



**New York State  
Golf Course Best Management Practices - Draft Final  
Revised May 2019**

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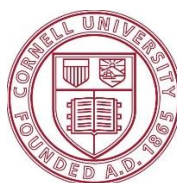
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## Acknowledgements

The development of the *Best Management Practices for New York State Golf Courses* was made possible by golf course superintendents on the New York Golf Course Foundation's Board of Directors and scientists at Cornell University. Representatives from each provided their time and expertise to develop and review drafts of best management practices specifically for New York State designed to protect the state's natural resources. Expert scientific review was provided by Cornell University scientists Dr. Frank Rossi and Dr. Kyle Wickings.



Cornell University

Funding and support for this project was provided by the Turf Environmental Stewardship Fund (TESF) administered by the New York State Turf Association (NYSTA). Additional material used to create this template was provided by Golf Course Superintendents Association of America (GCSAA), with funding provided by the Environmental Institute for Golf (EIFG) and the United States Golf Association (USGA).

### **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 those 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**

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**

USGA provides governance for the game of golf, conducts the U.S. Open, U.S. Women's Open, U.S. Senior Open, 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.



# 1 INTRODUCTION

2 The New York State Best Management Practices (NYS BMP) project is an innovative research  
3 and outreach education program that has resulted from a partnership of superintendent leaders in  
4 the state and Cornell University. Begun in 2012, this project has codified standards and continues  
5 to actively demonstrate the implementation of best management practices for the protection of  
6 water quality in the state of New York. The success of this work has led to the commitment of  
7 superintendents to continue these efforts in perpetuity as part of a sustainable 501(c)(3) non-  
8 profit, the New York Golf Course Foundation (NYGCF).

9 As the stewards of golf courses in NY, superintendents are dedicated to protecting New York's  
10 natural resources and embrace the responsibility to maintain these facilities in harmony with the  
11 natural environment. These BMPs are helping those in the golf industry work in concert with  
12 policymakers and regulators in a shared commitment to water quality protection. The BMPs  
13 integrate the latest research on New York's climate and environment.

14 The research-based, voluntary BMP guidelines are designed to protect and preserve New York's  
15 water resources that enhance open space using current advances in golf turf management. This  
16 effort to provide extensive guidance for environmental stewardship is being conducted in the  
17 best traditions of golf, as defined by golf's inherent values: honesty, integrity, and fair play  
18 (including upholding the rules when no one is watching). These are core values of golf turf  
19 professionals and serve as the basis for this innovative environmental effort.

20 Golf courses, particularly in New York's urban areas, represent some of the largest areas of open  
21 space in metropolitan communities. Large expanses of grass allow water to infiltrate into the  
22 ground naturally instead of flowing into storm sewers or streams and rivers. Golf courses also  
23 provide additional environmental benefits to the public, such as providing habitat, recreational  
24 opportunities, and economic benefits.

25 Since the time of publication of [\*Best Management Practices for New York State Golf Courses\*](#) in  
26 2014, the [Golf Course Superintendents Association of America](#) (GCSAA) has begun a  
27 nationwide effort to complete golf course BMPs nationwide. As part of this effort, GCSAA is  
28 making available state BMPs through their BMP portal for superintendents in each state to use to  
29 create their own facility-specific BMP. This version of New York's golf course BMPs serves as  
30 that template and includes additional information beyond the 2014 publication, including  
31 information on protecting pollinators on golf courses.

## 32 1.1 Best Management Practices

33 BMPs are methods or techniques found to be the most effective and practical means of achieving  
34 an objective, such as preventing water quality impacts or reducing pesticide usage. Research  
35 indicates that successful implementation of BMPs virtually eliminates the golf course risk to  
36 water quality. In fact, several studies have shown that implementing BMPs enhances water  
37 quality on its journey on and through the golf course property. Besides contributing to natural



1 resources stewardship, additional incentives for golf courses in New York State to create a  
2 facility BMP plan and implement BMPs include the following:

- 3 • potential for more efficiently allocating resources by identifying management zones
- 4 • cost savings associated with applying less fertilizer and pesticide
- 5 • cost savings associated with more efficient irrigation and other water conservation efforts
- 6 • improved community relations
- 7 • recognition by club members and the community at large of golf courses as  
8 environmental stewards

