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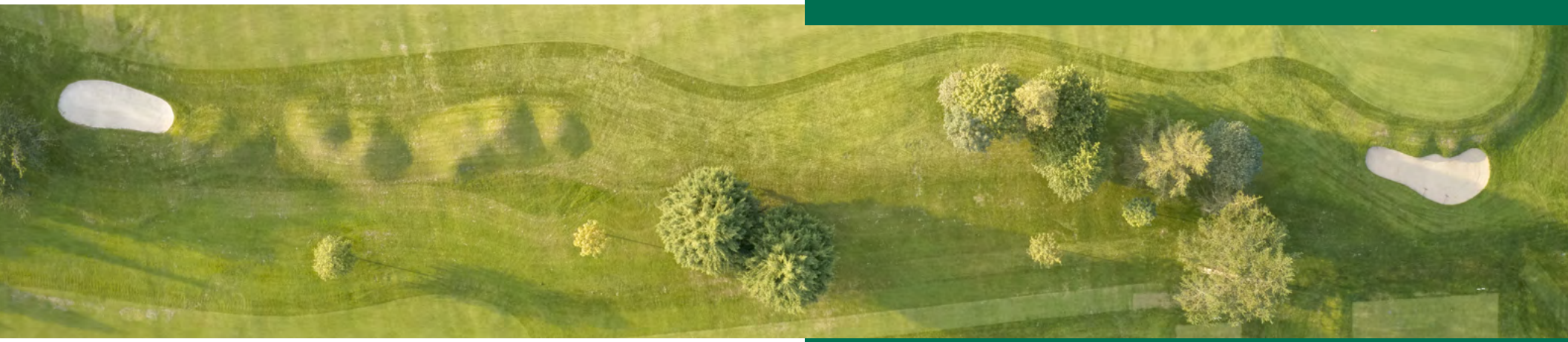


Golf Course
SUSTAINABILITY HANDBOOK

Developed by:

NYS P2I | New York State Pollution Prevention Institute

Cornell CALS College of Agriculture and Life Sciences

Table of Contents

Introduction

Don't have the poster?

To get the longest drive out of this handbook, order a copy of the **Golf Course Sustainability Practices poster** (24 by 37 inches). Hang it up in an area where your maintenance staff can easily see it, then use this resource for guidance on how to put any of the best management practices (BMPs) into action. Order your free copy by emailing **nysp2i@rit.edu** or calling **585-475-2512** today.

If you're reading this, then you're a step closer to learning how you can sustain a beautiful and healthy golf course using less resources and saving money. This handbook is a companion to an instructional poster ("Golf Course Sustainability Practices") that was created by the New York State Pollution Prevention Institute (NYSP2I) and Cornell University's Turfgrass Science program in the College of Agriculture and Life Sciences (Cornell CALS).

Why use this handbook?

Like the "Golf Course Sustainability Practices" poster, this handbook is designed to be a simple, easy-to-use reference for you and your staff. It focuses on 34 unique and impactful BMPs that address our most pressing environmental issues. It provides practical, step-by-step instructions on how to put each of the BMPs into action. We recommend sharing this with your staff, either as a printout copy alongside the poster or digitally, whichever format is most straightforward for your team.

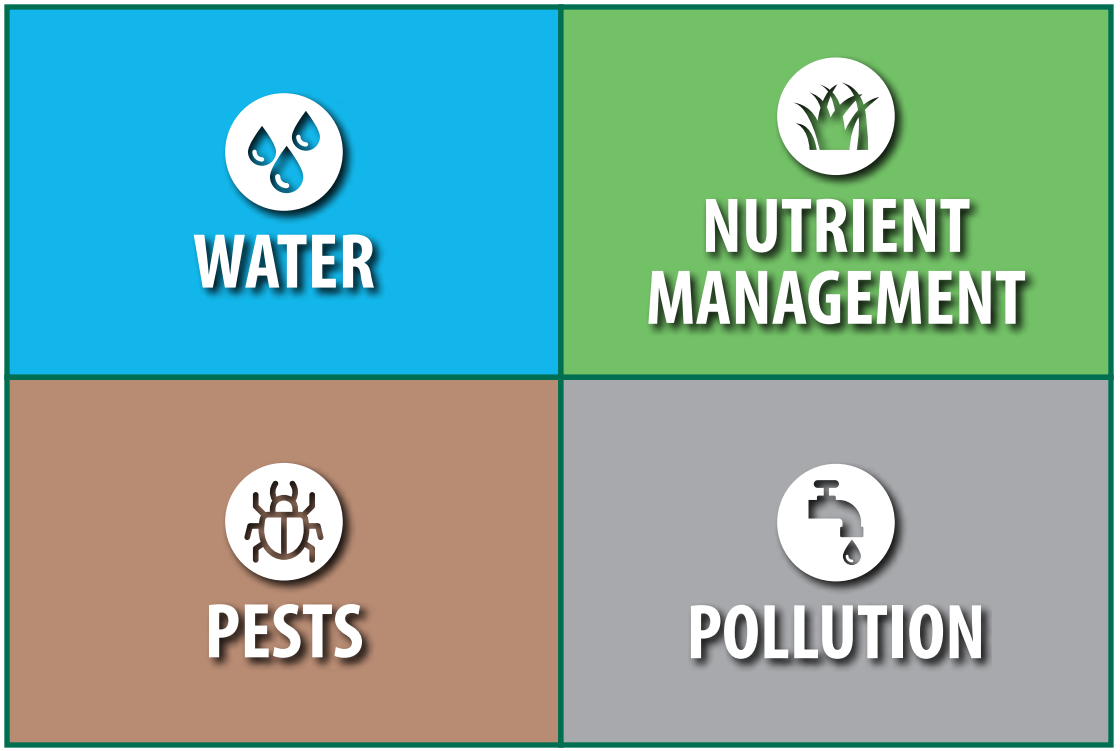
A BMP—what's that exactly?

A **best management practice (BMP)** is a technical term used in the United States and Canada to describe a practice or set of practices for preventing or reducing pollution, waste, or contamination. Originally, BMPs were developed to address water pollution and quality, but they can also be applied more broadly to environmental stewardship that concerns biodiversity and climate change.

34 BMPs

The 34 BMPs in this workbook were developed to provide guidance on

- water use,
- fertilizer use (nutrient management),
- pest management, and
- waste and pollution.



How to use this handbook

Set your handicap.

There are three general ways you can "play" this handbook: aim for par, birdie, or eagle.

Just as in golf, everyone can't post a perfect score, but you can strive to improve with practice and strategy. The pathway that is best for you will, in part, depend on your overall experience of sustainable golf course management. It will also rely on what resources you have available in terms of finances, expertise, and labor. These factors must be considered in balance with what you want to achieve—what tradeoffs will work best for you?

PAR	BIRDIE	EAGLE
PAR BMPs are perfect if you're just starting out—they're easy to implement, laying solid ground for more advanced sustainability practices.	**BIRDIE BMPs** take basic sustainability practices to the next level. They require a bit more time, planning, and money, but deliver bigger results.	**EAGLE BMPs** are designed to harmonize a full sustainability program with course operations using science-based, data-driven strategies.

Get to know the lay of the land.

Every BMP featured on the "Golf Course Sustainability Practices" poster can be found in this workbook. Throughout, you'll find information to help you better understand the science behind the BMPs and, most importantly, how you can put them to work.

