check the effectiveness of the application.

Weeds

Principles

- Weeds compete with desired plants for space, water, light, and nutrients and can harbor insect pests and diseases.
- Weed management is an integrated process where good cultural practices are employed to encourage desirable turfgrass ground cover, and where herbicides are intelligently selected and judiciously used. A successful weed management program consists of:
    - preventing weeds from being introduced into an area
    - using proper turfgrass management and cultural practices to promote vigorous, competitive turf
    - properly identifying weeds
    - properly selecting and using the appropriate herbicide, if necessary
- Weeds are hosts for other pests such as plant pathogens, nematodes, and insects, and certain weeds can cause allergic reactions in humans.
- Weeds 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.

Best Management Practices

Target selected:

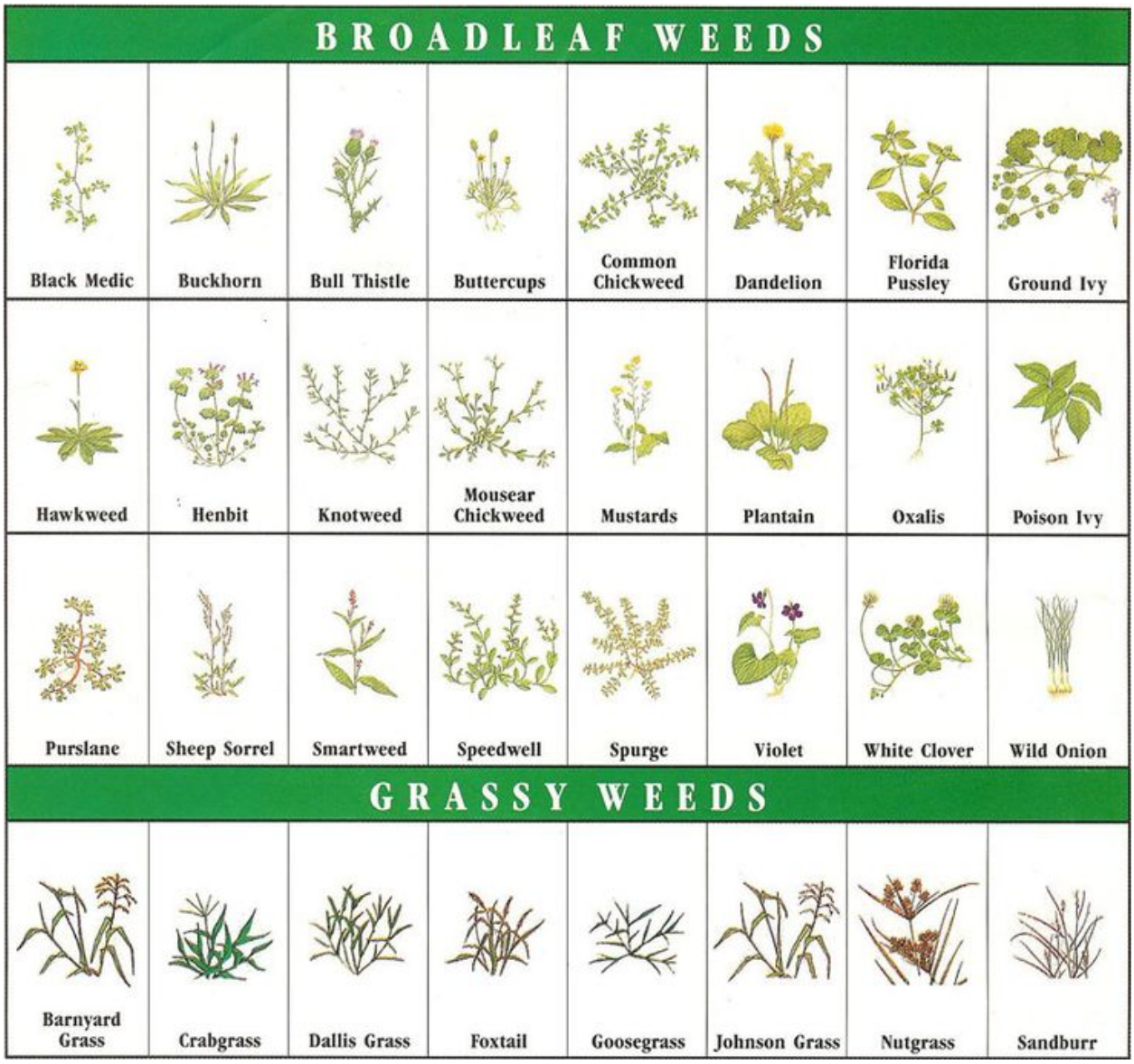
- Proper weed identification is essential for effective management and control.
- Proper pesticide identification is essential in eradicating or suppressing said target.
- Is the pesticide compatible with your desired environment?

Choose less Pesticides more natural choices when applicable:

- Select appropriate turf species or cultivars that are adapted to the prevalent environmental conditions to reduce weed encroachment that may lead to bare soils.
- To prevent weed encroachment, adopt or maintain cultural practices that protect turfgrass from environmental stresses such as shade, drought, and extreme temperatures.
- To reduce weed infestation, address improper turf management practices, such as the misuse of fertilizers and chemicals, improper mowing height or mowing frequency, and improper soil aeration, and physical damage and compaction from excessive traffic.
- Proper fertilization is essential for turfgrasses to sustain desirable color, growth density, and vigor and to better resist diseases, weeds, and insects.
- Avoid scalping; it reduces turf density, increasing weed establishment.
- Weed-free materials should be used for topdressing.
- Address damage from turfgrass pests such as diseases, insects, nematodes, and animals to prevent density/canopy loss to broadleaf weeds.

Mapping weed infestation areas:

- Record and map weed infestations to help identify site-specific issues for preventative actions.
- Like turgrass certain weeds desire certain soils and nutrient. Mapping Chronic weed areas along with soil tests and monitoring of the site can help you to develop a site specific plan to eradicate undesirable plants for the overall success of the property.



Disease

Principles

- In the presence of a susceptible host and a conducive environment, plant pathogens can disrupt play by damaging and destroying intensely managed turf.
- No measure can completely eliminate the threat of turfgrass disease on a golf course. However, turfgrass managers have multiple tactics and tools that can reduce the likelihood of disease.
- Cultural factors that can influence turfgrass stress and the likelihood of disease problems include organic layer management, fertility programs, water management, and mowing height selection. Healthy, well-managed turfgrass is less likely to develop disease problems.
- Disease outbreaks that do occur are less likely to be severe on turf that is healthy because it has better recuperative potential than stressed, unhealthy turf.

Best Management Practices

Cultural Control

- Proper selection and culture practices to ensure the health of the plant.
- Proper fertilization for optimal growth.
- Proper drainage for managed soils.
- Proper mowing and grooming to maintain plant help.

Identify:

- Correctly identify the disease pathogen. This often involves sending samples to diagnostic clinics.
- Document the conditions the were present 48 hours prior to onset of disease and current conditions.
- Document products applied to that specific area over the last 4 weeks.
- Document any unusual weather events or man made stresses to the area over the last 2 weeks.

Create a plan of attack:

- Ensure that proper cultural practices that reduce turfgrass stress are used.
- Correct conditions that produce stressful environments for the turf (for example, improve airflow and drainage, reduce or eliminate shade.)
- Fungicide use should be integrated into an overall management strategy for a golf course.
- The appropriate (most effective) preventive fungicide should be applied to susceptible turfgrasses when unacceptable levels of disease are likely to occur.
- Preventative apply appropriate fungicides where diseases are likely to occur and when conditions favor disease outbreaks.
- Record and map disease outbreaks and identify trends that can help guide future treatments and focus on changing conditions in susceptible areas to reduce disease outbreaks.

IPM Overview

Principles

- The fundamental basis of an environmentally sound pest control program is a process called IPM.
- IPM focuses on the basics of identifying the pests, choosing pest-resistant varieties of grasses and other plants, enhancing the habitat for natural pest predators, scouting to determine pest populations and determining acceptable thresholds, and applying biological and other less toxic alternatives to chemical pesticides whenever possible.
- Chemical controls should have minimal effect on beneficial organisms and the environment and minimize the development of pesticide resistance.

Best Management Practices

Chemical pesticide applications should be carefully chosen for effective and site-specific pest control with minimal environmental impact.

Identify key pests on key plants.

- Determine the pest's life cycle, and know which life stage to target (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, prepare the site, select resistant cultivars), reduce pest habitat (for example, practice good sanitation, carry out pruning and dethatching), or to help promote biological control (for example, provide nectar or honeydew sources).
- Decide which pest management practice is appropriate and carry out corrective actions. Direct control where the pest lives or feeds.
- Use preventive chemical applications only when your professional judgment indicates that properly timed preventive applications are likely to control the target pest effectively while minimizing the economic and environmental costs.
- Determine whether the corrective actions actually reduced or prevented pest populations, were economical, and minimized risks. Record and use this information when making similar decisions in the future.

Written Plan

Principles

- IPM is an overall pest management strategy that includes biological controls, cultural methods, pest monitoring, other applicable practices, and is the last measure when threshold levels are exceeded.
- A pest-control strategy should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated. A control strategy should be implemented that reduces the pest numbers to an acceptable level while minimizing harm to non-targeted organisms.
- When a pesticide application is deemed necessary, its selection should be based on effectiveness, toxicity to non-target species, cost, and site characteristics, as well as its solubility and persistence.

Best Management Practices

Written IPM plan

- Decide which pest management practice(s) are appropriate and carry out corrective actions. Direct control where the pest lives or feeds. Use properly timed preventive chemical applications only when your professional judgment indicates they are likely to control the target pest effectively while minimizing the economic and environmental costs.
- Determine whether the corrective actions actually reduced or prevented pest populations, were economical, and minimized risks. Record and use this information when making similar decisions in the future.
- Observe and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pests are present, so intelligent decisions can be made regarding how damaging the pests are and what control strategies are necessary.
- Observe and record weather conditions when pest is most active and at time of application.

Pest Thresholds

Principles

- IPM is commonly used in agricultural crop production, where the economic thresholds for key pests have been determined. Pest levels exceeding the site's threshold warrant treatment.
- Using IPM is more challenging on golf courses than in an agricultural setting. The golf industry is sensitive to aesthetic damage, and golfers are often intolerant of anything that could affect the appearance of turfgrass and ornamental plants. Increased education of golfers and maintenance personnel could raise their tolerance of minor aesthetic damage without compromising plant health, play, and aesthetics.

	**ARMYWORMS** Feed on grass blades and sometimes roots. Damage can be scattered and not confined to patches.		**FLEAS** Beware of pets bringing these pests indoors.
	**BILLBUGS** Burrow in the grass and feed on the leaves and roots. Can damage large sections of grass if not controlled/eliminated.		**WHITE GRUBS** The most damaging turf insect pest. Grubs are the larvae stage of especially the Japanese Beetle and feed on lawn roots.
	**CHIGGERS** A parasite that feeds on animals & humans. They like fields, grasses, and weedy areas.		**SOD WEBWORMS** Feed at night on grass blades. Blades may appear ragged and brown spots left in lawns. May damage large areas of lawns.
	**CHINCHBUGS** A common pest that feeds on many grasses. Detected by large patches of lawn turning yellow or straw colored.		**TICKS** HEALTH RISK! There are over 850 species of ticks and over 100 can transmit diseases to humans. Especially by forest floors, fallen leaves.
	**CUTWORMS** Feed on grass and cut off the blades near the soil. Leave approx. 2" wide patches of brown grass.		**SPITTLEBUG** Form masses that look like spittle around soil surface. They suck the juice from grasses.
	**MOLE CRICKETS** Feed on grass at night during warm weather and after rain or watering. Can't be eliminated but only controlled.		**JAPANESE BEETLES** Highly destructive plant pest that eats foliage and fruits of many plants. Lays eggs in lawns that produce grubs and do root damage.
	**WHITEFLIES** Can transmit and spread viruses to crops. They injure plants by sucking the juices out and leaving them wilted or dead.		**SOWBUGS** Will feed on foliage, stems, and roots of vegetable plants, seedlings, and bedding plants.

Best Management Practices

Putting a Plan to Action

- Use available pest thresholds to guide pesticide application decisions (see IPM Guide).
- Use preventive chemical applications only when professional judgment indicates that properly timed preventive applications are likely to control the target pest effectively while minimizing the economic and environmental costs.
- Record and use this information when making similar decisions in the future.
- Careful planning should be given to not to endanger Pollinators.

Monitoring

Principles

- Monitoring, or scouting, is the most important element of a successful IPM program. Monitoring documents the presence and development of pests, or the conditions that are conducive for pest outbreak throughout the year.
- It is essential to record the results of scouting in order to develop historical information, document patterns of pest activity, and document successes and failures.

Best Management Practices

Observation

- Train personnel to observe and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pests are present, so intelligent decisions can be made regarding how damaging they are and what control strategies are necessary.
- Train personnel to determine the pest's life cycle, and know which life stage to target (for an insect pest, whether it is an egg, larva/nymph, pupa, or adult).
- Train personnel to determine whether the corrective actions actually reduced or prevented pest populations, were economical, and minimized risks. Record and use this information when making similar decisions in the future.
- Train personnel to document, identify and record key pest activities on key plants.
- Look for signs of the pest. These may include mushrooms, animal damage, insect frass, or webbing.
- Identify the symptoms of the pest. Look for symptoms such as chlorosis, dieback, growth reduction, defoliation, mounds, or tunnels.
- Determine the damage. Problem areas might include the edges of fairways, shady areas, or poorly drained areas.
- Document when the damage occurred. Note the time of day, year, and flowering stages of nearby plants.
- Map pest outbreaks locations to identify patterns and susceptible areas for future target applications and ultimate pesticide reductions.

Record Keeping

Principles

- It is essential to record the results of scouting in order to develop historical information, document patterns of pest activity, and document successes and failures.
- Record keeping is required to comply with the federal Superfund Amendments and Reauthorization Act (SARA, Title III), which contains emergency planning and community right-to-know legislation
- Certain pesticides are classified as restricted-use pesticides (RUPs). Very few pesticides in this category are routinely used in turf maintenance, but if you happen to use one of them, certain record-keeping requirements apply.

Best Management Practices

Recording Results.

- This is more sight and target specific record keeping over your standard Pesticide application record keeping. This is site and pest specific record keeping that will get more specific and detailed per the pest your targeting.
- Document, identify and record key pest activities on key plants and locations.
- Determine the pest's life cycle, and know which life stage to target (for an insect pest, whether it is an egg, larva/nymph, pupa, or adult).
- Determine whether the corrective actions actually reduced or prevented pest populations, were economical, and minimized risks. Record and use this information when making similar decisions in the future.
- Observe and document turf conditions regularly (daily, weekly, or monthly, depending on the pest), noting which pests are present, so intelligent decisions can be made regarding how damaging they are and what control strategies are necessary.

Turfgrass Selection

Principles

- Selecting pest-resistant cultivars or plant species is a very important part of IPM, and it leads 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 for or selected for).
- Educate builders, developers, golf course and landscape architects, sod producers, golfers, and others on which plants are best suited to their areas.
- Turfgrasses must be scientifically selected for the eco-region of the golf course, resulting in minimized irrigation requirements, fertilization needs, and pesticide use.

Best Management Practices

Turf selection

- Select the most suitable turfgrass for existing conditions and one that adheres to design specifications.
- Avoid the use of turfgrass in heavy shade.
- 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.
- Reduce fertilizer applications in shaded areas.
- Reduce traffic in shaded areas to protect turfgrasses and trees from injury and soil compaction, if practical.

Today's courses have multiple varieties, Greens, Bunker surrounds, Fairways, tees, rough, and deep rough.

Other things to consider.

- Encroachment. This can become a costly issue.

- Mechanically removing one turf from another.
- Chemically removing one turf from another.
- Overseeding or Paint / Pigments in the winter.

Biological Controls

Principles

- The biological component of IPM involves the release and/or conservation of natural predators, such as parasites and pathogens, and other beneficial organisms (pollinators).
- Natural enemies (including ladybird beetles, green lacewings, and mantids) may be purchased and released near pest infestations.
- Areas on the golf course can also be modified to better support natural predators and beneficial organisms.

Best Management Practices

Turf Areas

- Release insect-parasitic nematodes to naturally suppress mole crickets and white grubs.

- Identify areas on the golf course that can be modified to attract natural predators, provide habitat for them, and protect them from pesticide applications.
- Install flowering plants that can provide parasitoids with nectar, or sucking insects (aphids, mealybugs, or soft scales) with a honeydew source.
- Avoid applying pesticides to roughs, driving ranges, or other low-use areas to provide a refuge for beneficial organisms.

Aquatic areas

- Aquatic additions include carp or algae eaters to keep clean free from surface and subsurface algae.
- Gates may be installed at overflow points to keep carp in a pond for continued feeding.
- Removing carp when they become too large and quit eating as much.

Natural areas

- Creating natural areas allows for an eco-friendly balance and saves time, money and labor from having to maintain them in season.
- Winter is a great time to selectively, manually clean these areas up to keep them presentable yet natural.

Pollinators

Principles

- It is important to minimize the impacts on bees and beneficial arthropods. Pesticide applicators must use appropriate tools to help manage pests while safeguarding pollinators, the environment, and humans.
- Pollinator-protection language is a labeling requirement found on pesticide labels.
- Be mindful of pollinators; when applying pesticides, focus on minimizing exposure to non-target pollinators in play and non-play course areas.
- Pollinators may be negatively impacted when pesticide applications are made based on insufficient information and/or made without regard to the safety of pollinators.

https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_021377.pdf

Best Management Practices

Adopt a spot treatment philosophy.

Choose your products wisely

- When using pesticides, minimize injury and damage by following label directions.
- Follow label information concerning the application of pesticides when plants may be in bloom. Avoid applying pesticides during the bloom season.
- Consider lures, baits, and pheromones as alternatives to insecticides for pest management.
- Use granular formulations of pesticides that are known to be less hazardous to bees.

- Use insecticides that have a lower impact on pollinators.

Protect the Pollinators

- Do not apply pesticides when pollinators are active.
- Before applying a pesticide, scout/inspect the area for both harmful and beneficial insect populations and apply only when the indicated threshold of damage has been reached.
- Mow flowering plants (weeds) before insecticide application.
- If flowering weeds are prevalent, control them before applying insecticides.

Application Equipment

- Use the latest spray technologies, such as drift-reduction nozzles to prevent off-site (target) translocation of pesticide.
- Stay on target by using coarse-droplet nozzles and monitor wind to reduce drift.
- Avoid applications during unusually low temperatures or when dew is forecasted.
- Drop spreaders when using granular for site-specific targets.