9  
10 Through a cooperative approach between the golf industry and friends and neighbors outside the  
11 industry, practices have been developed that benefit all parties. Because of limitations, such as  
12 budget, staff, clientele expectations, and management decisions, not all golf courses can achieve  
13 all of the best practices. However, planning for improvements over time and making small  
14 changes that meet the goals of BMPs can be achieved. For example, while a sophisticated  
15 washwater recycling system may be too expensive for many facilities, blowing clippings off  
16 mowers onto a grassed surface is easily achieved and markedly reduces the amount of nitrogen  
17 and phosphorus in clippings that end up in washwater. With a bit more of a budget, facilities can  
18 utilize the information from the [NYS BMP case study on a prototype low-cost wash operation](#)  
19 that protects water quality at Locust Hill Golf Club in Rochester. Additional case studies of  
20 BMPs implemented on golf courses in the state can be found in the [Case Studies](#) section of the  
21 NYS BMP website.

## 22 1.2 Environmental Concepts

23 The following environmental concepts provide the basis for understanding the role of BMPs in  
24 water quality protection:

- 25
- 26 • climate and microclimates
- 27 • water, including the hydrologic cycle and watersheds
- 28 • soils, including soil texture and moisture
- 29 • geology, including karst topography

30  
31 Water, soils, and geology all play a role in environmental fate and transport mechanisms (such as  
32 runoff and leaching) that can contribute to water quality. BMPs act on these fate and transport  
33 mechanisms to prevent water quality contamination. These basics are covered in detail in  
34 Chapter 2 of [Best Management Practices for New York State Golf Courses](#).

### 35 36 1.2.1 Climate Change

37 Projections of a changing climate suggest that rainfall will become less frequent, but more  
38 intense. As a result, a greater volume of the precipitation is expected to run off instead of  
39 infiltrating into the soil and replenishing groundwater. Consequently, the need for supplemental  
40 irrigation may increase, and superintendents will need to take greater care in the applying

1 fertilizer and pesticides to reduce the risk of runoff. Structural BMPs are valuable in managing  
2 increased runoff. For more information on available climate data for New York, see the  
3 [Northeast Regional Climate Center](#).

### 4 5 **1.2.2 Environmental Fate and Transport Mechanisms**

6 Understanding contaminant fate and transport mechanisms helps superintendents to  
7 minimize the risk of off-site movement of nutrients and chemical pesticides applied to golf  
8 courses. The fate and transport mechanisms of concern to golf course managers are as follows:  
9

- 10 • **Runoff** is the movement of water across the turf and soil surface, typically following a  
11 storm event or heavy irrigation. The potential for runoff is greatest on steep slopes.  
12
- 13 • **Leaching** is the downward movement of water through the soil and potentially into  
14 groundwater. Several variables influence the probability and rate of leaching, such as soil  
15 type and structure, vegetation, chemical properties, rate of precipitation, and depth to  
16 groundwater. When deciding on the rate and timing of fertilizer and pesticide application,  
17 it is critical to assess soil moisture status and potential for high infiltration in order to  
18 minimize potential losses.  
19
- 20 • **Spray drift** is the movement of fine particles, or droplets, through the air while the  
21 pesticide is being applied. Droplet size and wind and weather conditions affect the  
22 potential for spray drift during pesticide applications.  
23
- 24 • **Vapor drift** is the movement of pesticide in the form of a gas or vapor during or after  
25 application. Pesticide formulation, wind and atmospheric conditions affect the potential  
26 for vapor drift during pesticide applications.  
27
- 28 • **Volatilization** occurs when pesticide surface residues change from a solid or liquid to a  
29 gas or vapor after a pesticide application. Once airborne, volatile pesticides can come into  
30 contact with applicators or move long distances off site.  
31
- 32 • **Spills** are the unintended releases of chemicals, such as fertilizers, pesticides, hazardous  
33 materials, or petroleum products released during transportation, storage, and routine  
34 maintenance and facility operations.  
35