What to expect:

- a short explanation of why the BMP matters when it comes to sustainability
- detailed, step-by-step instructions for implementing the BMP

You'll also see the following icons to help you find and implement the BMP that's right for you:

Use these to choose the path that is right for you (see chart on previous page).

Some BMPs are ideally done at certain times of the year, but others can be done at any time—these icons indicate which season(s) a BMP could be most effectively implemented.

Go deeper with extra details and advice on what to look out for when putting some of the more challenging BMPs into practice.

It's okay to mix it up.

Every course is different, so you might find yourself shooting for par on one BMP, but feel more confident about going for an eagle on another. Just be sure to consider where you feel comfortable when it comes to financial investment, effort, and resources for each.

WATER

Why it matters

- State and local governments are likely to pay increasing attention to water use on large facilities—including golf courses—as natural resources like water become more strained.
- Optimizing how you irrigate today could help justify water use under potential future regulations.

By the numbers

39% Adoption rate of BMPs for water use among New York golf courses.*

18% The drop in water use on golf courses in northeastern U.S. states between 2006 and 2020, thanks to conservation and efficiency measures.†

"If I cut down on how much I water, my golfers might complain and I could lose my job."

Consider this:

» Golfers preferences are shifting to value firmness over lush, green turf. This has allowed golf courses to reduce water use in recent years.

» Achieving firm conditions requires a well-planned water-conservation strategy. This must consider soil type, climate, and grass type to determine unique water needs that can lead to healthier turf, better playing conditions, and cost savings.

Look for Leaks.

Visually check all sprinklers during start-up.

WHY?

- Intentional observation of sprinklers can improve irrigation coverage and uncover flaws before they lead to failure at the worst time, like when drought stress occurs.
- Small leaks can inch up your water bill and lead to untimely repairs down the road.
- Water-tight irrigation is essential to maintaining consistent playing conditions.

HOW?

1. Watch each sprinkler turn through its entire arc to see if it is level and throwing water the correct distance and height.
2. Check to ensure endpoints of part-circle sprinklers are set correctly, and sprinklers are rotating at the proper speed.
3. Observe nozzles closely to identify any wear and tear that could cause distribution issues.
4. For more precision, distribute catch-cups and conduct an irrigation audit (pictured below).
5. Don't forget to check your pump station for leaks and proper operation as well.

Prevent with preventative maintenance (PM).

Perform PM on sprinklers before malfunctions occur.

WHY?

» A consistent PM schedule will ensure uniformity of playing surfaces, and could help you avoid a catastrophic—and costly—failure when you least expect it.

HOW?

1. Employ periodic edging, leveling, and raising of sprinklers.
2. Check for leaks and monitor nozzle pressure several times per year.
3. Perform irrigation audits to quantify irrigation uniformity.
4. Tasks can be outlined in a written schedule and checked off throughout the year as they are completed.

PRO TIP

A little time spent now saves a lot of time later.

While a PM program might seem like a big project to set up, it will make life easier for you in the long run. Here's why:

- A reactionary approach creates a never-ending loop of repairs and persistent turfgrass decline, especially as an irrigation system ages. A PM schedule can help you stay ahead of the curve and ensure smoother operation.
- Any unplanned down-time for an irrigation system risks turf quality—PM can help you maintain consistent playing conditions.

A little stress goes a long way.

Allow some moisture stress before irrigating.

WHY?

- Intentionally allowing moisture stress helps improve rooting.
- When plants sense drought, they adapt by slowing vertical leaf growth and developing more expansive root systems able to access additional water in the soil.
- Just as professional athletes work out to build muscle, plants must stress themselves at opportune times to become stronger and more resilient.

HOW?

1. Identify localized areas that tend to dry out before others and avoid irrigating them until there are visual signs of moisture stress.
2. When irrigating, favor "deep and infrequent" over "light and frequent" cycles to encourage plants to grow deeper roots as the soil dries from the top downwards.

Turf showing signs of wilt

PRO TIP

Some stress can make turf stronger!

Adaptation occurs slowly over time, so strategically allowing drought stress is a learning process.
Here are some tips for "strength training" your grass to need less water:

- Focus on the shoulders of the season (spring and fall): Moisture stress at these times is low-risk and allows ample time for recovery.
- Reduce irrigation until changes to leaf texture and rigidity indicate when irrigation is required. If your footprint remains on the turf, the grass is wilting and you have pushed it to its limit.
- As your comfort level grows, gradually employ these irrigation strategies during more stressful parts of the season.

Let nature do the work.

Eliminate irrigation of large rough areas and out-of-play areas.

PAR

WHY?

- Climatic conditions generally supply adequate moisture to golf course rough areas on native, loamy soils in New York.
- Rough and out-of-play areas receive low amounts of traffic and are not highly scrutinized by golfers, so they don't require additional irrigation for aesthetic purposes.

HOW?

1. Reduce irrigation—or simply turn off sprinklers—in rough areas on native soils that receive low traffic or have low golfing value.

PRO TIP

What if your membership wants lush, green rough?

Begin a dialogue with golfers or ownership. Determine if the course design allows areas where dormant rough would be acceptable in the case of drought. If possible, begin by withholding irrigation in a few out-of-play areas as a trial run.

Find your number.

Use a soil moisture meter.

WHY?

- Modern soil moisture meters provide quick and consistent data.
- While visual cues or soil-sampling probes can be useful for noticing potential problems, they can vary person-to-person, and are susceptible to daily biases that can lead to inconsistent watering decisions.
- A soil moisture meter can give you more accurate data to support more consistent, smarter decision-making.

HOW?

1. First, take moisture meter readings in areas that exhibit visual moisture stress—known as the "wilting point"—to measure the lowest threshold for soil moisture when irrigation is required.
2. Then assess the high end of soil moisture by taking readings when soil is saturated, known as "field capacity."
3. Monitor soil moisture between the wilting point and field capacity while observing how the turfgrass looks and performs during play.
4. Use your observations to identify moisture levels where turf performs its best. Optimal soil moisture ranges will change based on the types of soil, grass, and environmental conditions, all of which will be unique to your course. (See "Useful resources" for a link to moisture meter resources.)

Calibrating moisture meter readings to observations

PRO TIP

Get everyone involved.

There is no question that a good superintendent knows how to irrigate turfgrass areas in a way that maintains uniform quality without a moisture meter. However, "going by feel" can be difficult to transfer to other crew members, and is prone to the day-to-day variability of an individual's judgement. A moisture meter will allow the whole team to evaluate moisture on a daily basis, instead of placing the burden on a single person to do it.

Improve the competition.

Incorporate new turfgrass varieties to reduce water and chemical use.

WHY?

- Using new turfgrass varieties can improve playability and lead to decreased water, fertilizer, and pesticide use—all of which saves the course money.
- The latest varieties can be especially valuable when sown on large areas like fairways where water, fertilizer and pesticide use is greatest.

HOW?

There are two approaches (below). Each requires management adjustments that will promote the desirable species and varieties through judicious water, pesticide, and fertilizer use.

1. Perform a renovation of playing surfaces to allow for a complete transition to new grasses. In as little as a month, fairways and tees can be put back into play after renovation. (Note that this strategy requires halting play for a time and may not be financially possible at all clubs.)
2. Introduce new turf varieties to the existing stand over time by over-seeding at opportune times for a more gradual and less disruptive approach.
3. To identify the most suitable turfgrass variety for your site, visit the **National Turfgrass Evaluation Program website** and review their latest data.