Conventional Pesticides

Principles

- IPM does not preclude the use of pesticides. However, pesticides should be viewed as one of the many tools used to minimize pest problems.
- IPM involves both prevention — keeping the pest from becoming a problem — and suppression — reducing the pest numbers or damage to an acceptable level.
- A pest-control strategy using pesticides should be used only when the pest is causing or is expected to cause more damage than what can be reasonably and economically tolerated.
- Pesticides are designed to control or alter the behavior of pests. When, where, and how they can be used safely and effectively is a matter of considerable public interest.
- 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.
- A control strategy should be implemented that reduces the pest numbers to an acceptable level while minimizing harm to non-targeted organisms.
- Always follow the directions on the label. These directions have been developed after extensive research and field studies on the chemistry, biological effects, and environmental fate of the pesticide. The label is the single most important document in the use of a pesticide. State and federal pesticide laws require following label directions!

Best Management Practices

Applications and timing.

- Train employees in proper pest identification and pesticide selection techniques.
- Choose the product most appropriate for the problem or pest.
- Mix only the quantity of pesticide needed in order to avoid disposal problems, protect non-target organisms, and save money.

- Spot-treat pests whenever appropriate.
- Make note of any environmental hazards and groundwater advisories included on the label.
- Rotate pesticide modes-of-action to reduce the likelihood of resistance.
- Follow guidelines and advice provided by the Fungicide Resistance Action Committee (FRAC), Herbicide Resistance Action Committee (HRAC), and Insecticide Resistance Action Committee (IRAC).

Nematodes

Principles

- Plant-parasitic nematodes adversely affect turfgrass health.
- Plant-parasitic nematodes are microscopic roundworms (unsegmented), usually between 0.0156 and 0.125 inches (0.25 and 3 mm) in length, and are difficult to control.
- 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. Additionally, weakened turf favors pest infestation, especially troublesome weeds that necessitate herbicide applications.
- 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

Nematode applications

- When nematode activity is suspected, an assay of soil and turfgrass roots is recommended to determine the extent of the problem.
- The application of a nematicide on golf course turf should always be based on assay results.
- Divert traffic away from areas that are stressed by insects, nematodes, diseases, or weeds.
- Increase mowing height to reduce plant stress associated with nematodes, root-feeding insects, disease outbreaks, or peak weed-seed germination.
- Reduce/eliminate other biotic/abiotic stresses when nematodes are compromising the root system and plant health.
- Prevention is your best cure.

Maintenance Operations

Regulatory Considerations

BMP GCSAA USGA Alabama

Equipment maintenance, fueling, and chemical storage can have an impact on water quality on-site and off-site both during construction and during the maintenance of existing golf courses.

Regulatory Considerations

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 maintenance and storage facility that minimizes environmental impact and meets the needs for the approval process.

Storage and Handling of Chemicals

Principles

- Proper handling and storage of pesticides and petroleum-based products are important to reduce the risk of serious injury or death of an operator or bystander. Fires or environmental contamination may result in large fines, cleanup costs, and civil lawsuits if these chemicals are not managed properly.
- Check federal, state, and local regulations for specific requirements related to storage of pesticides.

Best Management Practices

Storage facilities

- Only select personnel should have access to the storage areas.
- Storage buildings should have appropriate warning signs and placards.
- Store pesticides in a lockable concrete or metal building.
- Locate pesticide storage away from other buildings, especially fertilizer storage facilities.

- Floors of chemical storage buildings should be impervious and sealed with chemical-resistant paint.
- Floors of chemical storage buildings should have a continuous sill to contain spills and should not have a drain. A sump is acceptable.
- Shelving should be fabricated from plastic or reinforced metal. Metal shelving should be painted to avoid corrosion.
- Wood shelving should never be used because of its ability to absorb spilled pesticides.
- Automatic exhaust fans and an emergency wash area should be provided
- Explosion-proof lighting may be required. Locate fan and light switches outside the entrance to the building to facilitate ventilation of building before the entrance of staff.
- Store pesticides in a lockable concrete or metal building.

P.P.E.

- Follow all personal protective equipment (PPE) statements on pesticide labels.
- Store PPE away from pesticide storage areas in an area that is easily accessible.
- Develop an emergency response plan and educate all golf course personnel regarding emergency procedures on a regular basis.
- Individuals conducting emergency chemical cleanups should be properly trained under requirements of the federal Occupational Safety and Health Administration (OSHA

Handling of Pesticides

- Maintain detailed records of current pesticide inventory in the storage facility. Safety Data Sheets (SDS) for the chemicals stored on-site should be stored separately from the storage room, but readily accessible on-site.
- Do not store large quantities of pesticides or chemicals for long periods of time. Follow a "first in, first out" principle to rotate products into use to ensure products do not expire.
- Store chemicals in original containers. Never store them in containers that might be mistaken as packaging for food or drink.
- Arrange containers so the labels are clearly visible. Securely fasten loose labels to ensure containers and associated labels are kept together.
- Damaged labels should be replaced immediately.
- Store flammable pesticides separate from those that are nonflammable.
- Store liquid materials below dry materials to prevent leaks from contaminating dry products.
- Ensure that oil containers and small fuel containers (service containers) are properly labeled and stored within the facility.

Equipment Storage and Maintenance

Principle

Storing and maintaining equipment properly will extend useful life and reduce repairs.

Best Management Practices

Many times the maintenance facility is a preexisting structure from the previous land owner. These buildings will need to be assessed for their ability to properly store equipment, fuels, oils and pesticides.

Moving in

- Store and maintain equipment in a covered area complete with a sealed impervious surface to limit the risk of fluid leaks contaminating the environment and to facilitate the early detection of small leaks that may require repair before causing significant damage to the turf or the environment.
- Seal floor drains unless they are connected to a holding tank or sanitary sewer with permission from the local wastewater treatment plant.
- Store pesticide and fertilizer application equipment in areas protected from rainfall. Rain can wash pesticide and fertilizer residues from the exterior of the equipment and possibly contaminate soil or water.
- Store solvents and degreasers in lockable metal cabinets away from ignition sources in a well-ventilated area. These products are generally toxic and highly flammable. Never store them with fertilizers or in areas where smoking is permitted.
- Keep an inventory of solvents and SDS for those materials on-site but in a different location where they will be easily accessible in case of an emergency.
- Keep basins of solvent baths covered to reduce emissions of volatile organic compounds (VOC).
- When possible, replace solvent baths with recirculating aqueous washing units. Soap and water or other aqueous cleaners are often as effective as solvent-based products and present a lower risk to the environment.
- Always use appropriate PPE when working with solvents.
- Never allow solvents or degreasers to drain onto pavement or soil, or discharge into water bodies, wetlands, storm drains, sewers, or septic systems.
- Collect used solvents and degreasers in containers clearly marked with contents and date; schedule collection by a commercial service.
- Blow off all equipment with compressed air to reduce damage to hydraulic seals.

Some are fortunate to get to design their own facility.

Designing your own takes a lot of considerations. Start with visiting other facilities in and around your area.

The best knowledge you will receive is from other Superintendents on what works and what does not work.

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Waste Handling

Principles

- Proper disposal of waste materials is critical for the protection of water and natural resources. State or local laws and regulations related to the disposal of hazardous waste products may vary. Be sure to familiarize yourself with all state and local laws related to disposal/recycling of these waste materials.
- Identify and implement waste-reduction practices.
- Look for ways to increase recycling efforts and programs.
- Purchase environmentally preferred products in bulk packaging when possible.

Best Management Practices

Shop management extends beyond the mechanic shop.

- Pesticides that have been mixed for an application must be disposed of as waste and may be classified as hazardous waste depending on the materials involved. Contact local authorities for guidance regarding proper disposal.
- Collect used oil, oil filters, and antifreeze in separate marked containers and recycle them as directed by local and state authorities.
- Antifreeze may be considered hazardous waste by state or local laws and should be handled accordingly. Commercial services are available to collect and recycle antifreeze.

- Lead-acid batteries are classified as hazardous waste unless they are properly recycled.
- Store old batteries on impervious services where they are protected from rainfall and recycle as soon as possible.
- Recycle used tires.
- Recycle or dispose of fluorescent tubes and other lights according to state requirements.

Equipment Washing

Principle

Wash water generated from equipment-washing facilities can be a source of both surface-water and groundwater pollution. Steps should be taken to prevent pollution.

Best Management Practices

Check local codes

- 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.
- Wash equipment with a bucket of water and a rag to minimize the amount of water used and use only the minimal amount of water required to rinse the machine.
- Spring-operated shut-off nozzles should be used.
- Do not allow any wastewater to flow directly into surface waters or storm drains.

Fueling Facilities

Principle

Safe storage of fuel, including the use of above-ground tanks and containment facilities, is critical to the protection of the environment. State or local laws and regulations related to storage of fuel may vary.

Best Management Practices

Tank installation and care

- Install emergency fuel shut off located away from tanks and easily accessible.
- Keep on hand adequate fire extinguishers easily accessible if needed.
- Locate fueling facilities on roofed areas with a concrete (not asphalt) pavement. Areas should be equipped with spill-containment and recovery facilities.
- Use of above ground double walled fuel tanks is preferred.
- Erect (safety yellow for visibility) Perimeter protecting Bollards, position in corners and middle to protect the integrity of the tanks from accidental damage.
- Double walled tanks tend to have their own containment system in case of leaks. Check with manufacturer.

- Keep decals fresh and paint annually to protect the tanks exterior from rust.
- Keep the area clear for easy access and maneuverability.

Pollution Prevention

Principles

- Plan appropriately to minimize the possibility of an illicit discharge and need for disposal. Monitor the water to be discharged for contamination; never discharge to the environment any contaminated water. If the water is not contaminated, it can be reused or discharged to a permitted stormwater treatment system.
- 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 water bodies.
- Wash water from pesticide application equipment must be managed properly since it contains pesticide residues. This applies to wash water from both the inside and the outside of the application equipment. Material should be collected and used as a pesticide in accordance with the label instructions for that pesticide.
- An equipment-washing facility can be a source of both surface water and groundwater pollution if the wash water generated is not properly handled. All equipment used in the maintenance of golf courses and associated developments should be designed, used, maintained, and stored in a way that eliminates or minimizes the potential for pollution.
- One of the key principles of pollution prevention is to reduce the unnecessary use of potential pollutants. Over time, the routine discharge of even small amounts of solvents can result in serious environmental and liability consequences, because of the accumulation of contaminants in soil or groundwater.
- The proper handling and storage of pesticides is important. Failure to do so correctly may lead to the serious injury or death of an operator or bystander, fires, environmental contamination that may result in large fines and cleanup costs, civil lawsuits, the destruction of the turf you are trying to protect, and wasted pesticide product.
- Generating as little as 25 gallons per month of used solvents for disposal can qualify you as a "small quantity generator" of hazardous waste, triggering EPA and state reporting requirements.
- Pesticides that have been mixed so they cannot be legally applied to a site in accordance with the label must be disposed of as waste. Depending on the materials involved, they may be classified as hazardous waste.
- Provide adequate protection from the weather. Rain can wash pesticide and fertilizer residues from the exterior of the equipment, and these residues can contaminate soil or water.
- Never allow solvents to drain onto pavement or soil, or discharge into water bodies, wetlands, storm drains, sewers, or septic systems, even in small amounts.
- Office paper, recyclable plastics, glass, and aluminum should be recycled. Place containers for recycling aluminum cans and glass or plastic soft drink bottles at convenient locations on the golf course.

Best Management Practices

As much as you do on the golf course to protect the environment just as much, if not more will be done at your facility. Everything that goes on the course starts at the facility.

Facility Management

- Pesticides should be stored in a lockable concrete or metal building.
- Pesticide storage and mixing facility floors should be impervious and sealed with chemical-resistant paint. Floors should have a continuous sill to retain spilled materials and no drains, although a sump may be included.
- For valuable information about constructing chemical mixing facilities, reference the Midwest Plan Service book, Designing Facilities for Pesticide and Fertilizer Containment (revised 1995); the Tennessee Valley Authority (TVA) publication, Coating Concrete Secondary Containment Structures Exposed to Agrichemicals (Broder and Nguyen, 1995); and USDA–NRCS Code 703.
- Use a chemical mixing center (CMC) as a place for performing all operations where pesticides are likely to be spilled in concentrated form—or where even dilute formulations may be repeatedly spilled in the same area—over an impermeable surface. (A CMC is a concrete pad treated with a sealant and sloped to a liquid-tight sump where all of the spilled liquids can be recovered.)
- Flush wash pad with clean water after the equipment is washed. Captured wash water can be used as a dilute pesticide per labeled site, or it may be pumped into a rinsate storage tank for use in the next application.
- FIFRA, Section 2(ee), allows the applicator to apply a pesticide at less than the labeled rate.
- The sump should then be cleaned of any sediment before another type of pesticide is handled.
- Discharge to a treatment system that is permitted under industrial wastewater rules.
- Never discharge to a sanitary sewer system without written permission from the utility.
- Never discharge to a septic tank.
- Use a closed-loop wash-water recycling system and follow appropriate BMP.
- Use non-containment wash water for field irrigation.
- Do not discharge non-contaminated wastewater during or immediately after a rainstorm, since the added flow may cause the permitted storage volume of the stormwater system to be exceeded.
- Whenever practical, replace solvent baths with recirculating aqueous washing units (which resemble heavy-duty dishwashers).
- Use soap and water or other aqueous cleaners; these products are often as effective as solvent-based ones.
- Blowing off equipment with compressed air instead of washing with water is often easier on hydraulic seals and can lead to fewer oil leaks.
- Grass-covered equipment should be brushed or blown with compressed air before being washed. Dry material is much easier to handle and store or dispose of than wet clippings.
- It is best to wash equipment with a bucket of water and a rag, using only a minimal amount of water to rinse the machine.
- Clean up spills as soon as possible.
- Keep spill cleanup equipment available when handling pesticides or their containers.
- If a spill occurs of a pesticide covered by certain state and federal laws, you may need to report any accidental release if the spill quantity exceeds the "reportable quantity" of active ingredient specified in the law.
- Large spills or uncontained spills involving hazardous materials may best be remediated by hazardous material cleanup professionals.
- For emergency (only) information on hazards or actions to take in the event of a spill, call CHEMTREC, at (800) 424–9300. CHEMTREC is a service of the Chemical Manufacturers Association. For information on whether a spilled chemical requires reporting, call the CERCLA/RCRA helpline at (800) 424–9346.
- Do not allow any wash water to flow directly into surface waters or storm drains.
- Avoid washing equipment in the vicinity of wells or surface water bodies.

- Wash equipment over a concrete or asphalt pad that allows the water to be collected. After the residue dries on the pad, collect, compost, or spread in the field.
- If applicable, allow runoff onto a grassed area to soak into the ground, but never into a surface water body or canal.
- Use compressed air to blow off equipment. This is less harmful to the equipment's hydraulic seals, eliminates wastewater, and produces dry material that is easier to handle.
- Handle clippings and dust separately. After the residue dries on the pad, it can be collected and composted or spread in the field.
- Minimize the use of detergents. Use only biodegradable non-phosphate detergents.
- Minimize the amount of water used to clean equipment. This can be done by using spray nozzles that generate high-pressure streams of water at low volumes.
- Do not discharge wash water to surface water or groundwater either directly or indirectly through ditches, storm drains, or canals.
- Do not conduct equipment wash operations on a pesticide mixing and loading pad. (This keeps grass clippings and other debris from becoming contaminated with pesticide).
- Solvents and degreasers should be used over a collection basin or pad that collects all used material.
- Oil/water separators can be used but must be managed properly to avoid problems. Do not wash equipment used to apply pesticides on pads with oil/water separators
- Collect used solvents and degreasers, place them into containers marked with the contents and the date, and then have them picked up by a service that properly recycles or disposes of them. Never mix used oil or other liquid material with the used solvents.
- Collect used oil, oil filters, and antifreeze in separate marked containers and recycle them. Arrange pickup of used oil, or deliver to a hazardous waste collection site.
- Do not mix used oil with used antifreeze or sludge from used solvents. Antifreeze must be recycled or disposed of as a hazardous waste.
- Store batteries on an impervious surface and preferably under cover. Remember, spent lead-acid batteries must be recycled if they are to be exempt from strict hazardous waste regulations.
- Lead-acid storage batteries are classified as hazardous wastes unless they are recycled. All lead-acid battery retailers in Florida are required by law to accept returned batteries for recycling.
- Spent lead-acid batteries must be recycled if they are to be exempt from strict hazardous waste regulations.
- Equipment used to apply pesticides and fertilizers should be stored in areas protected from rainfall.
- Pesticide application equipment can be stored in the chemical mixing center (CMC), but fertilizer application equipment should be stored separately.
- Blow or wash loose debris off equipment to prevent dirt from getting on the CMC pad, where it could become contaminated with pesticides.
- Ensure that all containers are sealed, secured, and properly labeled. Use only regulatory agency-approved, licensed contractors for disposal.
- Rinse pesticide containers as soon as they are empty. Pressure rinse or triple-rinse containers, and add the rinse water to the sprayer.
- Shake or tap non-rinseable containers, such as bags or boxes, so that all dust and material fall into the application equipment.
- After cleaning them, puncture the pesticide containers to prevent reuse (except glass and refillable mini-bulk containers).
- Keep the rinsed containers in a clean area, out of the weather, for disposal or recycling.
- Storing the containers in large plastic bags/tubs to protect the containers from collecting rainwater.

- Recycle rinsed containers in counties where an applicable program is available, or take them to a landfill for disposal. Check with your local landfill before taking containers for disposal, as not all landfills will accept them.

Surface Water Management

Regulatory Considerations

Principle

Course owners and superintendents should investigate regulatory requirements that apply to the golf facility to protect surface and groundwater quality.

http://www.adem.state.al.us/programs/water/groundwater.cnt

Best Management Practices

Aquatic management.

- Aquatic management of plants may be regulated under construction permitting and regulatory licensing requirements. Consult with federal, state, and local water management agencies before managing golf course lakes and wetland areas.
- Consult with federal, state, and local water management agencies, and/or consult an approved management plan before performing cultural practices: fertilization, installation of plants, hand removal of plants, or mechanical harvesting.
- The introduction of aquatic triploid grass carp, biological controls, aeration, and chemical controls (herbicide/algaecide) must be approved and monitored according to permit and licensing protocols and compliance.
- The disposal of sediments from surface water ponds (storm water detention) may be subject to regulation.
- Golf course management may be affected by Total Maximum Daily Loading (TMDL), mitigation, and watershed basin management action plans (BMAP).
- Wetlands are protected areas; consult with federal and state agencies before altering natural aquatic areas.
- Constructed wetlands should have an impervious bottom to prevent groundwater contamination.
- Studies of water supplies are needed for irrigation systems, including studies of water bodies or flow on, near, and under the property to properly design a course's storm water system and water features to protect water resources.

Stormwater Capture

Although golf courses are typically large properties ranging in size from 60 to 200 acres, they are just one link in a stormwater management chain. Generally, a quantity of stormwater enters the golf course area, supplemented by what falls on the golf course proper, and then the stormwater leaves the golf course. Therefore, golf courses are realistically capable of having only a small impact on major stormwater flow. That impact should be to add only small increments of water over a given period of time. Engineers call this function "detention."