36 While most of the fate and transport mechanisms of concern can contribute to nonpoint sources  
37 of pollution, spills can be a point source of pollution. The legal definition of "point source" is  
38 provided in 6 NYCRR Part 050-1.2(65) as follows:  
39

40 The term "point source" means any discernible, confined and discrete conveyance,  
41 including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete  
42 fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other

1 floating craft, or landfill leachate collection system from which pollutants are or may be  
2 discharged. This term does not include agricultural storm water discharges and return  
3 flows from irrigated agriculture.  
4

5 On golf courses, point sources of pollution can originate from:  
6

- 7 • storage and maintenance facilities
- 8 • the unintended release of chemicals, such as pesticides, fertilizers, or fuel, during  
9 transportation, storage, or handling
- 10 • drainage discharge outlets (e.g. the end of a drainage pipe)  
11

12 Containment measures can easily prevent chemicals from becoming point sources of pollution  
13 during storage and handling. To prevent discharges from contaminating surface water, the  
14 discharges must be diverted away from surface water and onto turf areas or other appropriate  
15 areas instead. For more information, see the blog post "[Stuck in the Shop? Do a Point Source  
16 Pollution Assessment](#)" on the NYS BMP website.  
17

### 18 **1.2.3 Sedimentation**

19 A primary benefit of turfgrass or any perennial vegetation is the reduction in sediment and  
20 particulate movement. Precipitation and irrigation can carry soil particles (sediment) in runoff  
21 and deposit them into surface water. Too much sediment can cloud surface water, reducing the  
22 amount of sunlight that reaches aquatic plants and impairing aquatic species habitat. In addition,  
23 sediments can carry fertilizers, pesticides, and other chemicals attached to soil particles and  
24 transport them into waterbodies, causing algal blooms that lead to oxygen depletion.  
25 Sedimentation is controlled through BMPs that control the volume and flow rate of runoff water,  
26 maintain adequate turf density, and reduce soil transport.

## 27 **1.3 Water Quality**

28 If water quality contaminants reach surface water or groundwater, the potential water quality  
29 impacts can include the following:  
30

- 31 • drinking water impairment if nitrogen as either nitrate (NO<sub>3</sub>) or nitrite (NO<sub>2</sub>) are present  
32 at levels above health-based risk values in drinking water, which may adversely affect  
33 health
- 34 • nutrient enrichment of surface water
- 35 • sedimentation due to eroding soils
- 36 • toxicity to aquatic life  
37

38 Each potential impact is discussed in more detail on the NYS BMP website [Water Quality  
39 Protection](#) page.  
40

## 1 1.4 Pollution Prevention

2 Because of the efforts aimed at protecting surface water and groundwater quality, the majority of  
3 BMPs addressed in this document relate to water quality. At any golf course, preventive  
4 strategies should include combinations of land use controls and source prevention practices. An  
5 integrated water quality protection system is based on a tiered concept as follows:

- 6 • prevention – prevent problems from occurring
- 7 • control – have safeguards in place to control any problems
- 8 • detection – consider a monitoring program to detect changes in environmental quality

9 Preventive measures are categorized as either land use BMPs or source prevention BMPs. Land  
10 use BMPs are engineered and incorporated into the course during golf course design and  
11 construction. Land use BMPs protect natural resources through primarily mechanical methods,  
12 as described in the remainder of this chapter. Source prevention BMPs are implemented during  
13 golf course operation to prevent or preclude the possibility of movement of sediment, nutrients,  
14 or pesticides from the property or from toxic materials being introduced into ecologically  
15 sensitive areas.

16 BMPs reduce stormwater volume, peak flow, and nonpoint source pollution through  
17 evapotranspiration, infiltration, detention, filtering, as well as biological and chemical actions.  
18 Implementing BMPs can prevent or minimize the effects of golf course management on surface  
19 and groundwater to ensure and enhance public health and environmental quality. Pollution  
20 prevention is easier, less expensive, and more effective than addressing problems "downstream."  
21 Essentially, BMPs are a sustainable approach to providing environmental, economic, and social  
22 benefits to golf and to society.