Photo: Kevin Morris – National Turfgrass Evaluation Program

How much is enough?

Track water usage.

BIRDIE

WHY?

- Knowing how much water is required to manage a golf course will help justify water use if, in the future, access to water is scrutinized by regulators.
- Benchmarking your water use annually, monthly, or even daily makes it easy to see trends over time. With this data in hand, you can see how changes in your irrigation practices are affecting overall water use, if at all.
- Tracking water flows can be a useful way to spot potential leaks in the irrigation system early.

HOW?

1. Record water use every month using a flow meter on your irrigation supply.
2. Track precipitation to provide context for monthly water use.
3. Review data annually to evaluate trends and plan future water use accordingly.

Hope for the best, plan for the worst.

Develop a drought emergency plan.

EAGLE

WHY?

- As drought becomes more common in New York State, it is crucial to document the use of sensitive water resources.
- A drought emergency plan provides justification when water use becomes scrutinized or restricted, and demonstrates to decision-makers that you are aware of what is required to keep the golf course running smoothly.
- Documentation displays a level of preparedness that ownership responds to favorably when resource requirements and associated costs are being discussed.

HOW?

1. Use the worksheet below, which walks you through all the components necessary for a drought emergency plan.
   - **Drought and Nutrient Management Plan Worksheet**

Let data tell the story.

Monitor evapotranspiration (ET) values to help determine watering needs.

WHY?

- ET is the combined amount of water that leaves soil through evaporation and plants through transpiration.
- ET is typically reported in units of depth (inches), and is driven by factors such as temperature, sunlight, humidity, and wind.
- ET is useful because it provides a definite amount of water lost each day, allowing you to determine a precise amount of irrigation (in inches) to apply.

HOW?

1. Gather ET data from a local weather station or from one of the following online resources:
   - **Northeast Regional Climate Center (NRCC)**
   - **National Weather Service**
2. Monitor ET data simply as a general indicator of how much water your plants use.
3. Once you become more comfortable looking at ET values, transition to a more precise way of using the data, such as applying irrigation relative to how much ET occurs in a week alongside any soil moisture readings you collect.
   - **NYS Golf Course Irrigation BMPs**
4. Use the ET data you collect to set irrigation run times to provide the depth of water (in inches) that needs to be applied.

PRO TIP

Where water is scarce, data is gold.

In water-scarce regions like the southwestern United States, managers are forced to find the best ways to utilize water, which includes relying on ET values. Without ET data, golf course managers risk wasting hundreds of thousands of dollars in water. If you are unsure if ET can help, rest assured knowing that it works for those who need irrigation solutions the most.

Identify high-risk areas.

Identify and document areas with a high risk of runoff into local water bodies.

WHY?

- Areas with poor soils, significant slopes, or drainage may carry harmful chemicals (fertilizers and pesticides) into local water bodies.
- Identifying and mapping these areas increases awareness for the maintenance team that these are environmentally sensitive areas that require close monitoring when fertilizer or pesticide applications are made.
- These areas might require site-specific management in the form of alternative fertilizers or “no-spray” zones.
- Documenting these areas is beneficial should club ownership or regulatory bodies have questions about landscape-management practices.

HOW?

1. The best time to identify high-risk runoff areas is immediately after a large rainstorm.
2. Walk the property and document what you see through pictures or on a property map where there is standing water, eroded banks, and significant drainage swales.
3. After documentation, create a written plan addressing pollution-prevention practices for high-risk areas.

NUTRIENT MANAGEMENT

Why it matters:

- Applying too much fertilizer—or mis-applying it—poses a serious risk to the water quality of your course and community.
- Regulation of fertilizer use is likely to increase.
- Fertilizer costs are increasing dramatically.

By the numbers:

54% Adoption rate of nutrient management BMPs among New York State golf courses*

61% Drop in phosphate use on golf courses in northeastern U.S. states†

49% Drop in potash use on golf courses in northeastern U.S. states†

31% Drop in nitrogen use on golf courses in northeastern U.S. states†

"Cutting down on fertilizer will make my grass weaker."

Consider this:

» Simple measures—like the BMPs listed below—can help you reduce fertilizer use while improving playing conditions, saving money, and protecting your course's water quality.

» The health and environmental risks associated with fertilizer use can be easily managed through simple planning and forward-thinking—all without deteriorating turf quality.

Be precise, measure twice.

Calibrate and ensure proper function of spreaders and sprayers.

PAR

WHY?

- Calibrating equipment ensures that field application rates match what is intended.
- Applying a higher rate than desired may result in turf injury while a lower rate could result in undernutrition or ineffective pest control, leading to wasted time and money.
- It is essential to properly calibrate application equipment at least twice per year.

HOW?

1. Use an in-depth resource (such as those below) to help you calibrate a boom sprayer.
   - **Sprayer Calibration for Turfgrass**
   - **Calibrating Boom Sprayers for Turf Applications**
2. Use an in-depth resource (such as those below) to help you calibrate fertilizer spreaders.
   - **Calibrating Your Fertilizer Spreader**
   - **Rotary Spreader Calibration Procedures**

Photo: Dr. Erdal Ozkan, Ohio State University

Know your nutrient needs.

Use soil tests and Minimum Levels of Sustainable Nutrition Guidelines (MLSN) to guide fertilizer applications.

WHY?

- Soil can be tested to assess nutrient concentrations, important information that can guide fertilizer applications.
- Soil-test data can be interpreted using a variety of methods, the most applicable being the MLSN guidelines.
- MLSN was developed for turfgrass and typically recommends using far less fertilizer than other methods to produce high-quality turf. This saves you time and money while limiting potential environmental impacts.

HOW?

1. Take soil samples from a variety of greens and send them to a laboratory for analysis.
   - **Brookside Soil Laboratory**
   - **"Learn how to soil test" (YouTube video)**
2. Once results are received, use the **MLSN Guidelines** to interpret them.
3. If nutrient concentrations in your samples are higher than the MLSN level, no fertilizer is necessary at that time. In the event your soils are lower than MLSN guidelines, fertilizer amounts can be calculated through the process outlined in the **MLSN Cheat Sheet**.
4. Regularly fertilized surfaces, such as putting greens, can be tested annually while less frequently fertilized surfaces can be tested once every three years.

PRO TIP

Keep it simple.

The MLSN Guidelines are the starting point when interpreting soil tests. They are the simplest method available, backed by the most data, and proven to work in the field. Simple, easy, and effective.

	MLSN Soil Guidelines	*Previous Guidelines*
pH	>5.5	*6-7.5*
Potassium (K ppm)	>37	*>110*
Phosphorus (P ppm)	>21	*>50*
Calcium (Ca ppm)	>331	*>750*
Magnesium (Mg ppm)	>47	*>140*
Sulfur as sulfate (S ppm)	>7	*15-40*

MLSN guidelines developed by Pace Turf

Don’t apply late.

Avoid applying nitrogen late in the fall.

PAR

WHY?

- Applying nitrogen in the fall is still important to sustain regular root growth and spring green-up, but should not be done once average daily temperatures drop below 50°F (degrees Fahrenheit) when turf growth slows down.
- If fertilizer is applied at these times, very little nitrogen applied will enter the plant, leaving most of it to leach or run off into the environment.
- High-rate nitrogen applications later in the fall may waste time and money, providing little added benefit in rooting or spring green-up.
- New York State laws prohibit fertilizer applications after December 1, but local regulations may include further restrictions.

HOW?