When golf courses are designed and built, their drainage capability concept is guided by an average rainfall event of a given frequency. For example, typically, a golf course drainage system is designed to detain a two- or five-year rain event. In other words, when that rain event happens, the golf course will be able to be reasonably drained in a matter of hours, as excess water not absorbed by the soil flows through the drainage system, is temporarily held, and finally leaves the property. In some instances, golf courses and other recreational facilities are mandated to be designed to handle a 20-, 50- or 100-year rain event, which means the golf course must detain more water for perhaps a longer period of time. This ability to detain large amounts of water requires accurate engineering and extensive construction to prevent physical or financial damage to the facility.

Best Management Practices are intended to prolong the detention process as long as practical, harvest as much of the stormwater in surface or underground storage as reasonable, and to improve the quality of water leaving the property when possible.

Principles

- When the golf course is properly designed, rain and runoff captured in water hazards and stormwater ponds may provide most or all of the supplemental water necessary under normal conditions, though backup sources may be needed during drought conditions.
- Capture systems should be considered part of the overall treatment.
- Stormwater capture is desirable where the lowest quality of water is needed to conserve potable water, maintain hydrologic balance, and improve water treatment.
- This practice uses natural systems to cleanse and improve water treatment.

Best Management Practices

Storm water capture and clean.

- Install berms and swells to capture pollutants and sediments from runoff before it enters the irrigation storage pond.
- Monitor pond water level for water loss (seepage) to underground systems. If seepage is occurring, it may be necessary to line or seal the pond or install pumps to relocate water.
- Install water-intake systems that use horizontal wells placed in the subsoil below the storage basin; use a post pump to filter particulate matter.
- A backup source of water should be incorporated into the management plan.
- Inspect irrigation pumps, filtration systems, conveyances and control devices to prevent / incorrect system issues.
- Service pumps regularly and inspect for efficiency of use.

Water Quality Protection

Principle

- An aquatic plant management strategy should address the intended uses of the waterbody to maintain water quality. Proper documentation of the site's physical attributes and location, the presence of invasive or weedy species, aesthetics, watershed and groundwater assessments, and other environmental considerations. Proper documentation of nuesense weeds or inavasive species better your chance of eliminating the problem.
- Only licensed individuals or contractors should be allowed to select and apply aquatic pesticides.

Best Management Practices

Aquatic plant management strategy.

- Accommodate natural lake processes in the construction of lakes and ponds; include herbaceous and woody vegetation and emergent and submergent shoreline plants to reduce operational costs.
- Use integrated pest management (IPM) strategies and native or naturalized vegetation wherever practical.
- Apply appropriate herbicides to minimize damage to non-target littoral plantings.
- Maintain a narrow band of open water at the pond edge to control the expansion of plants into more desirable littoral plantings.
- Use appropriate aquatic herbicides to prevent turfgrass injury and to protect water quality and wildlife habitat.
- Irrigation should not directly strike or run off to water bodies, and no-fertilization buffers should be maintained along water edges.
- Outline goals and priorities to guide the development of the BMP necessary to support the lake/aquatic management plan.
- Superintendents should monitor designated waters in their area for the persistence of toxic herbicides and algaecides in the environment.
- Secondary environmental effects on surface water and groundwater from the chemical control of vegetation should be monitored and recorded.
- Apply fertilizer and reclaimed (reuse) irrigation/fertigation appropriately to avoid surface water and groundwater contamination.
- Apply copper products per label instructions to reduce the risk of impairing water quality and causing negative biological impacts.
- Identify the position of property in relation to its watershed.
- Identify overall goals and validate concerns of the local watershed.
- Identify surface water and flow patterns.
- Indicate stormwater flow as well as existing and potential holding capacity.
- Indicate impervious surfaces, such as buildings, parking lots, or pathways.
- Indicate major drainages and catch basins that connect to local surface water bodies.
- Identify and understand the depth of water tables and soil types.
- Locate and protect wellheads.

Dissolved Oxygen

Principles

- Every golf course should have a plan to monitor the state of the environment and the effects the golf course may be having on the environment.
- Monitoring is used to determine whether outside events are changing the water quality entering the golf course, or whether the golf course is having a positive, neutral, or negative effect on water quality. It also provides a body of evidence on the golf course's environmental impact.
- A water-quality monitoring plan should be prepared to ensure the ongoing protection of groundwater and surface-water quality after construction has been completed. The same sites should be monitored during the preconstruction phase, although the monitoring plan can be modified based on site-specific conditions.
- Sampling parameters are determined based on golf course operation and basin-specific parameters of concern (these may be identified by local/state Total Maximum Daily Load (TMDL) Programs). Typically, samples should be analyzed for nutrients, pH and alkalinity, sediments, and suspended solids, dissolved oxygen (DO), heavy metals, and any pesticides expected to be used on the golf course.
- Ongoing, routine water sampling provides meaningful trends over time. A single sample is rarely meaningful in isolation.
- A post-construction sampling of surface-water quality should begin with the installation and maintenance of golf course turf and landscaping. Samples should be collected a minimum of three times per year.
- If there is no discharge on the scheduled sample date, samples should be taken during the next discharge event.
- Post-construction surface-water quality sampling should continue through the first three years of operation and during the wet and dry seasons every third year thereafter, provided that all required water-quality monitoring has been completed and the development continues to implement all current management plans. It may also be wise to sample if a significant change has been made in course operation or design that could affect nearby water quality.
- Sampling parameters should be determined based on golf course operation and any basin-specific parameters of concern (identified by the TMDL program or local regulators).
- The purpose of quality assurance/quality control (QA/QC) is to ensure that chemical, physical, biological, microbiological, and toxicological data are appropriate and reliable. Data should be collected and analyzed using scientifically sound procedures.
- However, even if the data are only for proprietary use and are not reported to any regulatory agency, it is strongly recommended that a certified laboratory be used and all QA/QC procedures followed.
- Golf course management must have good data to make good decisions. If a golf course should ever want to produce data for an agency or go to court to defend the facility from unwarranted charges, those data must meet QA/QC standards to be defensible as evidence.

Best Management Practices

Aquatic life and Pond management.

- Establish DO thresholds to prevent fish kills (occur at levels of 2 ppm), for example, use artificial aeration (diffusers).
- Reduce stress on fish; keep DO levels above 3 ppm.

- Select algaecides containing hydrogen peroxide instead of copper or endothall to treat high populations of phytoplankton.
- Use IPM principles to limit the excessive use of pesticides.
- Spot-treat filamentous algae or frequently remove algae by hand to prevent lowering oxygen concentrations in water.
- Use dyes and aeration to maintain appropriate light and DO levels.
- Apply algaecides to small areas to prevent fish mortality; do not treat the entire pond at once.
- Coordinate construction/renovation activities to minimize the amount of disturbed area and possible risk of contamination via runoff.
- Plan construction/renovation activities in phases to limit soil disruption and movement.
- Sod, spring, or reseed bare or thinning turf areas.
- Mulch areas under tree canopies to cover bare soil.
- Avoid the use of trimmers along the edge of the water body.
- Mow lake and pond collars at a higher height to slow and filter overland flow to water bodies.
- Remove excess sediments to reduce irrigation system failures.
- Treat dredged materials as a toxic substance. Avoid contact with turf.
- Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard.
- Seek professional assistance from an environmental specialist to design an appropriate water sample collection strategy.
- Determine which sites will be analyzed, and use reputable equipment and qualified technicians.
- Demonstrate responsible land and water use practices based on water data.
- Define data values appropriately based on the associated BMP used to protect water quality.
- Record observations of fish, wildlife, and general pond conditions.

Water aerators for ponds help to keep a healthy balance.

Aquatic Plants

Principles

- Phytoplankton, which gives 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) can grow rooted to the bottom and supported by the water (submersed plants), rooted to the bottom or shoreline and extended above the water surface (emersed plants), rooted to the bottom with their leaves floating on the water surface (floating-leaved plants), or free-floating on the water surface (floating plants). Different types of aquatic macrophytes have different functions in ponds.
- Plant life growing on littoral shelves may help to protect receiving waters from the pollutants present in surface water runoff, and a littoral shelf is often required in permitted surface water-retention ponds. Floating plants suppress phytoplankton because they absorb nutrients from the pond water and create shade.
- The use of aquatic plants to improve the appearance of a pond (aquascaping) can be included as part of the overall landscape design.
- Ponds may be constructed on golf courses strictly as water hazards or for landscape purposes, but they often have the primary purpose of drainage and stormwater management and are also often a source of irrigation water.

Best Management Practices

Managing Aquatic plants.

- Properly designed ponds with a narrow fringe of vegetation along the edge are more resistant to problems than those with highly maintained turf.
- In ponds with littoral plantings, problem plants should be selectively controlled without damaging littoral shelves.
- Encourage clumps of native emergent vegetation at the shoreline.
- A comprehensive lake management plan should include strategies to control the growth of nuisance vegetation that can negatively affect a pond's water quality and treatment capacity.
- Frequently remove filamentous algae by hand and/or frequently apply algaecide to small areas of algae (spot treatment).
- To reduce the risk of oxygen depletion, use an algaecide containing hydrogen peroxide instead of one with copper or endothall.

Aquatic plants protecting the waters and providing erosion control for the edges.

Human Health Concerns

Principles

- The use of pesticides should be part of an overall pest management strategy that includes biological controls, cultural methods, pest monitoring, and other applicable practices, referred to altogether as IPM.
- Address areas where standing water may provide habitat for nuisance organisms.

Best Management Practices

Identifying Problems

- Use IPM principles to address insects that may pose a hazard to human health.
- Drain areas of standing water during wet seasons to reduce insect populations.
- Use *Bacillus thuringiensis* (*Bt*) products according to label directions to manage waterborne insect larvae.

Sensible Solutions through Biological Control Measures - for example, mosquitoes:

- Create habitats for Purple Martins
- Create Bat habitats

Floodplain Restoration

Principles

- Reestablishment of natural water systems helps mitigate flooding and control stormwater.
- Address high sediment and nutrient loads and vertical and lateral stream migration causing unstable banks, flooding, and reductions in groundwater recharge.
- Land use decisions and engineering standards must be based on the latest research science available.

Best Management Practices

Flood restoration

- Install stream buffers to restore natural water flows and flooding controls.
- Install buffers in play areas to stabilize and restore natural areas that will attract wildlife species.
- Install detention basins to store water and reduce flooding at peak flows.
- De Channelization

Stormwater, Ponds, and Lakes

-

Stormwater is the conveying force behind what is called nonpoint source pollution. Nonpoint pollution, which is both natural and caused by humans, comes not from a pipe from a factory or sewage treatment plant, but from daily activity. Pollutants commonly found in stormwater include the microscopic wear products of brake linings and tires; oil; shingle particles washed off roofs; soap, dirt, and worn paint particles from car washing; leaves and grass clippings; pet and wildlife wastes; lawn, commercial, and agricultural fertilizers; and pesticides.

Principles

- The control of stormwater on a golf course is more than just preventing the flooding of the clubhouse, maintenance, and play areas. In addition to controlling the amount and rate of water leaving the course, it involves storing irrigation water, controlling erosion and sediment, enhancing wildlife habitat, removing waterborne pollutants, and addressing aesthetic and playability concerns.
- Most golf courses plan their lakes and water hazards to be a part of the stormwater control and treatment system. However, natural waters of the state cannot be considered treatment systems and must be protected.
- Lakes and ponds may also be used as a source of irrigation water.
- It is important to consider these functions when designing and constructing ponds. Peninsular projections and long, narrow fingers may prevent mixing. Ponds that are too shallow may reach high temperatures, leading to low oxygen levels and promoting algal growth and excess sedimentation.
- Stormwater treatment is best accomplished by a treatment train approach, in which water is conveyed from one treatment to another by conveyances that themselves contribute to the treatment.
- Source controls are the first car on the BMP treatment train. They help to prevent the generation of stormwater or introduction of pollutants into stormwater. The most effective method of stormwater treatment is not to generate stormwater in the first place or to remove it as it is generated.

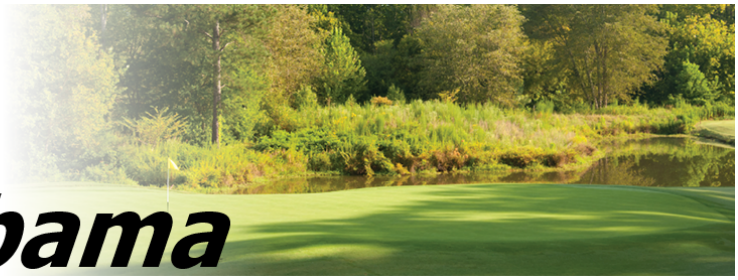
Best Management Practices

"Natural systems engineering" or "soft engineering" approach to stormwater management on a golf course.

- Install swales and slight berms where appropriate around the water's edge, along with buffer strips, to reduce nutrients and contamination.
- Design stormwater treatment trains to direct stormwater across vegetated filter strips (such as turfgrass), through a swale into a wet detention pond, and then out through another swale to a constructed wetland system.
- Ensure that no discharges from pipes go directly to water.
- Eliminate or minimize directly connected impervious areas.
- Use vegetated swales to slow and infiltrate water and trap pollutants in the soil, where they can be naturally destroyed by soil organisms.
- Use depressed landscape islands in parking lots to catch, filter, and infiltrate water, instead of letting it runoff. When hard rains occur, an elevated stormwater drain inlet allows the island to hold the treatment volume and settle out sediments while allowing the overflow to drain away.
- Maximize the use of pervious pavements, such as brick or concrete pavers separated by sand and planted with grass. Special high-permeability concrete is available for cart paths or parking lots.
- Disconnect runoff from gutters and roof drains from impervious areas so that it flows onto permeable areas that allow the water to infiltrate near the point of generation.
- Golf course stormwater management should include "natural systems engineering" or "soft engineering" approaches that maximize the use of natural systems to treat water.
- Ensure that no discharges from pipes go directly to water.
- Use a treatment train approach.
- Institute buffers and special management zones.

Water Quality Monitoring and Management

Regulatory Considerations



BMP Alabama

GCSAA USGA

Principle

Golf course owners and superintendents should investigate regulatory requirements that may exist in their location to protect surface and groundwater quality.

It is a good practice to regularly test and monitor the water coming onto your property. If there is an issue, your consistent monitoring will be key in finding any problems should they arise.

https://www.cleanwaterstore.com

Best Management Practices

- Aquatic management of plants may be regulated under construction permitting and regulatory licensing requirements. Consult with federal, state, and local water management agencies before managing golf course lakes and wetland areas.
- Consult with federal, state, and local water management agencies, and/or consult an approved management plan before performing cultural practices: fertilization; installation of plants; hand removal of plants or mechanical harvesting.
- The introduction of aquatic triploid grass carp, biological controls, aeration, and chemical controls (herbicide/algaecide) must be approved and monitored according to permit and licensing protocols and compliance.
- The disposal of sediments from surface-water ponds (stormwater detention) may be subject to regulation.
- Golf course owners are responsible for Total Maximum Daily Loading (TMDLs), mitigation, and watershed basin management action plans (BMAP).
- Wetlands are protected areas. Consult with federal and state agencies before altering natural aquatic areas. http://https://www.aswm.org/pdf_lib/state_summaries/alabama_state_wetland_program_summary_083115.pdf
- Constructed wetlands should have an impervious bottom to prevent groundwater contamination.
- Studies of water supplies are needed for irrigation systems, including studies of water bodies or flows on, near, and under the property to properly design a course's stormwater system and water features to protect water resources.https://gsa.state.al.us/

Site Analysis

Principle

Design an aquatic plant management strategy that addresses the intended uses of the water body to maintain water quality. Identify the site's physical attributes and location, the invasive or weedy species present, aesthetics, watershed and groundwater assessments, and other environmental considerations.

Best Management Practices

On Course water Features

- Accommodate natural lake processes in the construction of lakes and ponds; include herbaceous and woody vegetation and emergent and submergence shoreline plants to reduce operational costs.
- Use Integrated Pest Management (IPM) and native or naturalized vegetation wherever practical.
- Apply appropriate herbicides to minimize damage to non-target littoral plantings.
- Maintain a narrow band of open water at the pond edge to control the expansion of plants into more desirable littoral plantings.
- Use appropriate aquatic herbicides to avoid turfgrass injury.
- Irrigation should not directly strike or runoff to water bodies and no-fertilization buffers should be maintained along edges.

- Outline goals and priorities to guide the development of the BMP necessary to support the lake/aquatic management plan.
- Superintendents should monitor designated waters in their area for the persistence of highly toxic herbicides and algaecides in the environment.
- Secondary environmental effects on surface water and groundwater from the chemical control of vegetation should be monitored and recorded.
- Apply fertilizer and reclaimed (reuse) irrigation/fertigation appropriately to avoid surface and groundwater contamination.
- If Copper based products must be used always apply copper products per label instructions to reduce the risk of negative biological impacts and impairing water quality.

Off Site water ways.

- Identify the position of property in relation to its watershed.
- Identify overall goals and qualify concerns of the local watershed.
- Indicate surface water and flow patterns.
- Indicate storm water flow as well as existing and potential holding capacity.
- Indicate impervious surfaces, such as buildings, parking lots, or pathways.
- Indicate major drainage's and catch basins that connect to local surface water bodies.
- Identify and understand depth to water tables and soil types.
- Locate and protect wellheads.

Know what you are impacting downstream, always do your best to be environmentally friendly!

Water Quality Sampling Program

Principles

- Every golf course should have a plan to monitor the state of the environment and the effects the golf course may be having on the environment.
- Monitoring is the method used to determine whether outside events are impacting the water quality entering the golf course, or whether the golf course is having a positive, neutral, or negative effect on water quality. It also provides a body of evidence on the golf course's environmental impact.
- A water quality monitoring plan should be prepared to ensure the ongoing protection of groundwater and surface-water quality after construction is completed. The same sites should be monitored during the preconstruction phase, although the monitoring plan can be modified based on site-specific conditions.

- Sampling parameters are determined based on golf course operation and basin-specific parameters of concern (these may be identified by local/state Total Maximum Daily Load [TMDL] Programs). Typically, samples should be analyzed for nutrients, pH and alkalinity, sediments, suspended solids, dissolved oxygen (DO), heavy metals, and any pesticides expected to be used on the golf course.
- Ongoing, routine water sampling provides meaningful trends over time. A single sample is rarely meaningful in isolation.
- Post-construction surface-water quality sampling should begin with the installation and maintenance of golf course turf and landscaping. Samples should be collected a minimum of three times per year.
- Should there be no discharge on the scheduled sample date, samples should be taken during the next discharge event.
- Post-construction surface-water quality sampling should continue through the first three years of operation and during the wet and dry seasons every third year thereafter, provided that all required water quality monitoring has been completed and the development continues to implement all current management plans. It may also be wise to sample if a significant change has been made in course operation or design that could affect nearby water quality.
- Sampling parameters should be determined based on golf course operation and any basin-specific parameters of concern (identified by the TMDL program or local regulators).
- Golf courses should also sample for macroinvertebrates as determined useful by water quality specialists.

http://https://www.cleanwaterstore.com

Best Management Practices

Dissolved Oxygen

- Establish dissolved oxygen (DO) thresholds to prevent fish kills (occur at levels of 2 ppm), for example, use artificial aeration (diffusers).
- Reduce stress on fish; keep DO levels above 3 ppm.
- Use dyes and aeration to maintain appropriate light and DO levels.