## 23 1.5 Water Conservation

24 Water is a fundamental element for physiological processes in turf such as photosynthesis,  
25 transpiration, and cooling, as well as for the diffusion and transport of nutrients. Turf quality and  
26 performance depend on an adequate supply of water through either precipitation or supplemental  
27 irrigation. Too little water induces drought stress and weakens the plant, while too much causes  
28 anaerobic conditions that stunt plant growth and promote disease. Excessive water can also lead  
29 to runoff or leaching of nutrients and pesticides into groundwater and surface water.

30 Many BMPs in this document conserve our water resources and can be used to prepare for water  
31 use restrictions that may be imposed in times of extended drought. Proper irrigation scheduling,  
32 careful selection of turfgrass species, and incorporation of cultural practices that increase the  
33 water holding capacity of soil are addressed through these BMPs, as well as considerations in the  
34 design, construction, and maintenance of irrigation systems.

35 The following case studies focusing on water conservation on NYS golf courses have been  
36 published by the NYS BMP project:

- 37 • [\*Precision Water Management\*](#), North Hempstead Country Club, Port Washington

- 1 • [Conserving Water By Installing Quick Couplers](#), GlenArbor Golf Club, Bedford
- 2 • [Irrigation System Upgrades for Water Conservation](#), Hollow Brook Golf Club, Cortland
- 3 Manor
- 4 • [Opportunities for Improvement of Wash Pad Operations](#), Locust Hill Country Club,
- 5 Rochester

## 6 1.6 Pollinators

7 Protecting bees and other pollinators is important to the sustainability of agriculture. In 2017, the  
8 New York State BMP project published [Best Management Practices for Pollinators on New](#)  
9 [York State Golf Courses](#) and incorporated into this document. Minimizing the impacts of  
10 pesticides on bees and other pollinators, as well as on beneficial arthropods, is addressed in this  
11 document in two ways:

- 12 • promoting the use of integrated pest management (IPM) methods to reduce pesticide
- 13 usage and to minimize the potential of exposure
- 14 • providing specific guidance for pesticide applicators

15 Superintendents can also directly support healthy pollinator populations by providing and/or  
16 enhancing habitat for pollinator species and by supplying food sources and nesting sites and  
17 materials.

18 The following case studies focusing on protecting pollinators and IPM use on golf courses have  
19 been published by the NYS BMP project:

- 20 • [Enhancing Habitat for Native Pollinators with Low-to-No Maintenance Areas](#), Rockland
- 21 Country Club Golf Course, Sparkill
- 22 • [Reducing Environmental Impact of Pest Management](#), Soaring Eagles Golf Course,
- 23 Horseheads
- 24 • [Integrating BMPs to Increase Sustainability](#), Locust Hill Country Club, Rochester
- 25 • [Protecting Pollinators on the Golf Course](#), Rockville Links Club, Rockville Centre

## 26 1.7 Creating a Facility BMP

27 To adapt BMPs to an individual facility, superintendents should assess their individual site,  
28 consider their available resources (such as budget), and understand that implementing BMPs will  
29 be an ongoing process. In addition, understand that implementing BMPs will be a process that  
30 can be undertaken over time, and that multiple approaches can successfully protect natural  
31 resources. For example, the following describes an incremental approach to developing a nutrient  
32 management program, as published in the blog post "[Assess and Map Your Soils](#)" on the NYS  
33 BMP website:

- 34 • A **good practice** is to assess the chemical and physical analysis of your regularly fertilized
- 35 soils using a [Minimum Levels for Sustainable Nutrition \(MLSN\) Guideline](#) interpretation,
- 36 as well as looking at overall turf quality and growth, when developing a nutrient

1 management program. Make accurate supplemental nutrient applications to targeted areas  
2 of established need.

3 • A **better practice** is to use the Web Soil Survey as a guide to classify and sample all soils  
4 on the property using the MLSN interpretation and performance variables (quality and  
5 growth). Make supplemental applications of nutrients based on large-scale mapping in  
6 targeted areas of well-established needs.

7 • The **best practice** would be to implement a Web Soil Survey-driven sampling program  
8 and use appropriate interpretation and performance variables as layers in a GIS database  
9 built from the sampling locations. Use this GIS database of soil properties for GPS-based  
10 Variable Rate Application equipment for precise supplemental nutrient applications to  
11 targeted areas of well-established need.