1. Don’t apply nitrogen late in the fall once the average daily temperature drops below 50°F.

If soil's wet, leave it alone.

Consider soil moisture status when applying fertilizer.

PAR

WHY?

» Applying fertilizer when soil is saturated may lead to runoff or excessive leaching, resulting in lower uptake by the plants, as well as pollution to surface and ground water (not to mention wasted money).

HOW?

1. Don't apply fertilizer when the soils are saturated.

PRO TIP

Don't get stuck in the mud!

If you are concerned that driving a sprayer on the course would damage the soil, then the likelihood of runoff is increased.

Don’t lose track.

Keep records of all fertilizer applications.

PAR

WHY?

- Fertilizer records make it easy to compare fertilizer use over time, which is valuable data that can be used to make science-based recommendations.
- Fertilizer records can be combined with scouting reports to provide deeper insight into an application’s effect on turf conditions.
- Detailed records are crucial when communicating with course decision-makers or regulators as it displays organization, preparedness, and responsibility.

HOW?

1. Write fertilizer information down on paper or record it digitally on a computer using a program like Microsoft Excel. (Electronic records are preferred over written because they are more easily shared and analyzed.)
2. To get started, use one of the following online templates or software programs:
   - **Nutrient Management Plan**
   - **Playbooks for Golf**
   - **GreenKeeper App**

Let them be.

Avoid fertilizing large rough areas.

PAR

WHY?

- Fertilizer applications to a large area like a golf course's rough may have a greater potential environmental impact, particularly in sensitive areas with surface water nearby.
- Rough areas require low fertilizer amounts because they are grown on native soils and mowed in a way that returns nutrient-rich clippings, which offsets fertilizer needs.
- Rough is kept at higher mowing heights while receiving low amounts of traffic, which reduces stress and the need for routine fertilizer applications.
- Each of these factors should be carefully considered along with potential environmental risk before applying fertilizer to rough areas.

HOW?

1. Identify areas of rough that are thinning due to excess traffic, poor growing conditions, or of high value (e.g., clubhouse grounds) and fertilize only these areas.

Target traffic.

Adjust fertilizer application rates based on traffic.

BIRDIE

WHY?

- The more traffic that occurs on turf, the slower the growth rate will be. Examples of high-traffic areas are fairway landing areas and “walk-on/walk-off” areas around greens and approaches. Low-traffic areas, like parts of the fairway where golfers rarely hit to, require less fertilizer to reduce organic matter buildup and unnecessary growth.
- To account for non-uniform traffic rates across the golf course, fertilizer rates must be adjusted accordingly to achieve uniform density.

HOW?

1. Track traffic patterns across the golf course to identify high and low traffic areas.
2. Deploy slightly higher nitrogen-fertilizer rates to areas where traffic is more intense, and lower rates where traffic is sparse.

Go by growth.

Use growth rate to guide nitrogen-fertilizer applications.

BIRDIE

WHY?

- Nitrogen is required when the turf growth rate is too slow to sustain density under wear and tear.
- A schedule-based fertilizer program does not consider growth rates and may lead to turf that is growing too much or too little.
- Monitoring growth rate can help you to determine precisely when fertilizer is necessary based on routine visual observation of wear and expected stress. While not exact, these observations provide an indication of growth and can be calibrated along with turf performance to define optimum growth levels.

HOW?

1. Collect daily observations of growth by asking your mower operator to record how many times they empty the buckets while mowing putting greens, or how much grass built up during fairway- or tee-mowing.
2. See a more effective, though more involved, method for measuring turf growth rate using mowing clippings to schedule nitrogen-fertilizer use on the following page (BMP: “Measure—don’t guess.”).

Measure—don't guess.

Track clipping volume to schedule use of nitrogen fertilizer.

EAGLE

WHY?

- Nitrogen is required when the turf growth rate is too slow to sustain density under wear and tear.
- A schedule-based fertilizer program does not consider growth rates and may lead to turf that is growing too much or too little.
- Monitoring growth rate through clipping volume collection can help you to determine precisely when fertilizer is necessary. These measurements can be calibrated to turf performance to define optimal growth levels.

HOW?

1. Collect clippings in a measuring bucket, then divide the clipping volume by the area of the green to calculate a growth per unit area. This can be done on several greens to compare growth across the course.
2. Clipping volume numbers can be tracked over time to observe trends in turf performance. It is common to find that a specific range of clipping volume produces ideal playing conditions.
3. Management can then be adjusted through fertilizer, plant-growth regulators, or cultural practices to keep clipping volume within this optimal range.
4. The following resources offer more information on this method:
   - **Battle Island Case Study**
   - **One Bucket at a Time**

Photo credit: Micah Woods – Asian Turfgrass Center

Write it out.

Have a documented nutrient-management plan.

WHY?

- Documenting the use of nutrients and pesticides that have potential to cause pollution is a basic tenet of environmental stewardship.
- A nutrient-management plan demonstrates to decision-makers that you are aware of what is required to keep the golf course running smoothly.
- Documentation displays a level of preparedness that ownership and the public responds to favorably when resource requirements and associated costs are being discussed.

HOW?

1. Use the worksheet below to build a nutrient-management plan for your course. It includes a series of questions that will walk you through everything you need to create a nutrient management plan.
   - **Drought and Nutrient Management Plan Worksheet**

PESTS

Why it matters

- Most U.S. courses rely on conventional pesticides, which can be considered hazardous because of the chemicals they contain.
- Pesticides may pose a health risk to your team and can alter the natural environment.

By the numbers

47% Adoption rate of BMPs for pest management among New York golf courses*

66% Increase in reliance on cultural practices to control pests by United States Golf Courses†

"If I don't have a preventative pesticide program, pests will ruin the turf and even threaten my job security."

Consider this:

» Excessive pesticide use can lead to pesticide resistance, which can cause more harm than good.

» Non-pesticide practices can deliver strong results and lead to decreases in conventional pesticide use.

Welcome to the buffer zone.

Maintain 25-foot, chemical-free buffer zones around water bodies.