Algaecides

- Select algaecides containing hydrogen peroxide instead of one containing copper or endothall to treat high populations of phytoplankton.
- Use IPM principles to limit the excessive use of pesticides.
- Spot-treat filamentous algae or frequently remove algae by hand to prevent lowering oxygen concentrations in water.
- Apply algaecides to small areas to prevent fish mortality; do not treat the entire pond at once.

Pond Maintenance

- Coordinate construction/renovation activities to minimize the amount of disturbed area and possible risk of contamination via runoff.
- Plan construction/renovation activities in phases to limit soil disruption and movement.
- Sod, sprig, or reseed bare or thinning turf areas.
- Mulch areas under tree canopies to cover bare soil.
- Avoid the use of trimmers along the edge of the water body.
- Mow lake and pond collars at 2 inches or higher to slow and filter overland flow to water bodies.
- Remove excess sediments to reduce irrigation system failures.
- Treat dredged materials as a toxic substance. Avoid contact with turf.
- Locate littoral shelves at the pond's inlets and outlets to reduce problems with the playability and maintainability of a water hazard.

Sampling Parameters, Collection, and Analysis

Principles

- A water quality monitoring program must include monitoring of surface water, groundwater, and pond sediments. It should be implemented in three phases: background, construction, and long-term management.
- A sampling of all watershed ingress and egress points is important to know what is coming into the property to identify potential impacts and baseline of water quality data.
- The purpose of quality assurance/quality control (QA/QC) is to ensure that chemical, physical, biological, microbiological, and toxicological data are appropriate and reliable, and are collected and analyzed using scientifically sound procedures.
- It is strongly recommended that a certified laboratory be used even if the data are only for proprietary use and are not reported to any regulatory agency
- QA/QC procedures should be followed. Golf course management must have good data to make good decisions, and if a golf course should ever want to produce data for an agency or in court to defend the facility from unwarranted charges, those data must meet QA/QC standards to be defensible as evidence.

Best Management Practices

Develop A Plan

- Seek professional assistance from an environmental specialist to design an appropriate water sample collection strategy.
- Determine what sites will be analyzed and use reputable equipment and qualified technicians.
- Demonstrate responsible land and water use practices based on water data.
- Define data values appropriately based on the associated BMP used to protect water quality.
- Record observations of fish, wildlife, and general pond conditions.

Buffer Zones

Principles

- Buffers around the shore of a waterbody or other sensitive areas filter and purify runoff as it passes across the buffer. Ideally, plant buffers with native species provide a triple play of water quality benefits, pleasing aesthetics, and habitat/food sources for wildlife. As discussed above, it is important to continue these plantings into the water to provide emergent vegetation for aquatic life, even if the pond is not used for stormwater treatment.
- Effective BMP in these areas include filter and trap sediment, site-specific natural/organic fertilization, and limits on pesticide use, primarily focusing on the control of invasive species.
- Golf course stormwater management should include "natural systems engineering" or "soft engineering" approaches that maximize the use of natural systems to treat water.

Best Management Practices

Buffers

- Riparian buffer areas are above the high-water mark and should be unfertilized and left in a natural state.
- Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas.
- Institute buffers and special management zones.
- The placement of bunkers and the shaping of contours surrounding a green should allow proper drainage and provide for the treatment and absorption of runoff from the green.
- Use turf and native plantings to enhance buffer areas. Increase the height of cut in the riparian zone to filter and buffer nutrient movement to the water.
- Use a deflector shield to prevent fertilizer and pesticide prills from contacting surface waters.
- Apply fertilizer and pesticides based on the effective swath; keep application on target and away from buffers or channel swales.
- Use a swale and berm system to allow for resident time (ponding) for water to infiltrate through the root zone to reduce lateral water movement to the surface water body.
- Maintain a riparian buffer to filter the nutrients in stormwater runoff.
- An appropriate-sized buffer (steeper slope requires great buffer width) of turf mowed at a higher height of cut and minimally fertilized with enhanced-efficiency fertilizers can provide an effective buffer.
- Use plant buffers with native species to provide pleasing aesthetics, habitat, and food sources for wildlife.
- Encourage clumps of native emergent vegetation at the shoreline.

Water management Control

- Ideally, littoral zones should have a slope of about 1 foot vertical to 6-10 foot horizontal.
- Establish special management zones around pond edges.
- Reverse-grade around the perimeter to control surface water runoff into ponds and reduce nutrient loads.
- Planting on slopes with less than a 6-foot horizontal to a 1-foot vertical may not be as successful over the long term.
- Construct random small dips and ridges of a few inches to a foot to promote diversity within the plant community and provide a healthier and more productive littoral zone.
- All or most of the out-of-play water bodies should have shoreline buffers planted with native or well-adapted noninvasive vegetation to provide food and shelter for wildlife.
- Practice good fertilizer management to reduce the nutrient runoff into ponds that cause algae blooms and ultimately reduces DO levels.
- Manipulate water levels to prevent low levels that result in warmer temperatures and lowered DO levels.
- Aerate shallow lakes less than 6 feet in depth to maintain acceptable DO levels.
- Where applicable, aerate at night to control oxygen depletion in any pond.
- Install desirable plants to naturally buffer DO loss and fluctuation.
- Dispose of grass clippings where runoff and wind will not carry them back to the lake.
- Nutrient-rich runoff encourages alga blooms and other phytoplankton; apply appropriate fertilizer rates and application setbacks.
- Dredge or remove sediment to protect beneficial organisms that contribute to the lakes food web and overall lake health.

Buffers to protect holding ponds from stormwater runoff.

Wetland Protection

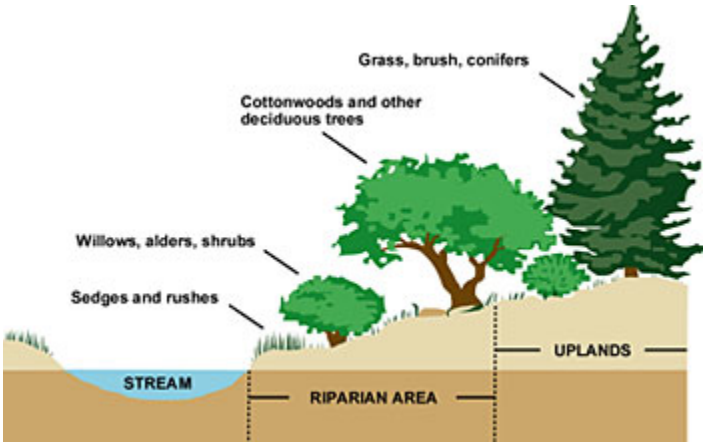
Principles

- Several states protect wetlands as waters of the state by rule of law. Wetlands act both as filters for pollutant removal and as nurseries for many species. Many people do not realize the vital role they play in purifying surface waters.
- The biological activity of plants, fish, animals, insects, and especially bacteria and fungi in a healthy, diverse wetland is the recycling factory of our ecosystem. While wetlands do pose a special concern, their mere presence is not incompatible with the game of golf. With care, many golf holes have been threaded through sensitive areas, and with proper design and management golf can be an acceptable neighbor.
- When incorporated into a golf course design, wetlands should be maintained as preserves and separated from managed turf areas with native vegetation or structural buffers.
- Constructed or disturbed wetlands may be permitted to be an integral part of the stormwater management system.

Best Management Practices

Wetland Buffers

- Establish wetlands where water enters lakes to slow water flow and trap sediments.
- Maintain appropriate silt fencing and BMP on projects upstream to prevent erosion and sedimentation.
- Natural waters cannot be considered treatment systems and must be protected. (Natural waters do not include treatment wetlands.)
- Establish a low- to no-maintenance level within a 75-foot buffer along non-tidal and tidal wetlands.
- Establish and maintain a 100-foot riparian buffer around wetlands, springs, and spring runs.



Example of a riparian buffer protecting wetlands.

Stormwater Management

Principle

Controlling stormwater on a golf course is more than just preventing the flooding of the clubhouse, maintenance, and play areas. In addition to controlling the amount and rate of water leaving the course, stormwater involves storing irrigation water, controlling erosion and sedimentation, enhancing wildlife habitat, removing waterborne pollutants, and addressing aesthetic and playability concerns. Keep in mind that not all stormwater on a golf course originates there; some may be from adjoining lands, including residential or commercial developments.

Best Management Practices

Storm Water Control

- Use vegetated swales to slow and infiltrate water and trap pollutants in the soil, where they can be naturally destroyed by soil organisms.
- Maximize the use of pervious pavements, such as brick or concrete pavers separated by sand and planted with grass.
- Special high-permeability concrete is available for cart paths or parking lots.
- Design storm water control structures to hold storm water for appropriate residence times in order to remove total suspended solids.
- Use a storm water treatment train to convey water from one treatment structure to another.
- Eliminate or minimize directly connected impervious areas as much as possible.
- Disconnect runoff from gutters and roof drains from impervious areas so that it flows onto permeable areas that allow the water to infiltrate near the point of generation.
- Use depressed landscape islands in parking lots to catch, filter, and infiltrate water, instead of letting it run off. When hard rains occur, an elevated stormwater drain inlet allows the island to hold the treatment volume and settle out sediments while allowing the overflow to drain away.
- Ensure that no discharges from pipes go directly to water.

Sediment

Principle

During construction and/or renovation, temporary barriers and traps must be used to prevent sediments from being washed off-site into water bodies. Wherever possible, keep a vegetative cover on the site until it is actually ready for construction, and then plant, sod, or otherwise cover it as soon as possible to prevent erosion.

Best Management Practices

Creating Natural Buffers

- Use shoreline grasses to prevent bank erosion.
- Use dry detention basins/catchments to buffer flooding and excessive runoff that may contain sediment.

- When constructing drainage systems, pay close attention to engineering details such as subsoil preparation, the placement of gravel, slopes, and backfilling.
- Internal golf course drains should not drain directly into an open water body but should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments.
- Maintain a vegetative cover on construction sites until it is actually ready for construction.

Sand Cordgrass is an excellent plant to protect banks from erosion.

Sodic/Saline Conditions

Principles

- All natural waters contain soluble salts; however, the amount and type of salts they contain vary greatly.
- Irrigation water can degrade when wells are pumped at high rates or for prolonged periods. Sometimes "up-coning" can occur from pumping, whereby saline water, rather than freshwater, is drawn into the well.
- Saline water typically is unsuitable for irrigation because of its high content of TDS.
- Saltwater intrusion from groundwater pumping near coastal areas can create a problem with some irrigation wells.

Best Management Practices

Removing Salts from Soil

- Use surface water to mix (blend) affected groundwater to lower the total salt concentration.
- Routinely monitor water quality to ensure that salt concentrations are at the acceptable levels.
- Consider fertilizer that uses soluble nitrogen forms with a relatively low concentration of salts in frequent applications.
- Consider a controlled-release fertilizer to reduce salt injury.
- Identify salt additions and saline sources that contribute to the total salt concentration.

- Base management plan on routine soil tests to determine sodium adsorption ration (SAR), exchangeable sodium percentage (ESP), electrical conductivity saturated paste method/unit (ECe), and free calcium carbonate content.
- Select alternative turfgrass and landscape plants that are more salt-tolerant.
- Reduce salt accumulations in the soil by flushing soils as needed with a higher-quality water source.
- Design irrigation systems to account for flushing of a salt accumulation from the soil.
- Amend soil and water to remove salt ions from affected areas.
- Evaluate BMP to determine the effectiveness of managing sodic/saline conditions.

Irrigation and Pump Station Design and Maintenance

Regulatory Considerations

Principles

- Golf course owners are responsible for contacting federal, state, and local water use authorities at the pre-and post-construction phase to determine annual or specific water consumption (water rights), permitting guidelines, and other requirements allowed by regulators. http://http://www.adem.state.al.us/default.cnt
- Superintendents have a responsibility to adhere to water-quality standard rules regarding groundwater and surface water flows resulting from the removal of water for irrigation use.

Best Management Practices

Custom Design

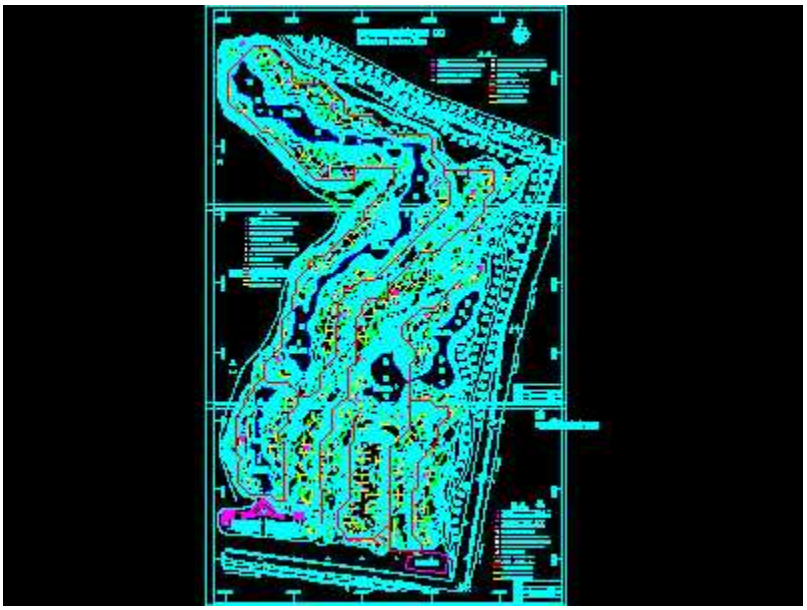
- Design and/or maintain a system to meet the site's peak water requirements under normal conditions and also be flexible enough to adapt to various water demands and local restrictions.
- Develop an annual water budget for the golf course.
- Look for ways to increase efficiency and reduce energy use associated with irrigation systems and practices.
- Demonstrate good stewardship practices by supplementing watering only for the establishment of new planting and new sod, hand watering of critical hot spots, and watering-in of chemicals and fertilizers (if permissible).
- Protect aquatic life and impairment of water systems by adhering to state and local water withdrawal allocations (gallons/day).
- Design an irrigation system that delivers water with maximum efficiency.
- Consider future needs as well as current.

New golf course pump station ready for install!

Irrigation System Design

Principles

- A well-designed irrigation system should operate at peak efficiency to reduce energy, labor, and natural resources.
- Irrigation systems should be properly designed and installed to improve water use efficiency.
- An efficient irrigation system maximizes water use, reduces operational cost, conserves supply and protects water resources.



Cad designed irrigation layout.

Best Management Practices

System Design

- The design should account for optimal distribution efficiency and effective root-zone moisture coverage. Target 80% or better Distribution Uniformity (DU).
- The design should allow the putting surface and slopes and surrounds to be watered independently.
- The design should allow for different soil types on the Property. example USGA greens mix vs Native soils.
- The design package should include a general irrigation schedule with recommendations and instructions on modifying the schedule for local climatic soil and growing conditions. It should include the base ET rate for the particular location.

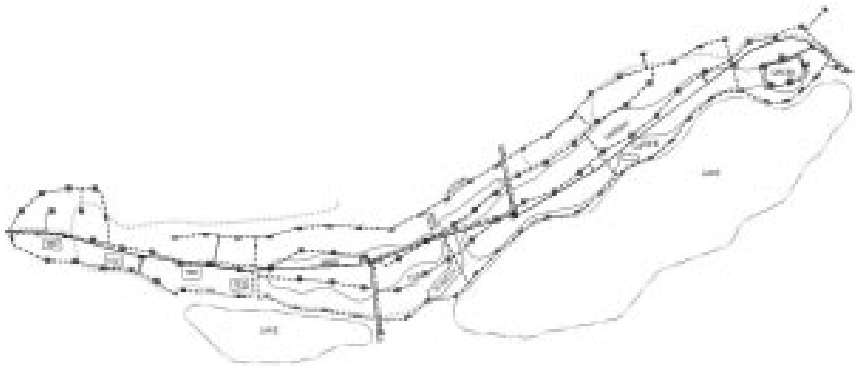
Course Requirements and needs

- The application rate must not exceed the infiltration rate, the ability of the soil to absorb and retain the water applied during any one application. Conduct saturated hydraulic conductivity tests periodically.
- The design operating pressure must not be greater than the available source pressure.
- The design operating pressure must account for peak-use times and supply line pressures at final buildout for the entire system.
- The system should be flexible enough to meet a site's peak water requirements and allow for operating modifications to meet seasonal irrigation changes or local restrictions.
- Turf and landscape areas should be zoned separately. Specific use areas zoned separately; greens, tees, primary roughs, secondary roughs, fairways, native, trees, shrubs, etc.
- The design should account for the need to leach out salt buildup from poor-quality water sources by providing access to freshwater.

Installation

- Only qualified specialists should install the irrigation system.
- Construction must be consistent with the design.
- The designer must approve any design changes before construction.
- Construction and materials must meet existing standards and criteria.
- Prior to construction, all underground cables, pipes, and other obstacles must be identified and their locations flagged.
- Permanent irrigation sprinklers and other distribution devices should be spaced according to the manufacturer's recommendations.
- Space should be based on average wind conditions during irrigation.
- For variable wind directions, triangular spacing is more uniform than square spacing.
- Distribution devices and pipe sizes should be designed for optimal uniform coverage.
- The first and last distribution device should have no more than a 10% difference in flow rate. This usually corresponds to about a 20% difference in pressure.
- Distribution equipment (such as sprinklers, rotors, and micro-irrigation devices) in a given zone must have the same precipitation rate.
- Heads for turf areas should be spaced for head-to-head coverage.
- Water supply systems (for example, wells, and pipelines) should be designed for varying control devices, rain shutoff devices, and backflow prevention.
- Water conveyance systems should be designed with thrust blocks and air-release valves.
- Flow velocity must be 5 feet per second or less.
- Pipelines should be designed to provide the system with the appropriate pressure required for maximum irrigation uniformity.
- Pressure-regulating or compensating equipment must be used where the system pressure exceeds the manufacturer's recommendations.
- Equipment with check valves must be used in low areas to prevent low head drainage.
- Isolation valves should be installed in a manner that allows critical areas to remain functional.
- Manual quick-coupler valves should be installed near greens, tees, and bunkers so these can be hand-watered during severe droughts.
- Install part-circle heads along lakes, ponds, and wetlands margins.
- Use part-circle or adjustable heads to avoid overspray of impervious areas such as roadways and sidewalks.
- Update multi-row sprinklers with single head control to conserve water and to enhance efficiency.

- Incorporate multiple nozzle configurations to add flexibility and enhance efficiency/distribution. Ensure heads are set on level ground and not on slopes.



Example of a fairway designed layout.