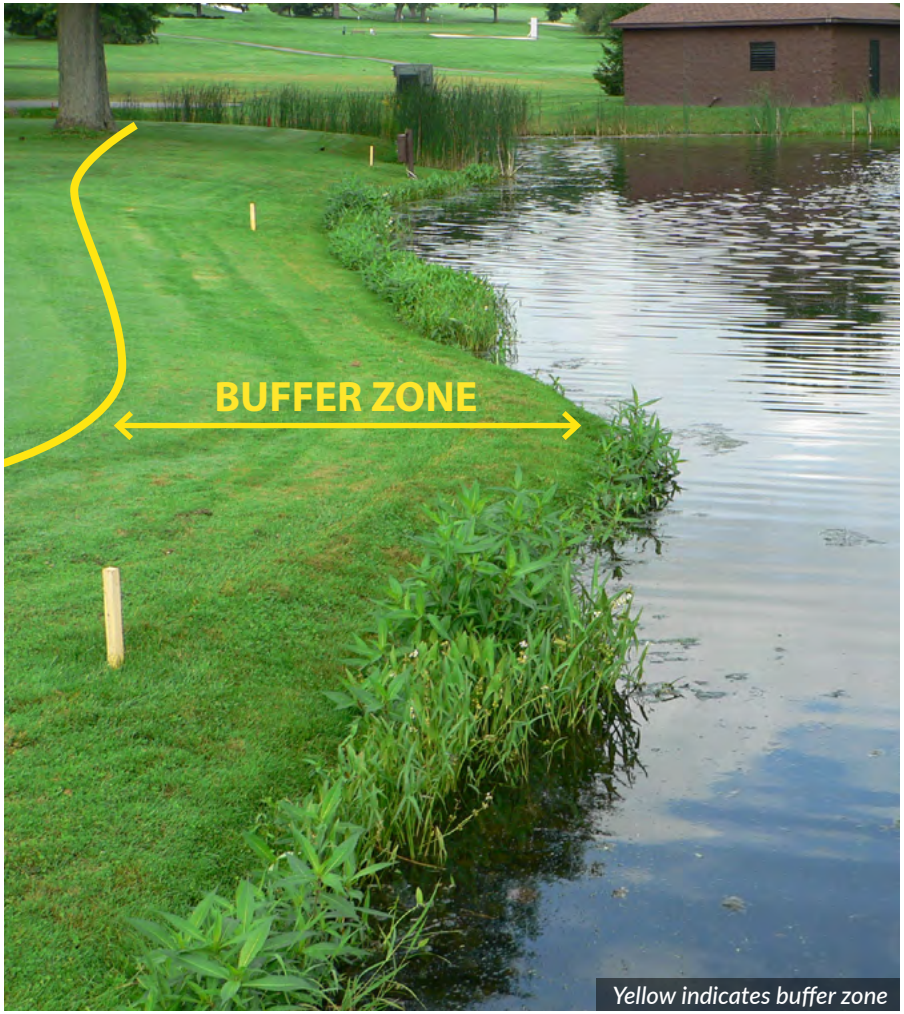
PAR

WHY?

- Pesticide applications made near surface waterbodies are susceptible to runoff.
- A chemical-free buffer of at least 25 feet or more from the water's edge should be maintained to limit the risk of water-quality impairment.

HOW?

1. Line out borders of the buffer zone around water bodies and keep chemical products off that area.
2. Always read the label—sometimes a pesticide's label requires a larger buffer.



Yellow indicates buffer zone

Spot treat for pests.

Only apply pesticides to areas that need it.

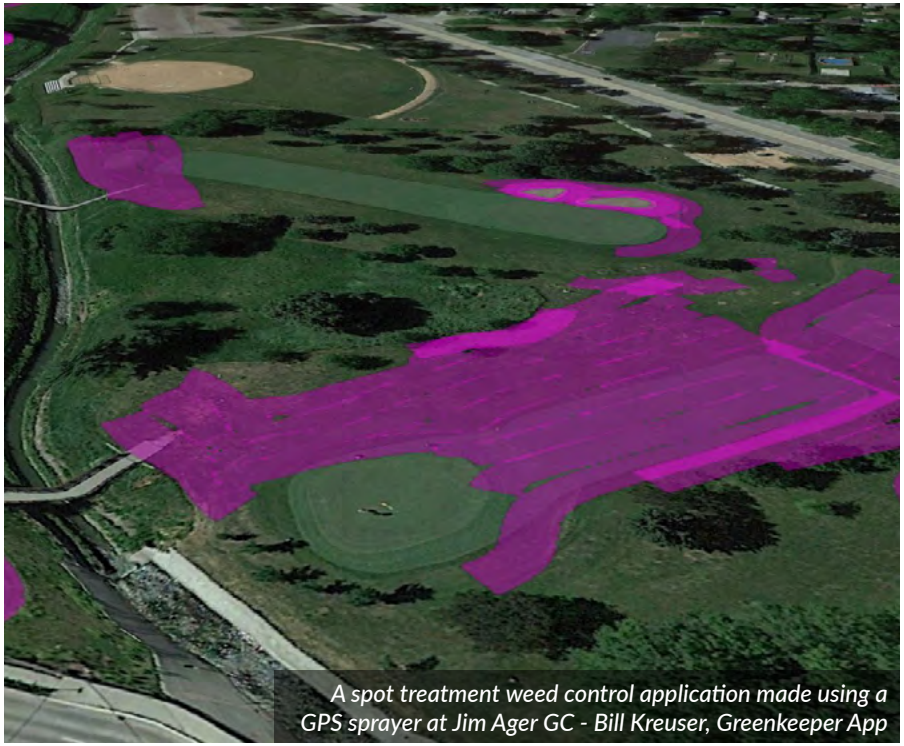
PAR

WHY?

- Large areas of the golf course like fairways and roughs can consume significant resources to treat regularly for pests, but it is common that only portions of these surfaces require pesticide treatment.
- Using a spot treatment approach in lieu of blanket applications will reduce product use, save you money, and reduce the risk of pesticide resistance.

HOW?

1. Regularly scout the course to find and record weak areas so they can be prioritized for treatment.
2. Intervene with pesticides on the areas of highest risk first, monitor weather conditions, and scout other areas for potential spread.
3. Designate “no spray areas” or establish “check plots” around the course to compare pest pressure with and without pesticide before implementing spot treatment across larger areas of the course.



A spot treatment weed control application made using a GPS sprayer at Jim Ager GC - Bill Kreuser, Greenkeeper App

PRO TIP

How to make sure spot-treating won’t put the rest of your course at risk.

Any potential risks associated with spot-treating can be lessened by scouting, weather-monitoring, and tracking pest models. Remember, there are risks to applying blanket applications, as well: wasted resources (time and money), environmental damage, and pests becoming resistant to treatment. Risks are part of any decision—what matters most are the strategies you have in place to mitigate them.

Don’t go when pressure is low.

Avoid preventative applications when pest pressure and stress are low.

WHY?

- During times of low pest pressure (spring and fall), applying pesticides preventatively may be unnecessary.
- Limiting pesticide applications during these times can save you time and money, and may help to increase turf resiliency by exposing it to minor levels of stress.

HOW?

1. Wait until environmental stress warrants pesticide applications.
2. Use indicator areas to appropriately time pesticide applications.

PRO TIP

Look before you leap.

Monitor indicator areas on the course that are the first to have pest damage—if they are not showing problems, you are in the clear!

Scout it out.

Routinely scout the golf course and record observations.

BIRDIE

WHY?

- Scouting—or any dedicated time a superintendent spends observing the golf course—is crucial to identifying short- and long-term pest incidence and severity.
- Documenting observations and trends through written notes and pictures should be done so that they can be referenced later when your memory is less clear.

HOW?

1. Prioritize areas of greatest importance and note the injury associated with any pest.
2. Be sure to properly identify the pest to choose the most appropriate control method—use online resources or submit samples to a diagnostic lab.
   - **Cornell Turfgrass Weed ID**
   - **Cornell Grub ID**
3. Record the date, symptoms, location, and the suspected pest along with pictures to contextualize your observations.

PRO TIP

Your memory might be good, but it's not perfect.

Written documentation is a lot more reliable than our memory. Recording observations ensures an accurate portrayal of events which can be referenced later for perspective by any member of the staff.

Upgrade to Buffer Zone 2.0.

Maintain longer vegetation around bodies of surface water.

WHY?

- Longer vegetation acts like a filter on runoff water and aids in the prevention of fertilizer and pesticides from entering water bodies.
- Longer vegetation's deeper root system will also serve to stabilize banks and prevent erosion, further protecting water quality.

HOW?

1. Let vegetation grow up to at least six inches in height around water bodies.
2. Create a buffer width of at least 15 feet to achieve benefits—larger widths provide increasing levels of water quality protection.
3. Communicate what you do and why to the membership, as aesthetics and playability of these areas may change.