Irrigation Pump 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, if electrical transients (such spikes and surges) are infrequent, and if the superintendent has access to qualified technical support.
- Design pumping systems for energy conservation.

New VFD drives like this save energy and wear and tear on your motors and pumps.

Best Management Practices

Controls and efficiency

- The design operating pressure must not be greater than the available source pressure.
- The design operating pressure must account for peak-use times and supply-line pressures at final buildout for the entire system.
- Maintain the air-relief and vacuum-breaker valves by using hydraulic-pressure-sustaining values.
- Install VFD systems to lengthen the life of older pipes and fittings until the golf course can afford a new irrigation system.
- An irrigation system should also have high- and low-pressure sensors that shut down the system in case of breaks and malfunctions.
- Pumps should be sized to provide adequate flow and pressure.
- Pumps should be equipped with control systems to protect distribution piping.
- System checks and routine maintenance on pumps, valves, programs, fittings, and sprinklers should follow the manufacturer's recommendations.
- Monitor pumping station power consumption.
- Monthly bills should be monitored over time to detect a possible increase in power usage.
- Compare the power used with the amount of water pumped. Requiring more power to pump the same amount of water may indicate a problem with the pump motor(s), control valves, or distribution system.
- Quarterly checks of amperage by qualified pump personnel may more accurately indicate increased power usage and thus potential problems.

Pump Station Maintenance

Principles

- Irrigation system maintenance on a golf course involves four major efforts:
    - Calibration of pumps and pressure regulators.
    - Preventive maintenance (PM)
    - Corrective maintenance. Corrective maintenance 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.
    - An annual irrigation system audit consists of going through and manually checking all heads for the proper use and spray patterns, also checking all pre-programmed watering programs.
- Personnel charged with maintaining any golf course irrigation system face numerous challenges. This is particularly true for courses with older or outdated equipment.
- Good system management starts with good preventive maintenance (PM) procedures and recordkeeping. Maintaining a system is more than just fixing heads.
- As maintenance costs increase, the question of whether to renovate arises. Renovating a golf course irrigation system can improve system efficiencies, conserve water, improve playability, and lower operating costs.
- As part of annual maintenance, look for energy-saving updates that can be applied to your irrigation pump station to make it more energy-efficient and cost-saving.

Best Management Practices

Annual and Semi-Annual Maintenance

- Respond to day-to-day failures in a timely manner, maintain the integrity of the system as designed, and keep good records.
- System checks and routine maintenance on pumps, valves, programs, fittings, and sprinklers should follow the manufacturer's recommendations.
- The system should be inspected daily for proper operation by checking computer logs and visually inspecting the pump station, remote controllers, and irrigation heads. A visual inspection should be carried out for leaks, misaligned or inoperable heads, and chronic wet or dry spots, so that adjustments can be made.
- Systems need to be observed in operation at least weekly. This can be done during maintenance programs such as fertilizer or chemical applications where irrigation is required, or the heads can be brought on-line for a few seconds and observed for proper operation. This process detects controller or communications failures, stuck or misaligned heads, and clogged or broken nozzles.
- Check filter operations frequently. An unusual increase in the amount of debris may indicate problems with the water source.
- Even under routine conditions, keeping filters operating properly prolongs the life of an existing system and reduces pumping costs.
- Keep records of filter changes, as this could be an early sign of system corrosion, well problems, or declining irrigation water quality.
- Application/distribution efficiencies should be checked annually. Implement a PM program to replace worn components before they waste fertilizer, chemicals, and water.
- Conduct a periodic professional irrigation audit at least once every five years.
- Document equipment run-time hours. Ensure that all lubrication, overhauls, and other preventive maintenance are completed according to the manufacturer's schedule.
- Gather together all of the documentation collected as part of the PM program, along with corrective maintenance records for analysis.
- Correctly identifying problems and their costs helps to determine what renovations are appropriate.
- Collecting information on the cost of maintaining the system as part of system overall evaluation, allows for planning necessary upgrades, replacement etc. and to compare after changes are made.

Irrigation System Program and Scheduling

Principles

- Irrigation scheduling must take plant water requirements and soil intake capacity into account to prevent excess water use that could lead to leaching and runoff.
- Plant water needs are determined by evapotranspiration (ET) rates, recent rainfall, recent temperature extremes, and soil moisture.
- Irrigation should not occur on a calendar-based schedule but should be based on ET rates and soil moisture replacement.
- An irrigation system should be operated based only on the moisture needs of the turfgrass, or to water-in a fertilizer or chemical application as directed by the label.
- Responsible irrigation management conserves water, reduces nutrient and pesticide movement.
- Time-clock-controlled irrigation systems preceded computer-controlled systems, and many are still in use today. Electric/mechanical time clocks cannot automatically adjust for changing ET

rates. Frequent adjustment is necessary to compensate for the needs of individual turfgrass areas.

Best Management Practices

Seasonal and site specific programming

- The reliability of older clock-control station timing depends on the calibration of the timing devices; this should be done periodically, but at least seasonally.
- An irrigation system should have rain sensors to shut off the system after 0.25 to 0.5 inch of rain is received. Computerized systems allow a superintendent to call in and cancel the program if it is determined that the course has received adequate rainfall.
- Install control devices to allow for maximum system scheduling flexibility.
- Generally, granular fertilizer applications should receive 0.25 inch of irrigation to move the particles off the leaves while minimizing runoff.
- Irrigation quantities should not exceed the available moisture storage in the root zone.
- Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water applied at any one time.
- Irrigation schedule should coincide with other cultural practices (for example, the application of nutrients, herbicides, or other chemicals).
- Account for nutrients in effluent supply when making fertilizer calculations.
- Irrigation should occur in the early morning hours before air temperatures rise and relative humidity drops.
- Base plant water needs should be determined by ET rates, recent rainfall, recent temperature extremes, and soil moisture.
- Use mowing, verticutting, aeration, nutrition, and other cultural practices to control water loss and to encourage conservation and efficiency.
- Visually monitor for localized dry conditions or hot spots to identify poor irrigation efficiency or a failed system device.
- Use predictive models to estimate soil moisture and the best time to irrigate.
- Avoid the use of a global setting; make adjustments to watering times per head.
- Base water times on actual site conditions for each head and zone.
- Adjust irrigation run times based on current local meteorological data.
- Use computed daily ET rate to adjust run times to meet the turf's moisture needs.
- Manually adjust automated ET data to reflect wet and dry areas on the course.
- Use soil moisture sensors to assist in scheduling or to create on-demand irrigation schedules.
- Use multiple soil moisture sensors to reflect soil moisture levels.
- Install soil moisture sensors in the root zone for each irrigation zone to enhance scheduled timer-based run times.
- Place soil moisture sensors in a representative location within the irrigation zone. Install a soil moisture sensor in the driest irrigation zone of the irrigation system.
- Wired soil moisture systems should be installed to prevent damage from aerification.
- Periodically perform catch-can uniformity tests.
- Reducing dry spots and soil compaction improves water infiltration, which in turn reduces water use and runoff in other areas.
- Install emergency shutdown devices to address line breaks.

Irrigation Water Management

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

The purpose of this section is to identify a lot of tools available for best management practices related to water use that conserve and protect water resources. It is important to keep in mind that, while new technology makes many tasks easier or less labor-intensive, the principles discussed in this section are important to understand and apply to protect water quality and quantity and surrounding natural resources.

Additionally, irrigation BMP may provide economic, regulatory compliance, and environmental stewardship advantage to those who consider them part of their irrigation management plan. BMP are not intended to increase labor or place an undue burden on the owner/superintendent. If applied appropriately, BMP can help stabilize labor cost, extend equipment life, and limit repair and overall personal and public liability.

The monetary investment in non-structural, BMP costs little to nothing to implement in a daily course water-use plan. Other advantages to using BMP include reduced administrative management stress, improved employee communication and direction, and effective facilities training procedures.

Several benefits of adopting BMP are:

- Conserving the water supply
- Protecting existing water quality
- Maintaining optimal ball roll and playing conditions
- Saving water and electricity
- Increasing pump and equipment life longevity
- Demonstrating responsible environmental stewardship
- Retaining knowledgeable and effective employees

Conservation and Efficiency

Conservation and efficiency consider the strategic use of appropriate 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.

Water management is one of the most important aspects of being a Golf course Superintendent. It touches on everything from plant health to energy savings (Budget) to conserving our natural resources.

Water is a lifeline needed for us to do our jobs well. http://http://www.usga.org/course-care/digitalcollections/irrigation-management.html

Plant Health

Water management is critical to the care of your turf. Most courses have a few different varieties of turf and therefore need to be treated and managed differently. With the rising cost of everything, being able to micromanage your watering practices is crucial to your success. New pumps with VFD capability provide financial savings and longevity of pumps. https://en.wikipedia.org/wiki/Variable-frequency_drive

With turf tools like the POGO you can see exactly how much moisture was lost for the day, dial in your irrigation system and replenish just what is needed. http://https://pogoturfpro.com/

Smart control panels, soil sensors, and pump stations do so much more than just pump water, they manage the flow, the pressure, the output to maximize efficiency.

Resource Protection

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

Irrigation Pond Use and Maintenance

Principles

Successful pond management should include a clear statement of goals and priorities to guide the development of the BMP necessary to meet those goals. Some of the challenges facing superintendents in maintaining the quality of golf course ponds are as follow

    - Sedimentation
    - Monitor and manage DO levels.
    - Changes in plant populations
    - Nuisance vegetation
    - Maintenance of littoral shelves
    - Vegetation on the lakeshore
- Each pond has regions or zones that significantly influence water quality and are crucial in maintaining the ecological balance of the system. It is important for the manager to understand their function and how good water quality can be maintained if these zones (riparian zone, littoral zone, limnetic zone, and benthic zone) are properly managed.
- Surface water sources can present problems with algae and bacteria growth. Algal cells and organic residues of algae can pass through irrigation system filters and form aggregates that may plug emitters.
- Pond leaks should be controlled and managed properly.
- Use an expert in aquatic management to help develop and monitor pond management programs.

- If you do it yourself or contract it out to be done. understand and know the products that are being used and the quantities used so they do not have an adverse effect on your turf when irrigating.

Best Management Practices

Pond Management

- Maintain a riparian buffer to filter the nutrients and sediment in runoff.
- Reduce the frequency of mowing at the lake edge and collect or direct clippings to upland areas.
- Prevent overthrowing fertilizer into ponds. Practice good fertilizer management to reduce nutrient runoff into ponds, which causes algae blooms and ultimately reduces DO levels.
- Establish a special management zone around pond edges.
- Dispose of grass clippings where runoff will not carry them back to the lake.
- Encourage clumps of native emergent vegetation at the shoreline.
- Maintain water flow through lakes, if they are interconnected.
- Maintain appropriate silt fencing and BMP on projects upstream to reduce erosion and the resulting sedimentation.
- Manipulate water levels to prevent low levels that result in warmer temperatures and lowered DO levels.
- Aerate ponds and dredge or remove sediment before it becomes a problem.

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. It also includes protecting wellheads from physical impacts, keeping them secure, and sampling wells according to the monitoring schedule required by the regulating authority, which is often a local health department or state department of environmental quality.
- When installing new wells, contact the regulating authority to determine the permitting and construction requirements and the required isolation distances from potential sources of contamination.
- Locate new wells up-gradient as far as possible from likely pollutant sources, such as petroleum storage tanks, septic tanks, chemical mixing areas, or fertilizer storage facilities.
- Licensed water-well contractors may be needed to drill new wells to meet state requirements, local government code, and water management districts' well-construction permit requirements.

Best Management Practices

Wellhead Protection

- Use backflow-prevention devices at the wellhead, on hoses, and at the pesticide mix/load station to prevent contamination of the water source.
- Properly plug abandoned or flowing wells.
- 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 each well to determine the local geology and how deep the well is; these factors will have a bearing on how vulnerable the well is to contamination.
- Sample wells for contaminants according to the schedule and protocol required by the regulating authority.
- Never apply fertilizer or pesticide next to a wellhead.
- Never mix and load pesticides next to a wellhead if not on a pesticide mix/load pad.

Pollinator Protection

Regulatory Considerations

BMP GCSAA USGA. Alabama

Most flowering plants need pollination to reproduce and grow fruit. While some plants are pollinated by wind, many require assistance from insects and other animals. In the absence of pollinators, many plant species, including the fruits and vegetables we eat, would fail to survive.

The western honey bee (*Apis mellifera*) is one of the most important pollinators in the United States. Hundreds of other bee species, including the bumblebee (*Bombus* spp.), also serve as important pollinator species. Protecting bees and other pollinators is important to the sustainability of agriculture.

Pesticides are products designed to control pests (for example, insects, diseases, weeds, nematodes, etc.). Pesticides and other plant growth products, including plant growth regulators, surfactants, biostimulants, etc., are used in golf course management. The non-target effect of products used in golf course management is of increasing concern; therefore, pesticide applicators, including those on golf courses, need to be mindful of the impact that pesticides have on pollinator species and their habitat.

Principles

- Pollinator-protection language is a labeling requirement found on pesticide labels; follow the label, it is the law.
- Pesticide applicators must be aware of honey bee toxicity groups and able to understand precautionary statements.
- Record keeping may be required by law in order to use some products. IPM principles suggest that you keep records of all pest control activity so that you may refer to information on past infestations or other problems to select the best course of action in the future.

Best Management Practices

Become a vigilant Pollinator Protector!

- Proper records of all pesticide applications should be kept according to local, state, or federal requirements.
- Use records to establish proof of use and follow-up investigation of standard protocols regarding:
    - Date and time of application
    - Name of applicator
    - The person directing or authorizing the application
    - Weather conditions at the time of application
    - Target pest

    - The pesticide used (trade name, active ingredient, amount of formulation, amount of water)
    - Adjuvant/surfactant and amount applied if used
    - Area treated (acres or square feet) and location
    - The total amount of pesticide used
    - Application equipment
    - Additional remarks, such as the severity of the infestation or life stage of the pest
    - A follow-up to check the effectiveness of the application
- Those applying pesticides, and who make decisions regarding their applications should be able to interpret pollinator protection label statements.
- Those applying pesticides should be aware of honey bee biology.
- Those applying pesticides should understand the various routes of exposure (outside the hive and inside the hive).
- Those applying pesticides should understand the effects of pesticides on bees.

Pollinator Habitat Protection

Principles

- It is important to minimize the impacts of pesticides on bees and beneficial arthropods. Pesticide applicators must use appropriate tools to help manage pests while safeguarding pollinators, the environment, and humans.
- Be mindful of pollinators; when applying pesticides, focus on minimizing exposure to non-target pollinators in play and non-play course areas.
- Pollinators require a diversity of flowering species to complete their life cycle. Pollinator habitat contains a diversity of wildflower species of different colors and heights, with blossoms throughout the entire growing season

Best Management Practices

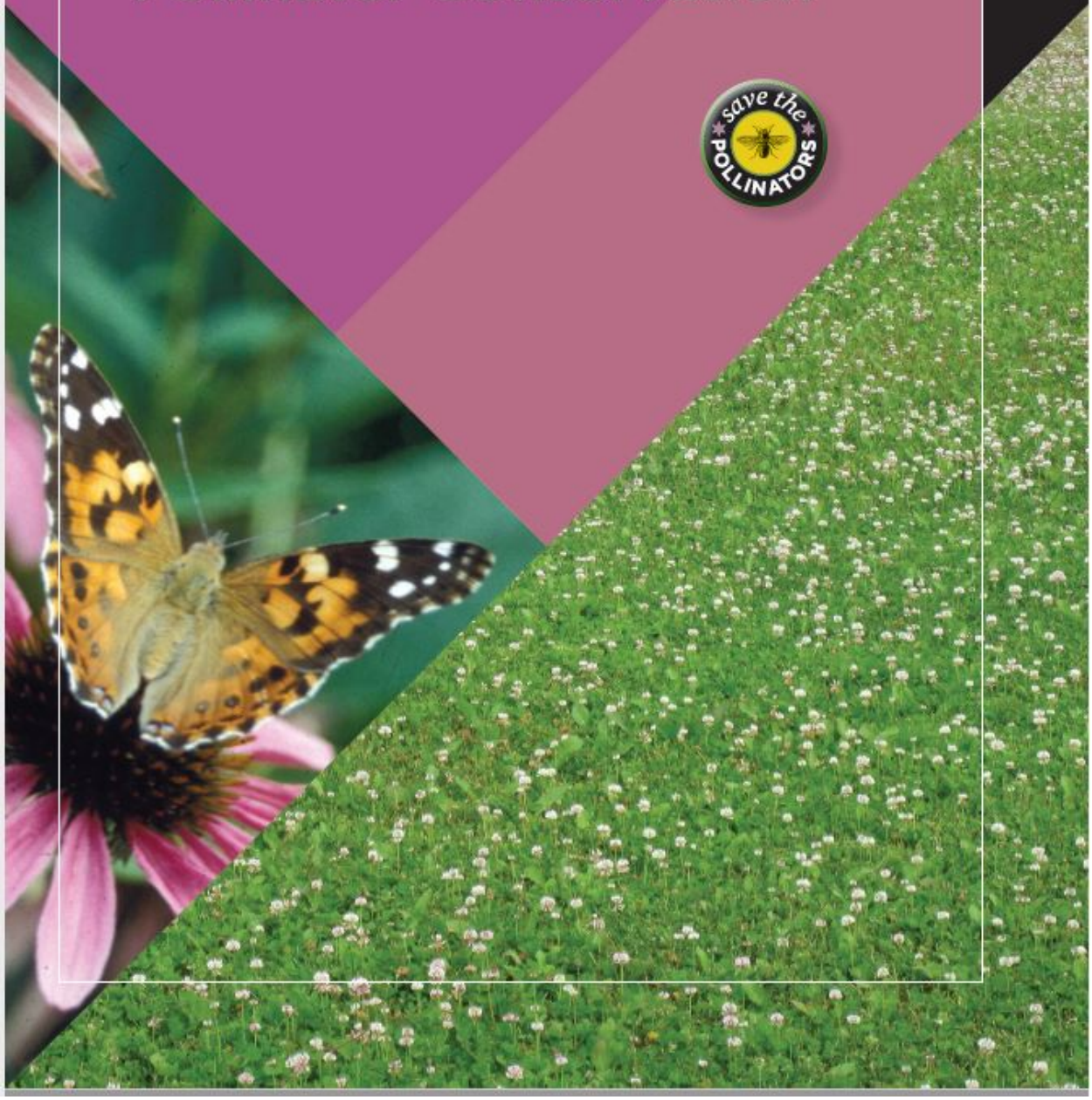
Care and consideration are key. There are only 2 million acres of Golf Courses in the United States. We all must be very active and vigilant for the care and survival of our pollinators.

- Follow label information directing the application of pesticides when the plant may be in bloom. Avoid applying pesticides during the bloom season.
- Stay on target by using coarse-droplet nozzles, and monitoring wind to reduce drift.
- Do not apply pesticides when pollinators are active.
- Before applying a pesticide, scout/inspect the area for both harmful and beneficial insect populations and use pesticides only when a threshold of damage has been indicated.
- Mow flowering plants (weeds) before insecticide application.
- If flowering weeds are prevalent, control them before applying insecticides.
- Use insecticides that have a lower impact on pollinators.
- Use the latest spray technologies, such as drift-reduction nozzles to prevent off-site (target) translocation of pesticide.
- Avoid applications during unusually low temperatures or when dew is forecast.
- Use granular formulations of pesticides that are known to be less hazardous to bees.
- Consider lures, baits, and pheromones as alternatives to insecticides for pest management.
- Develop new pollinator habitat and/or enhance existing habitat.

Pollinator Conservation

Best Management Practices for Turf Care and Pollinator Conservation

Pollinators



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To view an electronic version of this publication, visit
ncipmc.org/action/bmpturf.pdf

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This publication was developed during the National Pollinator Summit for the Development of Best Management Practices to Protect Pollinators in Turf (August 21–22, 2016, Sheboygan, Wisconsin). The authors, in collaboration with more than 60 university researchers, Extension specialists and industry stakeholders including lawn care professionals, golf course superintendents, managers and consultants, and product manufacturers have summarized and synthesized research and recommended management practices that protect pollinators in turf systems.

cover photo: Painted Lady, Daniel Herms, The Ohio State University, Bugwood.org

What are insect pollinators and what is happening to them?

Pollinating insects provide invaluable pollination services to crops like apples, almonds, blueberries and wild plants. Honey bees are the most recognized pollinating insect but there are over 4,000 species of wild native bees that also visit many plants, not to mention a wide variety of beetles, flies, butterflies, and moths. Populations of these important insects have declined in the last several decades due to numerous factors such as pathogens, parasites, habitat loss, and insecticide exposure. University research projects indicate that all of these stresses combined are responsible for pollinator decline. All of these issues must be addressed if we are to reduce declines and promote recovery. In the turf care industry, managers must be aware of this issue and professionals must implement scientifically-based recommendations for Best Management Practices that promote healthy turf while also conserving and enhancing pollinator health.

Populations of these important insects have declined in the last several decades due to numerous factors such as pathogens, parasites, habitat loss, and insecticide exposure.

Best Management Practices for pesticide use in turfgrass

Insecticides have been a focal point for concerns regarding pollinator decline, in particular the neonicotinoid class (including imidacloprid). Insecticides can have negative lethal or sub-lethal effects on pollinators, underscoring the need to be sure to always follow label precautions. This will include instructions for irrigating products to increase below ground efficacy and also remove residues from foraging zones of pollinating insects. While turf itself

Anita Common, BugWood.org

Honey bee (*Apis mellifera*) on butterfly milkweed.

may not bloom, flowering weeds are common in turf areas and are attractive to a wide variety of pollinating insects. If these weeds are present when applications are made, a scenario could arise where pollinators are harmed. To avoid direct contamination of flowering weeds in turf simply mow the flower heads of weeds like white clover, dandelion, bird's foot trefoil, etc. before treatment. If the insecticide label dictates you should not mow before treatment, follow-up the application with mowing to remove contaminated flowers. Controlling weeds with herbicides before insecticides are applied is another way to avoid direct insecticide contamination scenarios. There are other variables to consider before making an application though, such as the timing of the application, which formulation should be chosen, and which insecticide class to use.

In terms of seasonal timing, most insecticide applications in turf are made as preventative sprays between March and June. Unfortunately, this timing coincides with the blooming of flowering weeds and also the emergence of several species of pollinators. If turf managers can wait until May or June to make applications they can avoid exposing many pollinating insects. Managers can also adjust the time of day for insecticide applications. Since pollinators are typically most actively foraging during the middle of the day, consider restricting applications to the early morning or the late evening.

Turfgrass insecticides can be applied in various formulations but are mainly applied as granules or liquids. There are significant differences between these formulations and their effects on pollinating insects. In a study comparing neonicotinoid liquid sprays to their granular counterparts, when applied to flowering weeds in a turf setting, it was found that granular applications pose a reduced risk to pollinating insects. While both liquid and granular products are systemic, granular products rarely directly contaminate the

flowering portions of blooming plants. If a manager is trying to control below ground pests with a neonicotinoid, granules will accomplish this with reduced hazard to pollinators. While liquid formulations could pose more of a hazard by contaminating floral resources present at the time of application, this negative interaction can be avoided through irrigation or removal of flowering weeds with mowing or herbicide applications prior-to or post-bloom.

Certain insecticide classes better target certain pests, e.g. neonicotinoids being used for soil-dwelling white grubs or pyrethroids for leaf zone pests such as chinch bugs and caterpillars. Many classes, such as the neonicotinoids, pyrethroids, and carbamates, have documented negative effects on pollinating insects. Chlorantraniliprole, part of the newer anthranilic diamide class of chemistry, can control many of the same pests that are targeted with neonicotinoids and pyrethroids including white grubs, caterpillars, and billbugs. However, it does not have any documented effects on pollinating insects and may be a good fit for industry initiatives to reduce the impacts of turf and landscape management on pollinators.

Charles T. Bryson, USDA Agricultural Research Service, Bugwood.org

Monarch butterfly (*Danaus plexippus*).

Promoting pollinator welfare in and around managed turfgrass sites

Habitat loss is one of the main drivers behind pollinator decline. To help combat this problem turf managers can promote pollinator food resources and nesting habitats by creating pollinator sanctuary plots or naturalized areas. Depending on the type of turf area there will be different ways of creating forage for pollinating insects.

Not only do [conservation] programs benefit wildlife but they can also help to decrease golf course expenditures by reducing the acreage of managed turf and lowering the amount spent on irrigation, mowing, and chemical inputs.

Planting for pollinators on golf courses

Golf course managers and golf organizations such as the United States Golf Association (USGA) are actively increasing the acreage of natural habitats in out of play areas on golf courses. Initiatives like the Audubon Cooperative Sanctuary Program, Wildlife Links Program, Operation Pollinator, and the Golf and the Environment Initiative have all demonstrated that golf courses can provide a quality golfing experience while also serving as urban wildlife conservation areas. Not only do such programs benefit wildlife but they can also help to decrease golf course expenditures by reducing the acreage of managed turf and lowering the amount spent on irrigation, mowing, and chemical inputs. One notable project is Operation Pollinator, an international biodiversity project started by Syngenta in 2010. Operation Pollinator plots are placed in out of play areas on courses and superintendents can determine the habitat size that fits their needs. Syngenta provides participants with signage to mark conservation areas as well as educational materials to educate golfers and stakeholders about the project. One study found that Operation Pollinator plots attracted 51 unique bee species and identified wildflower species that were the most successful at attracting pollinators for their climatic area; New England aster, bergamot, black-eyed Susan, purple coneflower, plains coreopsis, prairie coneflower, and lanceleaf coreopsis. Superintendents and turf managers who are interested in establishing pollinator conservation plots should consult their local University Extension service to learn more about matching flowers with their climatic zone and should consult sources such as the Xerces Society or Pollinator Partnership for establishment advice.

Lawns and pollinators conservation

Golf courses are not the only managed turf areas that can contribute to pollinator conservation. Homeowners who have an interest in pollination conservation can plant their own Operation Pollinator style conservation plots or can take steps to make their yard and landscape more hospitable to these important invertebrates. While highly managed, typical turf lawns offer few foraging resources for pollinators, many lawns contain some flowering weeds such as white clover, *Trifolium repens* (Fabaceae), or common dandelion, *Taraxacum officinale* (Asteraceae). Deemed undesirable by some, these weeds represent a under recognized food source for pollinating insects. A 2014 study found that over 50 different species of pollinators visited these weeds and that urban pollinators rely on white clover as an important food source. Lawns that include rather than exclude clover are already being promoted due to their ability to withstand drought and the natural fertilization that comes from clover. Increased awareness of pollinator interactions with white clover may increase the acceptance of these plants in turf settings.

Conclusions

Professionals who apply pesticides must diligently follow label precautions when using insecticides including irrigating, mowing weeds before applications, and choosing the proper insecticide class and formulation. If industry practices good insecticide stewardship managers can control pests, reduce harm to beneficial insects, and ensure that insecticide tools stay available for use in turf. By diversifying golf courses and other turf areas the industry can take a proactive role in protecting pollinators by providing food plants and habitat while also educating the public about the importance of these insects in our environment.


Pollinators

Landscape

Species Selection and Size Considerations

BMP Alabama

GCSAA USGA

Landscape (non-play) areas are an essential part of the overall course design, providing enhanced course aesthetics, wildlife habitat, external sound/noise abatement, and natural cooling and freeze protection.

An environmental landscape design approach addresses environmentally safe and energy-saving practices; therefore, environmentally sound landscape management is also economically important. Non-play areas require a mix of sun and shade, optimal soil conditions and adequate canopy air movement to sustain growth and function.

Principles

- The fundamental principle for the environmentally sound management of landscapes is "right plant, right place." The ideal plant from an environmental standpoint is the one that nature and evolution placed there. It has adapted specifically to the soil, microclimate, rainfall, and light patterns, insects, and other pests, and endemic nutrient levels over thousands of years.
- 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.
- The addition of proper soil amendments can improve soil's physical and chemical properties, increase its water-holding capacity, and reduce the leaching of fertilizers. Amendments may be organic or inorganic; however, soil microorganisms rapidly decompose organic amendments such as peat or compost.
- The goal of species-selection BMP is to maintain as close to a natural ecosystem as practical while meeting the needs of a golf course.
- Landscape areas should be fundamentally designed to facilitate rapid plant establishment to conserve water and lower nutritional input requirements once mature. Plants within areas that are not in play or are not critical to the design of the course may be removed and replanted with the native plant material that requires little to no maintenance after establishment. Additionally, 50% to 70% of the non-play areas should remain in natural cover. As much natural vegetation as possible should be retained and enhanced through the supplemental planting of native trees, shrubs, and herbaceous vegetation to provide wildlife habitat in non-play areas, along water sources to support fish and other water-dependent species. By leaving dead trees (snags) where they do not pose a hazard, a well-developed understory (brush and young trees), and native grasses, the amount of work needed to prepare a course is reduced while habitat for wildlife survival is maintained.

Best Management Practices

Plant and turf selections

- Base plant selection as close to a natural ecosystem as practical, while meeting the needs of the golf course. It has adapted specifically to 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.
- Use plants that are adapted for the site based on the United States Department of Agriculture (USDA) cold-hardiness map.http://https://planthardiness.ars.usda.gov/PHZMWeb/
- Select stress-tolerant species or cultivars to manage periodic dry/wet conditions.
- Choose the most stress-tolerant species or cultivar for a particular area.

Design and Function

Principles

- Aesthetic gardens, window boxes, and container gardens should include a variety of plants of different heights that provide nectar for hummingbirds and butterflies. Again, "right plant, right place" is the key to success.
- 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 covers, or native plants may provide a pleasing view and also provide useful food, cover, or other environmental benefits to wildlife; they may also require reduced maintenance.
- Trees and shrubs along streams provide temperature moderation through the shade, which lowers water temperature in summer and increases it in winter.

Best Management Practices

Native areas on a golf course can be colorful and pleasing to the eye.

Purposeful Planning

- Well-designed forested buffers should contain a mixture of fast- and slow-growing native trees, shrubs, and grasses to provide a diverse habitat for wildlife.
- Use forested buffers to trap and remove upland sources of sediments, nutrients, and chemicals.
- Use forested buffers to protect fish and wildlife by supplying food, cover, and shade.

- Use forested buffers to maintain a healthy riparian ecosystem and stable stream channel.
- Leave dead tree snags whenever possible for nesting and food source to wildlife. However, make sure that these snags are a safe distance away from playing surfaces should they get blown over.
- Use turf as a landscape element where needed.

Planting Methods

Principles

- The ideal plant from an environmental standpoint is the one that nature and evolution placed there. It has adapted specifically to the soil, microclimate, rainfall, light patterns, insects, and other pests, and endemic nutrient levels over hundreds or thousands of generations. Where these factors have changed, the challenge is finding other suitable plants. A BMP goal is to maintain as close to a natural ecosystem as practical while meeting the needs of the golf course.
- The use of organic mulches in gardens and aesthetic areas increases the moisture-holding capacity of plantings and prevents weed growth when applied in sufficient depth. Organic amendments are decomposed by soil microorganisms and add 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

Planting and maintenance practices

- The plant palette and irrigation system should be appropriate for site conditions, taking into account 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 hydro-zones should be minimized. Local government ordinances should address the percentage of irrigated landscaped area that may be included in high-water-use hydro-zones. These high water-use limits should not apply to landscaped areas requiring large amounts of turf for their primary functions (for example, ball fields and playgrounds).
- 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 will also 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.

Golf Course Design and Construction

Regulatory Issues

The construction phase of any industry's infrastructure poses the greatest risk of ecosystem alteration. With proper planning and design, golf facilities can be constructed and maintained with minimal impact to existing wildlife and their habitat. Many times a properly planned golf facility can actually enhance wildlife habitat and provide water features that can help clean/filter surface water runoff. Furthermore, facilities should be designed and constructed to maximize energy efficiency.

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.

Start here and your local courthouse for zoning and regulations.

http://www.adem.state.al.us/default.cnt

Planning

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. When planning a project gather all the information you can about the property. Areas to consider are:

1. Know the topography of the land, soil types, watershed and waterways.

2. Biological, ecological, and hydrological characteristics of the property.

3. Are there any protected areas or species on the property?

4. Make a plan to manage any areas that deserve special attention. This will insure your compliant with state and local environmental protection laws.

Best Management Practices

- The Stakeholders will assemble a qualified team
    - Golf course architect
    - Golf course superintendent (Ideally you want to be in on the very front of the project)
    - Clubhouse architect
    - Irrigation engineer
    - Environmental engineer
    - Energy analyst
    - Civil engineer
    - Soil scientist
    - Geologist
    - Golf course builder
    - Legal team

The Superintendent has to work with each specialist in their field to bring everything together and make it work properly. This includes knowing what works from a design standpoint to properly installed drainage and irrigation. If he/she does not, it will lead to costly problems down the line and could result in a project's success or failure.

Other areas the Superintendent's expertise will be needed in the planning phase:

- 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 achieving the needs of stakeholders.
- Identify the strengths and weakness of the selected site.
- Identify any rare, protected, endangered, or threatened plant or animal species on the site.

The onsite golf course superintendent will be extremely important to the success of the project. He / She will play a vital role in every aspect of the construction of a golf course.

Design

Principles

The golf course architect will build his/ her golf course to his/her vision. It will be the job of the golf course superintendent to determine if the design of the greens, bunkers, and fairways are sustainable and cost efficient to maintain. There is much to consider as the golf course superintendent is the person in charge of getting and keeping the course in peak condition.

Proper design and planning of the project should meet the needs of the stakeholders, protect the location's environmental resources, and be economically sustainable. Soil types and water supply are just a few things that need serious consideration when pulling it all together.

Best Management Practices

- Retain a qualified golf course superintendent/project manager at the beginning of the design and construction process to integrate sustainable maintenance practices in the development, maintenance, and operation of the course.
- Direct the Architect to 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.
- Direct the Architect to 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.
- Direct the Architect to 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 a sufficient number of hole locations that are large enough to accommodate traffic and play damage, but not so large that it is not sustainable 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.
    - Greens should be irrigated separately from surrounding turf.
    - Select a turf species/variety that meets the needs of the stakeholders while adhering to the principle of "right plant, right place."
- Plant only certified turfgrass.
- Decide whether bunkers will contain drainage, and liner material type. There are several types depending on bunker style.
- 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 your needs. Use USGA spec materials.
- Define play and non-play maintenance boundaries.

Water Features and Functionality

- Size and depth of irrigation pond? What is your capacity and potential capacity?
- The irrigation pond should be the lowest elevation pond on the property and maybe the lowest spot on the entire property.
- Can ponds be linked together to flow into the irrigation pond if extra water is needed?
- Is there any free-flowing water than can act as a replenishing source for your irrigation pond?
- How will the irrigation pond be replenished? Natural runoff or well?

Grow-in

Principles

Turfgrass establishment is a unique phase in turfgrass growth, which can require greater quantities of water and nutrients than established turfgrasses. To this end, the establishment phase should be considered carefully to minimize environmental risk. During a grow in proper water management can make the process go very smooth or it can cause more problems for you. Be careful to not over water during grown in " pumping the water to it" is not the right attitude. To much can lead to erosion and disease.

Best Management Practices

The area to be established should be properly prepared and cleared of pests. (weeds, pathogens, etc)

Green being prepped for seeding!

- Ensure erosion and sediment control devices are in place and properly maintained.
- Sprigs should be "knifed-in" and rolled to hasten root establishment.Keep
- Sod should be top dressed to fill in the gaps between sod pieces. This hastens establishment and provides a smoother surface.
- Use appropriate seeding methods for your conditions.
- When using sod, nutrient applications should be delayed until the 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.)
- Slow-release nitrogen or light, frequent soluble-nitrogen sources should be used during grow-in. applying only what the plant can take up is minimizing potential run off chances.
- 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 due to leaching.
- Mow as soon as the sod has tacked-down, when sprigs have rooted at the second to third internode, and seedlings have reached a height one-third greater than intended height-of-cut. This will hasten the establishment, and the soil is moist but still firm enough not to rut up and destroy the final grade work.

Erosion and Sediment Control

This section of the BMP Handbook will not cover every detail of golf course construction for the protection of the environment. This is because golf courses are often built by companies who are solely in the business of building or renovating golf courses, while superintendents are often hired after the construction phase to manage a completed course. However, this may not always be the case, and superintendents may play an active role if a course is being renovated, or if construction projects (such as a clubhouse or swimming facility) require completion after a course has opened for play. In those cases, the superintendent should be aware of basic sediment and water control strategies because runoff and sediment movement from a construction project can affect the golf course.
Superintendents should know BMPs for several general erosion-control areas, especially those that are used as a part of renovation processes. These include fumigation practices for the renovation of golf greens, basic erosion control strategies for small-scale construction projects, covers and mulches to

protect bare soil, and planting practices for establishing turf in warm-season climates. This chapter of the BMP manual discusses those BMPs, and provide examples of BMPs to help protect water quality during renovation or construction projects.

Principles

- Soil carried by wind and water erosion transports contaminants with it. Contaminants can dislodge, especially on entering water bodies, where they can cause pollution.

In rural environments, land-disturbing activities that destroy natural vegetation, remove topsoil, or transform terrain features contribute significantly to nonpoint source (NPS) pollution. Disturbed land is vulnerable to the beating action of raindrops and the energy of flowing water, which do the real damage. Raindrops dislodge most of the solid particles that are eroded from disturbed lands while stormwater runoff erodes channels and transports pollutant-laden sediment to lakes, streams, and waterways. According to estimates by the U.S. Environmental Protection Agency, agricultural runoff is responsible for 50 to 70 percent of the nonpoint source pollution that impairs water quality nationwide. Urban runoff, the next largest source, contributes only 5 to 1 S percent. In Alabama, agriculture causes about 40 percent of the surface NPS problems, resource extraction (mining) causes 19 percent, and urban runoff causes 7 percent.