Predict the risk.

Use weather data and pest-pressure models to guide pesticide applications.

EAGLE

WHY?

- Environmental conditions dictate when and where pests present themselves over the growing season, making traditional, schedule-based approaches sub-optimal when trying to control pests.
- A risk-based approach uses models to ensure that pesticide applications are necessary and therefore worth the time, effort, and money to apply.

HOW?

1. Compare your scouting observations to available pest-pressure models for your area.
2. If, for example, you notice dollar spot on the course, compare it with the number on the Smith Kerns dollar spot model (see link below) to set the model threshold for your property. Superintendents find it helpful to monitor indicator areas—areas that display pest symptoms earlier than others—to establish such thresholds.
   - **Smith-Kerns Dollar Spot Model**
   - **Cornell ForeCast Model**
3. Once thresholds are established, you can begin forecasting pest pressure to time pesticide applications only when necessary.

Instill a spill drill.

Make sure your employees know what to do when spills happen.

WHY?

» A short document hung in the mixing station or attached to a sprayer that can be quickly referenced by an applicator ensures proper procedure is followed.

HOW?

1. Download our spill-control procedure at the link below and post it at your maintenance facility.

   » **Spill Control Checklist**

Photo: Sam Polly, Pesticide Safety Education Program; University of Missouri Extension

Photo: Pesticide Safety Education Program; Ohio State University Extension

POLLUTION

Why it matters

- The risk of pollution from golf course activities is greatest at your maintenance facility, such as the washing area for mowing equipment.
- Water for washing often contains pollutants like fertilizer, pesticides, and organic matter.

By the numbers

2,000 gallons Amount of water for washing equipment a single course can use in just one day

45% Adoption rate of BMPs for pollution prevention practices among New York golf courses

"If golfers can't see it, then it's not a priority. "

Consider this:

» Concentrated use of fuels, lubricants, and detergents as well as storage and handling of nutrients and pesticides around golf course maintenance areas can present significant risks to the environment if handled improperly.

Blow it off.

Remove clippings from equipment using pressurized air.

PAR

WHY?

» Blowing clippings off of equipment prior to washing cuts water use by half, extends equipment lifetime, and reduces foul odors caused by wet clipping piles.

HOW?

1. Set up an air-compressor station where staff can blow off debris prior to washing. Alternatively, have staff use a backpack blower to remove clippings in a designated area.

Low flow is the way to go.

Use a low-flow nozzle for washing equipment.

PAR

WHY?

- Using a low-flow hose nozzle can reduce water use up to 50% during equipment washing.
- Standard brass nozzles (Dramm nozzles are well-reviewed) are a cheap, low-flow option that have sufficient pressure for equipment washing.

HOW?

1. Switch out your existing nozzles for a low-flow nozzle.

Brass nozzles like these are cheap, and reduce water use

Plug floor drains.

Prevent oils and chemicals from getting into the environment.

PAR

WHY?

- Many maintenance buildings have built-in floor drains that send waste fluids into the environment outside.
- Even if these drains connect to a sewer or septic system, they are rarely suitable for discarding waste fluids of any kind.
- Whether these drains are in equipment-servicing areas or not, accidental spills can end up sending pollutants into the surrounding environment.

HOW?

1. Cover or permanently seal any drains that are not officially permitted to be used to discharge fluids like wash water.
2. Consider installing an underground holding tank so that spills can be contained and properly disposed of.

Control your clippings.

Collect and properly dispose of clippings from the wash pad.

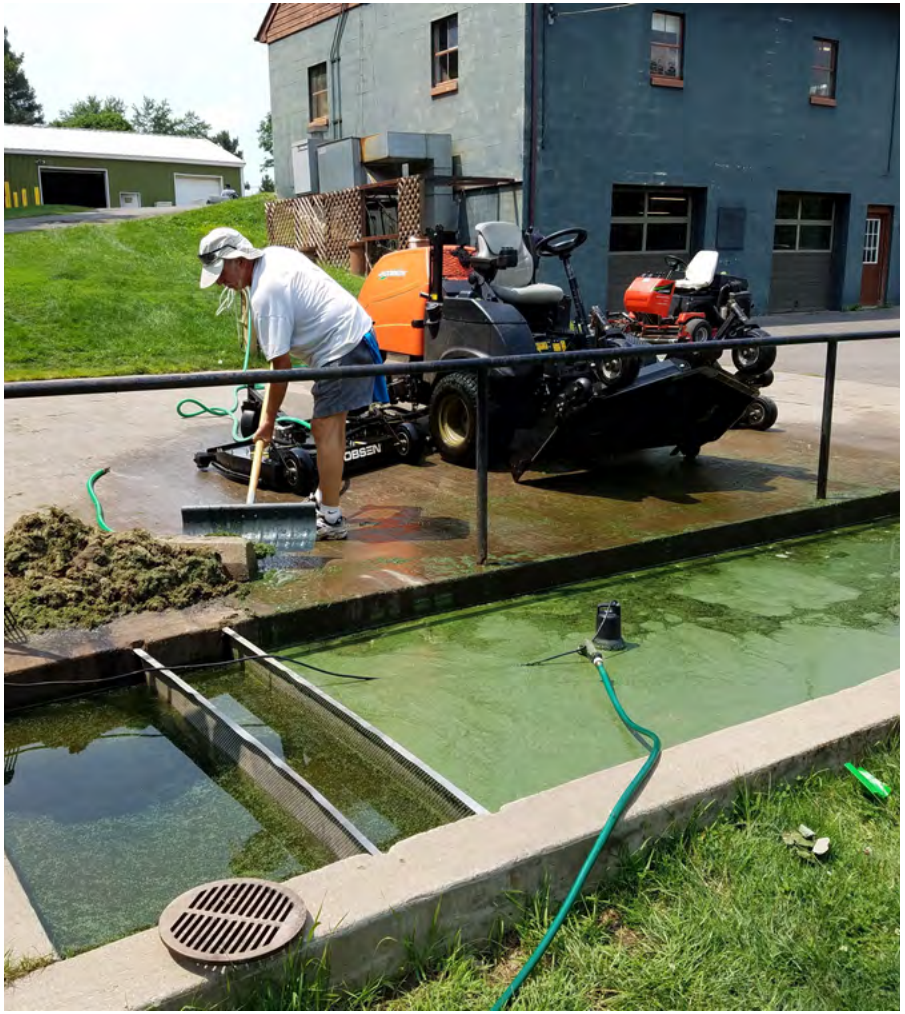
BIRDIE

WHY?

- Grass clippings contain nutrients that plants extract from the soil, particularly nitrogen and phosphorous, which are known to affect the environment and impair water quality.
- Grass clippings should be treated like fertilizer, which requires proper disposal.

HOW?

1. Create a contained compost pile where clippings can be mixed with other organic materials.
2. Grass clippings can be mixed with other brown material (e.g., leaves, chipped tree limbs, etc.) to compost. If this isn't feasible, simply redistribute clippings to areas of the property away from bodies of water.



Know the flow.

Install a flow meter on the hose for the wash pad.