- Erosion and sediment control is a critical component of construction and grow-in of a golf course.http://http://www.adem.alabama.gov/programs/water/constructionstormwater.cnt

Most sediment is eroded when the soil is bare. Soils are protected naturally by vegetation and vegetation residues, but under many crop production systems, farmers must remove or bury much of this protective cover. Once the cover is gone, bare soil is exposed to the erosive forces of wind, rain, and runoff.

> ***Sediment is by far the greatest NPS pollutant in rural environments. Sediment impairs water quality and transports other pollutants.***

What Is The Erosion-Sedimentation Process? http://https://alconservationdistricts.gov/wp-content/uploads/2018/09/05-Vol-I-Chapter-1-Erosion-Sedimentation-and-Stormwater-Process-2018.pdf

Erosion is the detachment and transport of soil particles by water or wind. Sedimentation occurs when water carrying eroded soil particles slows long enough to allow soil particles to settle out. The erosion-sedimentation process consists of (1)detachment of soil particles; (2) transport of soil particles; and (3) sedimentation or settling out of soil particles. These three steps may occur several times between the original detachment and when the particle actually reaches a stream or lake.

Best Management Practices

- Develop a working knowledge of erosion and sediment control management. Each state has its own specifications including types of acceptable structures, materials, and design features.
- Develop and implement strategies to effectively control sediment, minimize the loss of topsoil, protect water resources, and reduce disruption to wildlife, plant species, and designed environmental resource areas.
- Hydro-seeding or hydro-mulching offer soil stabilization.

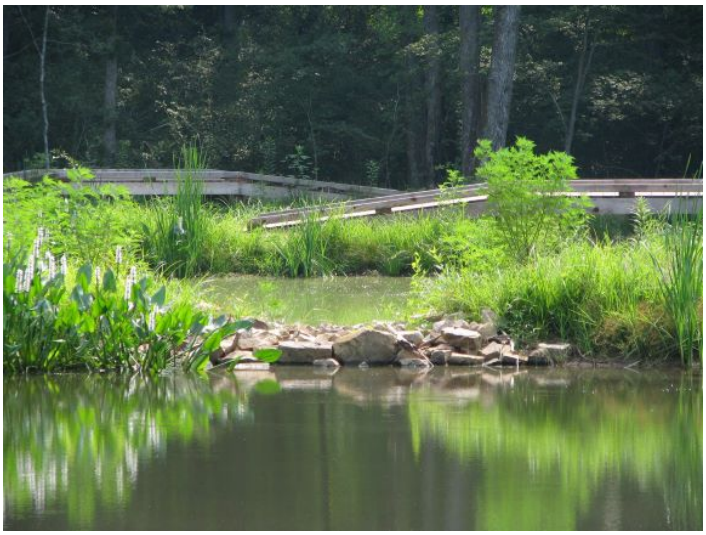
Wetlands

Principles

- Most states consider wetlands as "waters of the state," a designation that carries significant legal ramifications. Furthermore, permitting requirements for wetlands can have multiple overlapping jurisdictions of federal, state, and local agencies. At the federal level alone, the U.S. Army Corps of Engineers (USACOE), EPA, U.S Fish and Wildlife Service (FWS), National Oceanic and Atmospheric Administration (NOAA), and maritime agencies may all be involved.
- Wetlands act both as filters for pollutant removal and as nurseries for many species of birds, insects, fish, and other aquatic organisms. The biological activity of plants, fish, animals, insects, and especially bacteria and fungi in a healthy, diverse wetland is the recycling factory of our ecosystem.
- When incorporated into a golf course design, wetlands should be maintained as preserves and separated from managed turf areas with native vegetation or structural buffers. Constructed or disturbing wetlands may need to be permitted to be an integral part of the stormwater management system.
- Know your state laws and rules governing wetlands. http://http://adem.alabama.gov/programs/water/nps/305b/2008IWQMARPart4.pdf

Best Management Practices

- Ensure that proper permitting has been obtained before working on any wetlands.
- Ensure that wetlands have been properly delineated before working in and around any wetlands.
- Wetlands can be a vital part of your golf course. Learn to properly manage them. http://adem.alabama.gov/programs/water/waterforms/ContinuingPlanningProcess.pdf



Ruffner mountain wetlands

Drainage

Principles

Adequate drainage is necessary for growing healthy grass. A drainage plan of the entire property should be laid out just like an irrigation plan.

Using the topography of the land and understand the soil types involved creating a good healthy and sustainable drainage system will save you a lot of money.

"Cutting corners" will cost you time and lost revenue due to a saturated golf course if improperly done. Its always more costly to do after the construction phase is complete.

Drainage is just as important if, not more than an Irrigation plan.

A high-quality BMP plan for drainage addresses the containment of runoff, adequate buffer zones, and filtration techniques in the design and construction process to achieve acceptable water quality.

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

- When constructing drainage systems, pay close attention to engineering details such as subsoil preparation, the placement of gravel, slopes, and backfilling.
- Materials used should be proven for durability and long life expectancy using inferior products will become costly down the road.
- Internal golf course drains should not drain directly into an open water body but should discharge through pretreatment zones and/or vegetative buffers to help remove nutrients and sediments.
- Drainage should discharge through proper drainage and stormwater management devices, for example, vegetative buffers, swells, etc.
- The drainage system should be routinely inspected to ensure proper function. https://idtgolfservices.com/photos-and-videos
- Properly asses maintenance sites and golf course for priority areas related to water quality protection.
- Determine the most effective structural or vegetative BMP strategy, if needed.
- Assess current surface and groundwater quality.
- Quality of water is crucial for a golf course.
- You should always know what is coming onto your golf course and what is leaving your golf course.
- Conduct water quality assessments using accepted standards and an accredited lab.

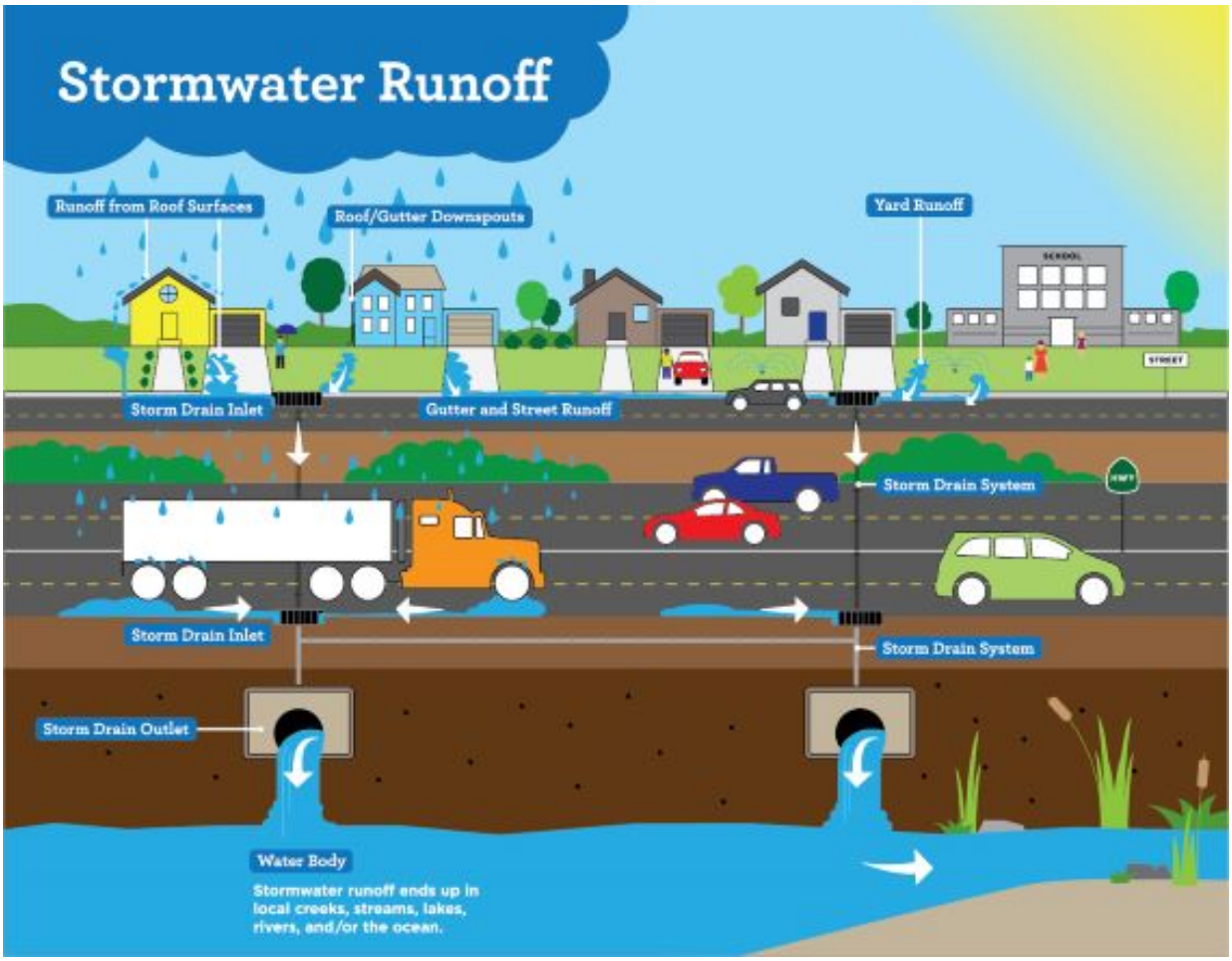
Surface Water: Stormwater, Ponds, Lakes

Principles

Stormwater is the conveying force behind nonpoint source pollution. https://alconservationdistricts.gov/

Working with the ADEM and the core f engineers to create a plan to manage run off and overflow will ensure protecting the environment and its habitat.

This is a crucial area of the job to be stewards of the environment.



When a golf course is near, this type of runoff usually passes through the golf course leaving behind garbage and debris to be cleaned up by golf course staff.

Controlling stormwater on a golf course is more than preventing the flooding of facilities and play areas. In addition to controlling the amount and rate of water leaving the course, stormwater control also involves storing irrigation water.

Lakes and ponds are a great way to help move water from the turf fast for future use. Recycling mother natures rainfall helps us all by controlling erosion and sediment, enhancing wildlife habitat, removing waterborne pollutants, and addressing aesthetic and playability concerns.

Keep in mind that not all stormwater on a golf course originates there; some may be from adjoining lands, including residential or commercial developments.

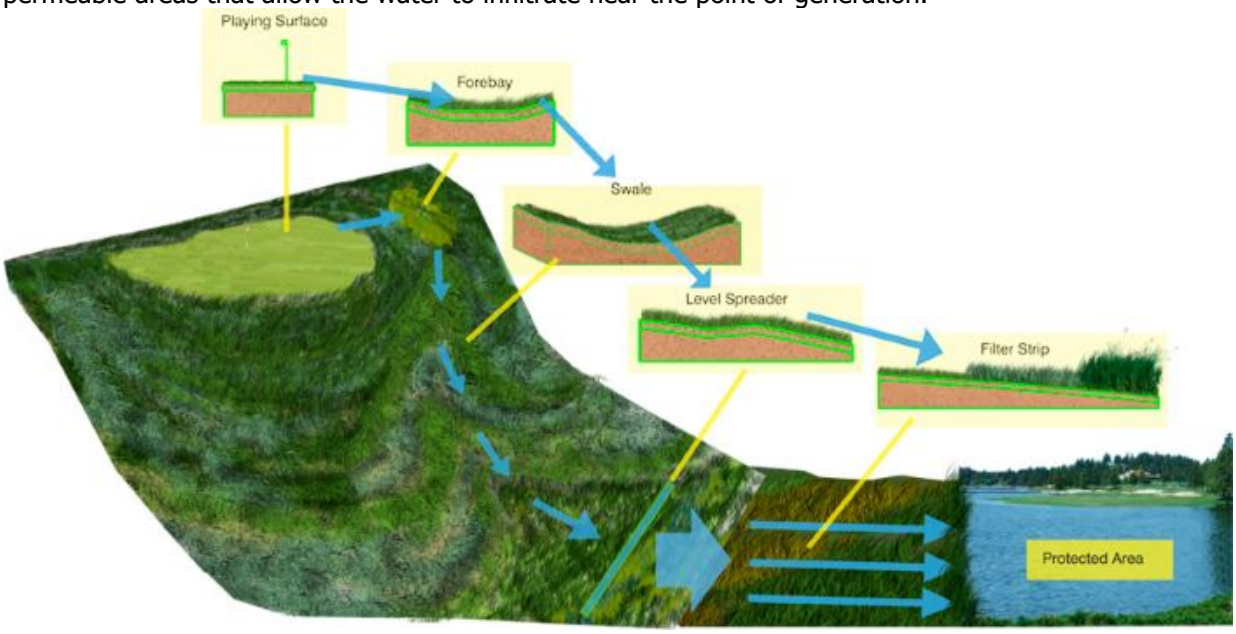
Best Management Practices

http://https://alconservationdistricts.gov/resources/erosion-and-sediment-control/

- Stormwater treatment is best accomplished by a "treatment train" approach, in which water is conveyed from one treatment to another by conveyances that themselves contribute to the treatment.
- Eliminate or minimize as much directly connected impervious area (DCIA) as possible.
- Use vegetated swales to slow and infiltrate water and trap pollutants in the soil, where they can be naturally destroyed by soil organisms.
- Use depressed landscape islands in parking lots to catch, filter, and infiltrate water, instead of letting it run off. When hard rains occur, an elevated stormwater drain inlet allows the island to hold the treatment volume and settle out sediments while allowing the overflow to drain away.

- Retention ponds are a great way to settle stormwater and filter it.

- Maximize the use of pervious pavements, such as brick or concrete pavers separated by sand and planted with grass. Special high-permeability concrete is available for cart paths or parking lots.
- Disconnect runoff from gutters and roof drains from impervious areas so that it flows onto permeable areas that allow the water to infiltrate near the point of generation.



- Properly assess maintenance sites and golf course for priority areas related to water quality protection.
- Determine the most effective structural or vegetative BMP strategy, if needed.
- Assess current surface and groundwater quality.
- Quality of water is crucial for a golf course.
- You should always know what is coming onto your golf course and what is leaving your golf course.
- Conduct water quality assessments using accepted standards and an accredited lab.

Maintenance Facilities

Principles

The maintenance facilities must incorporate BMP to minimize the potential for contamination of soil and water resources. The pesticide mixing and storage facility, the equipment wash pad, and the fuel center are focal points.

Best Management Practices

Design and build pesticide storage structures to keep pesticides secure and isolated from the surrounding environment.

Prefabricated buildings like this are self-contained and built to store corrosive materials.

Store pesticides in a roofed concrete or metal structure with a lockable door.

This area should not be accessible by everyone on the staff. Only properly trained and trusted individuals will have access to these pesticides and equipment.

- Construct floors of seamless metal or concrete sealed with chemical-resistant paint.
- Ensure that flow from floor drains does not discharge directly to the ground and that drains are not connected to the sanitary sewer line or septic system.
- Equip the floor with a continuous curb to retain spilled materials.

Some Dos and Dont's to Pesticide handling and application:

- Do not store pesticides near burning materials or hot work (welding, grinding), or in shop areas.
- Provide storage for personal protective equipment (PPE) where it is easily accessible in the event of an emergency, but do not store in the pesticide storage area.
- Provide adequate space and shelving to segregate herbicides, insecticides, and fungicides.
- Use shelving made of plastic or reinforced metal. Keep metal shelving painted.
- Provide appropriate exhaust ventilation and an emergency wash area.
- Always place dry materials above liquids, never liquids above dry materials.

- Never place liquids above eye level.
- Locate operations well away from groundwater wells and areas where runoff may carry spilled pesticides into surface water bodies.
- Do not build new facilities on potentially contaminated sites.
- An open building must have a roof with a substantial overhang (minimum 30° from vertical, 45° recommended) on all sides.
- In constructing a concrete mixing and loading pad, it is critical that the concrete has a water-to-cement ratio no higher than 0.45:1 by weight.
- The sump should be small and easily accessible for cleaning.
- Ensure that workers always use all personal protective equipment as required by the pesticide label and are provided appropriate training.
- Assess the level of training and supervision required by staff. (Certification) http://http://www.agi.alabama.gov/divisions/pesticide-management
- Any material that collects on the pad must be applied as a pesticide according to the label or disposed of as a (potentially hazardous) waste according to state laws and regulations.
- Clean up spills immediately!
- Always store nitrogen-based fertilizers separately from solvents, fuels, and pesticides, since many fertilizers are oxidants and can accelerate a fire. Ideally, fertilizer should be stored in a concrete building with a metal or other type of flame-resistant roof.
- Always store fertilizers in an area that is protected from rainfall. The storage of dry bulk materials on a concrete or asphalt pad may be acceptable if the pad is adequately protected from rainfall and from water flowing across the pad.
- Sweep up any spilled fertilizer immediately.

Stand-alone self-contained wash system,http://https://www.waste2water.com/service/golf-course-and-turf-care/

- Do not wash equipment unnecessarily.
- Clean equipment over an impervious area, and keep it swept clean.
- Brush or blow equipment with compressed air before, or instead of, washing.
- Use spring shutoff nozzles.

- Use a closed-loop recycling system for wash water when possible.
- a retention pond or settling pond may need to be added as the water leaves the surface of the facility along with an oil water separator.
- Recycle system filters and sludge should be treated and disposed of appropriately. http://adem.alabama.gov/programs/land/default.cnt
- Each piece of equipment should have an assigned parking area. This allows oil or other fluid leaks to be easily spotted and attributed to a specific machine so that it can be repaired.
- Use solvent-recycling machines or water-based cleaning machines to cut down on the use of flammable and/or toxic solvents.
- Use a service to remove the old solvents and dispose of them properly. http://www.hwhenvironmental.com/hazardous-waste-disposal-in-alabama/
- Design pesticide storage to keep pesticides secure and isolated from the environment.

External Certification Programs

Principles

- Golf-centric environmental management programs or environmental management systems can help golf courses protect the environment and preserve the natural heritage of the game.
- These programs help people enhance the natural areas and wildlife habitats that golf courses provide, improve efficiency, and minimize potentially harmful impacts of golf course operations.
- Golf courses can gain valuable recognition for their environmental education and certification efforts.https://audubonintenational.org/

Best Management Practices

- Obtain and review materials to ascertain whether the facility should seek certification. https://audubonintenational.org/acsp-for-golf/
- Work with staff to establish facility goals that lead to certification such as these:

    - Environmental Planning: Minimize the use of pesticides when applicable
    - Wildlife and Habitat Management: Know the wildlife that lives on and around your course. o
    - Chemical Use Reduction and Safety: always take precaution when discarding waste
    - Water Conservation: Recirculating pumps are a great way to create a running water effect.
    - Water Quality Management: know where your runoff water is going and where your water is coming from.
    - Outreach and Education: First green program, Offer field trips to your course.