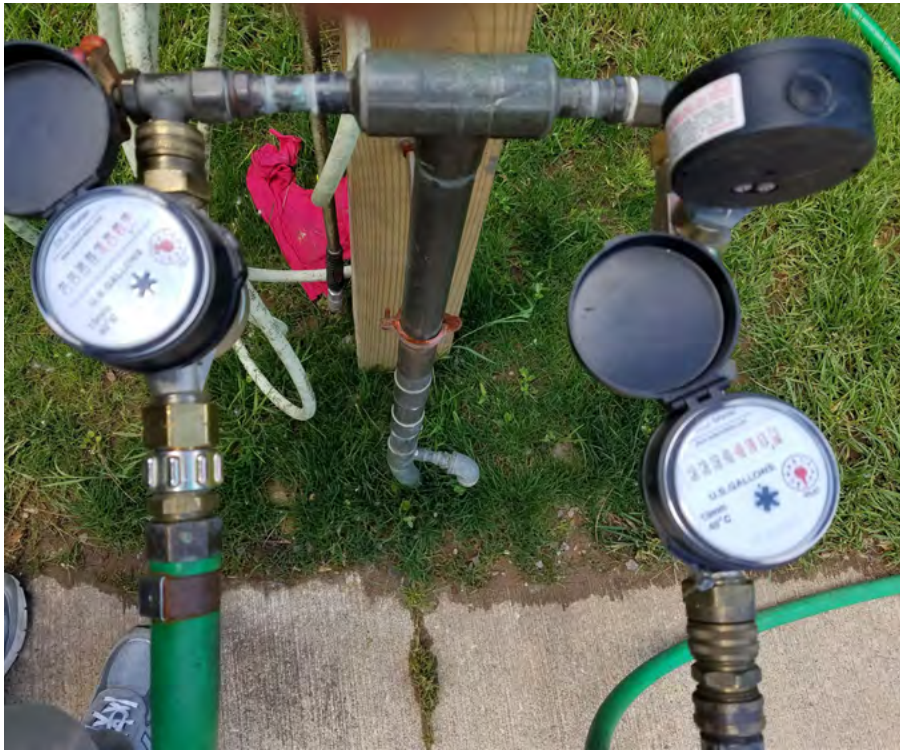
BIRDIE

WHY?

- Golf operations can use more than 2,000 gallons of water a day washing equipment.
- Quantifying how much water you are using is valuable information if you are paying for it. Plus, it's information that you can use to calculate potential savings through reduction practices.
- If you are interested in a recycled water system, knowing daily water use is crucial to sizing that system.

HOW?

1. Install flow meters onto your existing spigots. Many types are available online for less than $40.



PRO TIP

Free, endless water might not last forever.

There is never a guarantee that water will be free or accessible without limits, especially as climate change places more stress on water resources. Paying attention to water use now will help you if water becomes billable or restricted in the future.

Reduce. Reuse. Recycle.

Recycle wash-pad water.

EAGLE

WHY?

» Recycling wash-pad water dramatically reduces the total amount of water used to wash equipment, and offers an opportunity to filter out organic material and trace amounts of oils, nutrients, and pesticide chemicals that could make their way into local water bodies.

HOW?

1. Pre-fabricated wash-water recycling units are available from companies such as Carbtrol, ClearWater, and Waste2Water.
2. Consider installing a low-cost recycling wash-water system that was developed by NYSP2I and a number of New York golf courses. The system was able to reduce water use by 90% and cost much less than commercially available units (which are typically $40–100K). To learn more about this wash system, watch our latest webinar discussing these systems:

   » **Golf course pollution prevention BMPs webinar**

Long grass means less gas.

Let Nature take care of out-of-play rough areas.

EAGLE

WHY?

- Less mowing means less greenhouse gas emissions going into the atmosphere.
- Natural rough areas can bring new visual interest to golfers while providing an opportunity for more diverse vegetation to flourish.

HOW?

1. Outline areas of the course that receive little traffic in the spring before mowing begins.
2. Allow these areas to grow tall into the summer and mow only once in the early fall of the first year. If turf composition is desirable, one mowing a year may suffice to maintain visual quality.
3. For courses looking for "playable" long grass, additional mowings may be required.
4. Based on turf species, soil type, and weed pressure, pesticide applications or manual labor may be required to remove problematic weeds.

PRO TIP

How to sell membership on long-grass roughs.

There may be resistance to longer vegetation on the course because of concerns over aesthetics or that it will disrupt play. In such cases, be sure to communicate the resource and cost efficiency of the long-grass method in addition to its environmental benefits. Tightly mown areas around water bodies require dedicated labor to trim and edge, which can be re-allocated to other tasks if longer vegetation is allowed to grow. Consider showing members how long grass will look like by staging it in select out-of-play areas first—this will demonstrate both its natural appeal and logistical value.

How (and why) this handbook was made

Green Lakes State Park during sunrise

The best management practices (BMPs) included in this workbook were developed jointly by Cornell University's Turfgrass Science program in the College of Agriculture and Life Sciences (Cornell CALS) and the New York State Pollution Prevention Institute (NYSP2I) at Rochester Institute of Technology (RIT) following a 2020 survey of randomly selected New York State golf courses (more details about the survey are below).

While conducting the survey, Cornell CALS and NYSP2I researchers learned that many superintendents lacked access to science-based maintenance practices for golf turfgrass. BMPs were not widely known; barriers to adoption included labor and monetary restrictions, as well as golfer hesitancy towards the potential changes that BMPs might bring. Any effort to improve BMP adoption must recognize and address these common barriers.

Survey data used in the handbook

All statistics used in this handbook about golf courses in the northeastern United States were discovered through the two surveys described below. Relevant handbook pages where they are each referenced are also noted.

NYSP2I & Cornell CALS Survey (2020)

Cornell CALS and NYSP2I conducted a survey in 2020 from a random selection of 42 golf courses in the western and central regions of New York State to determine adoption of BMPs. A series of 31 questions were developed as indicators of key environmentally sustainable practices at golf courses. The overall adoption rate of BMPs in this survey was 46 percent. This information indicates a significant opportunity for improvement in several specific areas such as water management, nutrient use, pest management, and pollution prevention.

Look for the * symbol on pages 7, 18, and 29.

National GCSAA Environmental Profile Survey (2006-present)

The GCSAA Environmental Profile is an on-going initiative to periodically survey members of the GCSAA regarding water, fertilizer, and pest management BMPs in the United States. This survey is distributed digitally to members of the GCSAA and is filled out on a voluntary basis. It is used to document changes in BMP adoption over time, and has shown that adoption rates have increased since the first survey in 2006.

Look for the † symbol on pages 7, 18, and 29, which show reduction rates between 2006 and 2022.