- Establish goals to educate members about the certification program.

CERTIFICATE OF ACHIEVEMENT

Be it known that

Audubon International

hereby recognizes

Country Club

as having been recertified as a

Certified Audubon Cooperative Sanctuary

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Paul L. Carter, Superintendent, said, "Being able to state that our golf course is a Certified Audubon Cooperative Sanctuary has allowed us to communicate differently with state and federal authorities. Our actions on the golf course and our outreach and education efforts within the community have changed the way people look at our golf course and the activities that we do here."

Wildlife Considerations

Principles

- Golf courses occupy large land areas, generally in urban areas, providing critical links between urban and rural/natural environments. In many Urban areas, a golf course is the only Green Space within miles. Care should be taken to maintain the natural ecological system that already exits.
- The EPA does not yet recognize golf courses as Greenspace. https://www3.epa.gov/region1/eco/uep/openspace.html
- Maintaining wildlife habitat on golf courses better maintains biological diversity, which is especially important in the urban environment.
- Most golfers enjoy observing non-threatening wildlife as they play the game.

Geese will lay their eggs in the tall grass next to ponds and lakes.

Best Management Practices

- 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 or endangered by the federal or state government, including species the state deems "of special concern". https://www.fws.gov/daphne/es/specieslst.html
- Preserve critical habitat. https://www.fws.gov/daphne/backyard/backyard.html
- Identify and preserve regional wildlife and migration corridors.
- Design and locate cart paths to minimize environmental impacts. Construct the paths of permeable materials, if possible.
- Avoid or minimize crossings of wildlife corridors. Design unavoidable crossings to accommodate wildlife movement.
- Remove nuisance and exotic/invasive plants and replace them with native species that are adapted to a particular site. http://floraofalabama.org/
- 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.

Here is an example of a decorative fence that allows wildlife to move right through and adds a great look to the course.

- 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.

This is a great example of a way to naturally slow the water for less erosion.

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(Note: URLs are as of September 2016)

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Turfgrass Terminology

Turfgrass terminology

Presented by the Golf Course Superintendents Association of America

Topdressing. *Pythium* blight. Creeping bentgrass. Cultivar. *Poa annua.* If you listen to golf course superintendents awhile, you will hear these and many other similar terms. To the layperson, they may seem rather foreign. An understanding of some of the more frequently heard golf course management terms may help you understand the complexities of managing a golf course. The turfgrass science terms included here concern the quality of the playing surface. Here are a few of the most common - with translations.

A

acid soil

A soil having an acid reaction of pH below the neutral point, which is pH 7.0; a soil having an excess of hydrogen ions. Turfgrasses generally prefer slightly acid soils, in the pH range of 6.0 to 6.5.

aeration

The process of coring to allow more air into the soil and to relieve compaction; used synonymously with aerification.

algae

A growth of minute single-celled plants containing chlorophyll that develops on thin or bare areas in hot humid weather when soils are saturated with moisture.

alkaline soil

A soil having a basic reaction or a pH above the neutral point, which is pH 7.0; a soil having a predominance of hydroxyl (OH) ions, usually found in areas with relatively low rainfall.

annual grasses

Grasses that normally complete their life cycles in one year.

apron

The fairway area close to and in front of the putting green, adjoining the putting green collar. This area is normally mowed at fairway height but sometimes is mowed slightly closer.

B

bacteria

A large, widely distributed group of typically one-celled microorganisms, chiefly parasitic or saprophytic. Some bacteria are disease producing; many are active in processes such as the conversion of dead organic matter into soluble food for plants and the fixing of atmospheric nitrogen.

ball mark

A depression and/or a tear in the putting green surface made by the impact of a golf ball.

bench setting

See cutting height.

bentgrass

Bentgrasses, generally speaking, are tolerant of cold weather, extremely fine-bladed and very popular among golfers, especially for greens. Bentgrasses are even in demand in the South, but it is difficult and costly to maintain them in warm climates.

biennial

A term applied to plants that normally complete their life cycles in two years.

biological control

Control of turfgrass pests by the use of living organisms.

blend

A combination of two or more varieties of the same grass species.

blight

A general term used to describe symptoms of plant disease that may include sudden wilting or death of leaves, flowers, stems or entire plants. The most common blight of golf course turfs is *Pythium*.

broadleaved

Any of the dicotyledonous plants that grow in a turfgrass stand (e.g., dandelion, plantain, clover, chickweed, knotweed, etc.)

brushing

The practice of lifting excessive leaf and stem growth off grasses before mowing. Usually accomplished with brushes affixed to mowers ahead of the cutting reel.

C

calibrate

To determine or mark the graduation of, or to determine and control the amount of material delivered by a sprayer or spreader on a given area or in a given time.

chlorosis

As commonly used, the condition in plants relating to the loss or lack of green color. May be caused by disease activity, albinism or nutritional deficiency.

collar

An area of turf adjoining the putting green that is mowed at a height intermediate between the fairway and the green.

compaction

The reduction in the number and size of airspaces caused by compression. It is most often the result of traffic. Compaction prevents adequate water and air penetration, and reduces turfgrass root growth.

complete fertilizer

A fertilizer that contains nitrogen, phosphorus and potassium.

contour mowing

To shape the border between the fairway and rough to add interest, direction or strategy to the golf hole.

cool-season grasses

Among the best known are colonial bentgrass, creeping bentgrass, Kentucky bluegrass, perennial ryegrass, fine fescue and tall fescue. They grow best between 55 F and 85 F.

coring

The removal of a core from a turfgrass area with a soil probe or hollow metal tines, usually to provide aeration.

cultivar

A term used to distinguish cultivated varieties of plants from the naturally occurring varieties. Example: Penncross creeping bentgrass.

cultivation

A mechanical procedure such as spiking, grooving or core removal on established turf without destroying its sod characteristics.

cutting height

The distance above the soil line that grasses are clipped.

bench setting - the height at which the bedknife is set above a firm, level surface. This is generally the accepted measure for determining cutting height.

effective cutting height - the actual height at which grasses are cut. It varies from bench setting, depending on the degree of thatch and flotation of the cutting unit.

D

damping off

A disease of seeds or young seedlings caused by fungi, usually occurring under wet conditions.

desiccation

Drying up. A type of winter injury that exposed turf areas suffer when subject to high winds and inadequate moisture or snow cover.

dethatch

The procedure of removing an excessive thatch accumulation either mechanically, by practices such as vertical mowing, or biologically, such as by topdressing with soil.

disease

A disturbance in normal functioning and growth, usually caused by pathogenic fungi, bacteria or viruses.

dormant

In a resting, or nonvegetative, state.

drainage

The rapid removal of water by surface contouring (swales or ditches) or the installation of subsurface tile.

E

erosion

The wearing away of the land by running water, wind or other geological agents.

evapotranspiration

The combination of soil evaporation and transpiration from a plant; total water loss from plant and soil.

F

facing

The slope or incline of a bunker constructed in the direction of the putting green, intended to create an added obstacle for a player to negotiate.

fairway

No precise definition exists in the Rules of Golf for "fairway." It is deemed to be an area between the tee and putting green included in the term "through the green." In terms of maintenance, fairways are those areas of the course that are mowed at heights between 0.5 and 1.25 inches, depending on grass species and the cultural intensity desired. Fairways normally are about 50 yards wide but vary from about 33 yards to more than 60 yards, depending on the caliber of the golf course involved and limitations imposed by architecture or terrain.

fertigation

The application of fertilizer through an irrigation system.

fertilizer

A nutrient applied to plants to assist growth.

foliar fertilizers

Soluble plant nutrients applied to the leaf and capable of being absorbed through leaves.

foot printing

frost - discolored areas of dead leaf tissue left after live, frosted turfgrass leaves are walked on.

wilt - Temporary foot impressions left on a turf because the flaccid leaves of grass plants have insufficient water to spring back.

friable

Easily crumbled in the fingers. Most often used when describing soils.

fumigant

A liquid or solid substance that forms vapors that destroy pathogens, insects, etc. Fumigants are usually used in soils or closed structures.

fungicide

A chemical that kills or inhibits fungi.

fungus

A low form of plant life that, lacking chlorophyll and being incapable of manufacturing its own food, lives off dead or living plant and animal matter.

G

gang mower

A machine for cutting turfgrass - usually fairways - in which a tractor propels a cluster of reel mowers usually in groups of three, five, seven or nine.

germination

The beginning of growth in a seed, plant bud or joint.

grainy

As applied to putting greens, the tendency for grass leaves to lie down in one direction and interfere with the natural roll of the ball.

grooving

A form of cultivation using rotating knives that cut slits into the turf and soil.

ground covers

Plants used to provide a low-maintenance, vegetative cover that is not necessarily turf.

H

heaving

A swelling or rising of the surface caused by the freezing and thawing of soil.

herbaceous

Nonwoody plants.

herbicide

A chemical used to kill weeds or herbaceous growth.

humus

A dark, well-decomposed material formed from decayed vegetable or animal matter in the soil.

hydroseeding

A technique for applying seed, mulch and fertilizer in a water slurry over a seedbed.

I

infect

To become established in a parasitic relationship with a host plant.

infiltrate

To filter into; the penetration of water through soils.

inorganic fertilizer

Plant nutrients derived from mineral rather than organic sources.

insecticide

A chemical used to destroy insects.

internode

The portion of a stem between the nodes or joints.

L

leaching

The removal of materials from the soil through rainfall or the application of water.

lip

An abutment of sod raised 3 to 4 inches above the sand level of a bunker. It faces the putting green and prevents a player from putting out.

lime

Materials containing calcium and magnesium used to neutralize soil acidity and to supply calcium and magnesium as plant nutrients. Lime materials include limestone, shell, marl, slag and gypsum.

liquid fertilizer

Plant nutrients applied in solution.

localized dry spot

A dry area of sod and soil that resists water as normally applied; caused by various factors such as heavy thatch, soil or fungal organisms.

M

mat

In turf, an undecomposed mass of roots and stems hidden underneath green vegetation. Associated with sponginess or fluffiness in turf.

matting

The process of working topdressing, fertilizers or other materials into a turfgrass area with drag mats.

microenvironment

The area in the immediate vicinity of the turfgrass plant from the surface to the depth of root penetration into the soil.

micronutrient

An element needed in small amounts for turfgrass growth.

microorganisms

Small organisms such as bacteria and other minute entities; usually invisible to the unaided eye.

mildew

A disease in which the causal fungus forms a coating over the surface of plant parts. The coating, which is a mycelial growth, is usually thin and whitish. There are two types of mildew: downy and powdery.

mixture, seed

A combination of seeds of two or more turfgrass species.

mulch

A material such as straw, netting, burlap, etc., spread over seeded or stolonized areas to protect them from erosion, moisture loss and temperature extremes and to enhance germination and growth.

N

native grasses

Grasses that are indigenous or that occur naturally in a particular region.

nematicide

A substance used to destroy nematodes.

nematode

Small, round worms, usually microscopic and colorless, that live 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.

node

The joint of a grass stem from which leaves and buds arise.

noxious weeds

Weeds categorized by law as objectionable in a seed lot for commercial sale.

nursery

An area set aside for testing new turfgrass cultivars and chemicals and for growing replacement turf for the golf course.

nutrients, plant

The elements taken in by the plant, essential to its growth and used in elaboration of food and tissue.

O

organic fertilizer

Fertilizers that contain carbon, hydrogen and oxygen, as well as needed nutrients. Organic fertilizers can come from naturally occurring sources or be made synthetically.

organic matter

Decomposed material derived from plant or animal sources. An important component of topsoil often added to topdressing soil mixtures to give added water-holding capacity and exchange capacity to the soil.

organic soil

A general term used in reference to any soil that is at least 20 percent organic matter.

overseed

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.

P

pathogen

An organism causing disease.

peat

Unconsolidated soil material consisting largely of undecomposed or only slightly decomposed organic matter accumulated under conditions of excess moisture.

permeability

A measure of the ease with which air, roots and water penetrate the soil.

perennial grasses

Lasting or continuing from year to year in areas where adapted.

pesticide

A substance used to destroy pests such as weeds, insects or diseases.

pH

A measure of the acidity or alkalinity of a material or solution. pH ranges from 0 to 14. Values below 7 are increasingly acid; above 7, increasingly alkaline.

phytotoxic

Harmful to plants.

PGR

Stands for plant growth regulator. A chemical that can slow the growth of turfgrass.

plugging

The vegetative propagation of turfgrass by means of plugs or small sod pieces. A method of establishing vegetatively propagated turfgrasses, as well as repairing damaged areas.

Poa

Poa is the genus of all bluegrasses. *Pratensis* is the species name for Kentucky bluegrass. *Poa annua* is annual bluegrass. There's also *Poa trivialis* (rough bluegrass) and *Poa compressa* (Canada bluegrass).

pore space

That space between solid soil particles or aggregates that is normally filled with water, air or grass roots.

postemergence

A term used in reference to herbicide treatment made after weed seedlings have emerged from the soil.

preemergence

A term used in reference to treatments made before weed seedlings emerge from the soil.

profile, soil

A cross-section of soil that shows the layers or horizons lying above the unweathered parent material.

***Pythium* blight**

A highly destructive turfgrass disease that can totally destroy a turfgrass stand in less than 24 hours. *Pythium* blight most commonly occurs under conditions of high temperature and humidity.

R

rebuilding

A term that refers to practices involving complete changes in the total turf area, i.e., reconstruction of a green, tee, fairway, rough or any other area of the golf course.

renovation

Turf improvement involving replanting into existing live and/or dead vegetation.

resiliency

The capability of the turf to spring back when balls, shoes or other objects strike the surface, thus providing a cushioning effect.

rhizome

An underground, root-like stem; underground creeping stem.

rust

A disease caused by a fungus that results in a layer of reddish-orange material forming on the leaf or stem surface. The rust material will come off the plant readily when rubbed.

S

saline soils

Soils in which there is a heavy accumulation of salts.

scald

Turf damage occurring under conditions of excessive water, high temperatures and intense light.

scalping

Cutting into or below the crown of the grass plant while mowing. Continued scalping will weaken or kill the turf.

seed bed

An area of soil prepared for seeding.

seedling

A plant grown from seed; usually refers to a young plant.

selective herbicide

One that can be applied to a mixed stand of turfgrass and weeds that will selectively kill certain weeds without injuring the turfgrasses.

slicing

A form of cultivation involving a deep, vertical-cutting action that is used to open the soil as well as the turf.

smut

A disease caused by a fungus.

sod

Plugs, blocks, squares or strips of turfgrass with roots used for vegetative planting.

sodding

The installation of sod.

soil modification

Alteration of soil characteristics by adding soil amendments such as sand, peat, lime, etc.; commonly used to improve physical and chemical conditions.

soil probe

A tool used to remove a deep core from turf areas to examine root development, thatch depth, topsoil depth, soil arrangement and soil moisture.

soil sterilant

A chemical that renders soil free of living organisms.

soil testing

The analysis of soil samples for chemical and/or physical properties.

soil texture

The coarseness or fineness of the soil. Sand is coarse-textured; clay is fine-textured.

species

An established classification into which similar individuals in the plant or animal kingdom are placed. A species is described as a morphologically distinctive and genetically isolated natural population.

spiking

The act of perforating turf and soil crust by the use of solid tines, spikes or blades for the purpose of aerating the soil.

spray drift

The movement of small spray particles away from the target area.

sprigging

The planting of stolons (runners), rhizomes or vegetative segments of plants.

sterilize

To treat soil chemically or by heat to kill disease organisms, weed seeds and insects.

Stimpmeter

An implement used to measure the speed of putting greens.

stolons

Creeping stems or runners aboveground that may produce roots and new stems and become independent plants.

striping

A pattern left on turfgrass - usually a fairway or a green - using lightweight mowing equipment. Its main purpose is a pleasing appearance. Patterns are the result of light reflected from blades of grass lying in different directions because they have been mowed in different directions.

subsoil

That part of the soil profile below plow depth. Usually considered unsatisfactory for plant growth.

surfactant

An agent that reduces surface tension of liquids on plant materials or in the soil. Wetting agents are common examples.

susceptible

Lacking inherent ability to resist. Turf may be susceptible to diseases, insect damage or weed encroachment.

synergistic

The action of one chemical upon another causing an accelerated action or a result that neither one alone could produce.

syringing

Light sprinkling of water on turf, usually done during the hot part of the day to prevent wilting. Only enough water is applied to wet the leaves, not the soil.

T

teeing ground

The starting place for the hole to be played. It is a rectangular area two club lengths in depth, the front and the sides of which are defined by the outside limits of two tee markers.

texture, grass

The width of individual leaves. A narrow-leaved grass like creeping bentgrass is considered fine-textured. A wide-leaved grass like some tall fescues is considered coarse-textured.

thatch

A tightly intermingled layer of dead and decaying roots, stolons, shoots and stems that develops between the green vegetation and soil surface.

tolerance

The ability of a plant to withstand the effects of adverse conditions, chemicals or parasites.

topdressing

A prepared mixture usually containing sand and organic matter used for leveling and smoothing the playing surface. It acts as an aid in controlling thatch and in maintaining biological balance. Topdressing is also used to cover stolons or sprigs in vegetative planting.

topsoil

A general term applied to the top natural layer of soil.

toxicity

Quality, state or degree of being toxic; poisonous.

transition zone

Commonly referred to as the geographical zone that is too far north to easily grow warm-season grasses and too far south to easily grow cool-season grasses.

transpiration

The movement of water vapor out of a plant through leaf openings.

triplex mower

A machine for closely cutting greens involving a small power unit propelling three precision reel mowers, usually in front. Triplex mowers are also used widely on tees and fairways.

V

variety

In classification, a subdivision of species. Differing from the remainder of the species in one or more recognizable and heritable characteristics.

vegetative propagation

Propagation by means of pieces of vegetation, i.e., sprigs or sod pieces.

verdure

The green, living plant material remaining after mowing.

vertical mowing (verticutting)

The thinning of turfgrasses by blades or wire tines that cut perpendicular to the soil surface. Specifically designed to remove mat, thatch and grain from greens and to thin dense turf.

W

warm-season grasses

Among the best known are bermudagrass, St. Augustinegrass, zoysiagrass, bahiagrass, carpetgrass and centipedegrass. Bermudagrass is the most popular for greens. Warm-season grasses grow at their optimal rate between 75 F and 95 F.

weeds

Plants out of place; undesirable or unwanted plants.

wettable powder

A dry powdered formulation of a pesticide that is applied as a suspension in water.

wilt

A loss of freshness and turgidity. Drooping of leaves due to inadequate water supply or excessive transpiration. Also a vascular disease that interferes with utilization of water by a plant.

winterkill (injury)

The general term applied to injuries of turf from a variety of causes that occur during the winter and become evident in spring.

Read more: https://www.gcsaa.org/resources/research-information/secure/communication/informationforgolfers/turfgrass-terminology#ixzz5pGFmkk8K