Other references

- Gelernter, W.D., Stowell, L.J., Johnson, M.E., Brown, C.D. and Beditz, J.F. (2015). Documenting Trends in Water Use and Conservation Practices on U.S. Golf Courses. Crop, Forage & Turfgrass Management, 1(1), 1-10. https://doi.org/10.2134/cftm2015.0149
- Gelernter, W.D., Stowell, L.J., Johnson, M.E. and Brown, C.D. (2016). Documenting Trends in Nutrient Use and Conservation Practices on US Golf Courses. Crop, Forage & Turfgrass Management, 2(1), 1-10. https://doi.org/10.2134/cftm2015.0225
- Ibid. (2016). Documenting Trends in Pest Management Practices on US Golf Courses. Crop, Forage & Turfgrass Management, 2(1), 1-9. https://doi.org/10.2134/cftm2016.04.0032

Useful Resources

Boom-sprayer calibration resources:

- http://publications.tamu.edu/TURF_LANDSCAPE/PUB_turf_Sprayer%20Calibration%20for%20Turfgrass.pdf
- http://www2.ca.uky.edu/agcomm/pubs/AGR/AGR239/AGR239.pdf

Clipping-volume turf-growth measurement method:

- https://www.rit.edu/affiliate/nysp2i/sites/rit.edu.affiliate.nysp2i/files/docs/resources/NYSP2I_Battle_Island_Course_Uses_Data_Collection_to_Optimize_Management_Practices.pdf
- https://micahwoods.github.io/buckets/

Evapotranspiration (ET) measurement tools:

- NRCC: http://turf.eas.cornell.edu
- National Weather Service: https://www.weather.gov/abr/etforecasts
- Use of ET to make irrigation decisions: https://nysgolfbmp.cals.cornell.edu/4-irrigation/

Fertilizer-spreader calibration tool:

- https://extension.psu.edu/calibrating-your-fertilizer-spreader
- https://ag.umass.edu/turf/fact-sheets/rotary-spreader-calibration-procedures

Fertilizer application tracking tools:

- https://www.dcr.virginia.gov/soil-and-water/document/nmtmsc-example-golf-npm.pdf
- https://goplaybooks.com/
- https://www.greenkeeperapp.com/marketing/

Low-cost recycling wash-water system developed by NYSP2I:

- https://www.rit.edu/affiliate/nysp2i/sites/rit.edu.affiliate.nysp2i/files/docs/resources/Locust_Hill_Country_Club_Improves_Wastewater_Management.pdf
- https://youtu.be/L13Mc6tUDa0

Useful resources (continued)

Minimum Levels of Sustainable Nutrition Guidelines (MLSN):

- What is MLSN? https://www.paceturf.org/PTRI/Documents/1202_ref.pdf
- MLSN Cheat Sheet: http://files.asianturfgrass.com/mlsn_cheat_sheet_us.pdf
- How is it used? https://www.rit.edu/affiliate/nysp2i/sites/rit.edu.affiliate.nysp2i/files/docs/resources/Pearl_Lakes_Implements_Minimum_Levels_of_Sustainable_Nutrition_Guidelines_2.pdf
- How to soil sample: https://youtu.be/U-nCCxjomlE
- Soil Sampling Laboratories: Brookside Laboratories, Turf and Soil Diagnostics https://www.blinc.com/

Nutrient-management plan worksheet:

- https://www.rit.edu/affiliate/nysp2i/sites/rit.edu.affiliate.nysp2i/files/docs/resources/Drought%20and%20Nutrient%20Management%20Plan%20Worksheet.pdf

Pest Management:

- Smith-Kerns Dollar Spot Model: https://www.greencastonline.com/dollar-spot-solutions
- NRCC: http://turf.eas.cornell.edu
- Cornell Pest Management Resources: https://turf.cals.cornell.edu/pests-and-weeds/

Soil-moisture meter resources:

- https://www.gcmonline.com/course/environment/news/moisture-meters-golf

Soil-sampling laboratories:

- https://www.blinc.com/
- http://www.turfdiag.com/

Soil-sample procedure:

- https://youtu.be/U-nCCxjomlE

Spill-control procedure:

- https://www.rit.edu/affiliate/nysp2i/sites/rit.edu.affiliate.nysp2i/files/docs/resources/Spill-Control-Procedure.pdf

About the New York State Pollution Prevention Institute (NYSP2I)

The New York State Pollution Prevention Institute (NYSP2I) is led by the Golisano Institute for Sustainability at Rochester Institute of Technology (RIT) and is a partnership between RIT, Clarkson University, Rensselaer Polytechnic Institute, SUNY Binghamton, Cornell University, and the New York State Manufacturing Extension Partnership.

NYSP2I is a trusted resource for organizations across the state seeking cost-effective strategies for realizing new levels of efficiency and minimizing their impacts on the environment. Its team of engineers and researchers collaborate with decision-makers—small-business owners, manufacturers, community leaders, and municipalities—working to make New York State a national model for sustainability, waste reduction, and pollution prevention.

For more information, visit: **nysp2i.rit.edu**

About Cornell University's College of Agriculture and Life Sciences (Cornell CALS)

Cornell CALS is a premier institution of scientific learning, tackling the complex challenges of our time through purpose-driven science that advances understanding and improves life. As part of New York's land grant university, Cornell CALS connects the life, agricultural, environmental, and social sciences to provide world-class education, spark unexpected discoveries, and inspire pioneering solutions.

Cornell CALS actively pursues its mission to serve the public through its effort in education (more than 3,000 undergraduate and 1000 graduate students), research (350 faculty and more than $200 million in research expenditures), and extension/outreach. Putting knowledge and research to work for local, national, and global communities has always been a primary purpose of the college.

For more information, visit: **cals.cornell.edu**

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How does your score stack up?

Less than 10 = Beginner
The best way to improve is to make more pars. Nothing fancy, focus on basics.

10–15 = Intermediate
You're making a lot of pars, but now its time to sink some putts and make a few birdies.

15–20 = Advanced
You're ready for prime time. Get aggressive and try to make some eagles!

Scoring system: 1 point for each BMP adopted	Section	Level	Adopted
Visually check all sprinklers during start-up.		Par	☐
Perform preventative maintenance on sprinklers before malfunctions occur.		Par	☐
Allow some moisture stress before irrigating.		Par	☐
Eliminate irrigation of large rough areas and out-of-play areas.		Par	☐
Use a soil moisture meter.		Birdie	☐
Incorporate new turfgrass varieties to reduce water and chemical use.		Birdie	☐
Track water usage.		Birdie	☐
Develop a drought emergency plan.		Eagle	☐
Monitor evapotranspiration values to help determine watering needs.		Eagle	☐
Identify and document areas with a high risk of runoff into local water bodies.		Eagle	☐
Calibrate and ensure proper function of spreaders and sprayers.		Par	☐
Use soil tests and Minimum Levels of Sustainable Nutrition Guidelines to guide fertilizer applications.		Par	☐
Avoid applying nitrogen late in the fall.		Par	☐
Consider soil moisture status when applying fertilizer.		Par	☐
Keep records of all fertilizer applications.		Par	☐
Avoid fertilizing large rough areas.		Par	☐

	Section	Level	Adopted
Adjust fertilizer application rates based on traffic.		Birdie	☐
Use growth rate to guide nitrogen-fertilizer applications.		Birdie	☐
Track clipping volume to schedule use of nitrogen fertilizer.		Eagle	☐
Have a documented nutrient-management plan.		Eagle	☐
Maintain 25-foot, chemical-free buffer zones around water bodies.		Par	☐
Only apply pesticides to areas that need it.		Par	☐
Avoid preventative applications when pest pressure and stress are low.		Par	☐
Routinely scout the golf course and record observations.		Birdie	☐
Maintain longer vegetation around bodies of surface water.		Birdie	☐
Use weather data and pest-pressure models to guide pesticide applications.		Eagle	☐
Make sure your employees know what to do when spills happen.		Eagle	☐
Remove clippings from equipment using pressurized air.		Par	☐
Use a low-flow nozzle for washing equipment.		Par	☐
Prevent oils and chemicals from getting into the environment.		Par	☐
Collect and properly dispose of clippings from the wash pad.		Birdie	☐
Install a flow meter on the hose for the wash pad.		Birdie	☐
Recycle wash-pad water.		Eagle	☐
Let nature take care of out-of-play rough areas.		Eagle	☐
		Your Score:	0

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