## 12 1.8 Conclusion

13 This document was developed using the latest research-based information and sources. It will be  
14 posted on the [NYS BMP website](#) and made available through the [GCSAA's online tool](#)  
15 (available to GCSAA members only) for development of facility BMPs. At the time of this  
16 publication, the information was the latest available. Regulations may change, and  
17 superintendents should identify any changes (especially to regulations) since the publication  
18 date.

## 1    2    **SITE ANALYSIS**

2    Site analysis is the first and most important step in aligning golf course management with  
3    research-based BMPs designed to protect water quality. A site analysis describes site  
4    maintenance areas, chemical storage and handling practices, equipment cleaning, and other  
5    priority areas on the golf course associated with topography and environmental sensitivity.  
6    Following this thorough assessment, the feasibility of land use and management BMPs should be  
7    considered to ensure reasonable water quality protection.

8    BMPs can be incorporated into the design for a new course or course renovation. For an existing  
9    golf course, the golf course superintendent can undertake a site analysis to identify specific areas  
10   of interest to focus the implementation of BMPs. For a new golf course development or a  
11   renovation project, the New York State requires that a licensed golf course designer guide the  
12   site analysis process to ensure compliance with relevant regulations. Designers and others  
13   involved in golf course development are encouraged to work closely with local community  
14   groups and regulatory bodies during planning and siting and throughout the development  
15   process. For every site, local environmental issues and conditions must be addressed.

### **BMP Principles for Site Analysis**

- Properly assess maintenance sites and golf course for priority areas related to water quality protection.
- Determine most effective structural or vegetative BMP strategy, if needed.

#### 16   2.1    **Identify Priority Areas**

17   The site analysis will help to develop a better understanding of how a golf course fits into the  
18   landscape, including identifying the facility's location in relation to its watershed. The site  
19   assessment then should identify environmentally sensitive areas for protection such as:

- 20        • wetlands
- 21        • surface waterbodies
- 22        • shorelines
- 23        • steep slopes to surface water
- 24        • areas with shallow depth to ground water
- 25        • critical groundwater recharge zones (especially true for Long Island, due to its sandy  
26        soils)
- 27        • listed species habitat
- 28        • areas with unique geological characteristics, such as [karst topography](#), which leave  
29        groundwater vulnerable to contamination

30   On golf courses, areas that could serve as potential point sources of pollution should be identified  
31   as priority areas for water quality protection. Specifically, potential point source pollution can

1 originate as the unintended release of chemicals, such as pesticides, fertilizers, or fuel, during  
2 transportation, storage, handling, cleaning, or refueling of equipment. Containment measures can  
3 easily prevent chemicals from becoming point sources of pollution, as described in the  
4 "Maintenance Operations" chapter of this document.

## 5 **2.2 Establish Management Zones**

6 In order to manage a golf course in an environmentally sensitive and responsible manner,  
7 management zones can be established throughout the course. Management zones are defined as  
8 areas that have distinct management practices based on the area's position in the watershed and  
9 can be used to protect the priority areas identified in the site analysis. Management zones work  
10 hand-in-hand with source prevention BMPs, such as [IPM](#). More information is available on the  
11 [Management Zones web page](#) on the NYS BMP website.

## 12 **2.3 Site Analysis Best Management Practices**

### 13 **Identify Priority Areas**

- 14 ❖ Evaluate the watershed size to understand drainage needs and appropriate pipe sizing.
- 15 ❖ Identify areas on the course that may be prone to leaching (shallow depth to groundwater,  
16 sandy soils, etc.) and runoff (steep slopes, etc.)
- 17 ❖ Identify any listed species and critical habitat that may be present on the site and then  
18 preserve the habitat, as well as the feeding and nesting areas.
- 19 ❖ Identify and preserve regional wildlife and migration corridors by avoiding or minimizing  
20 crossings. Design unavoidable crossings to accommodate wildlife movement.

### 21 22 **Management Zones**

- 23 ❖ Establish a low- to no-maintenance level within the established buffer along wetlands.
- 24 ❖ Establish and maintain riparian buffers around wetlands, springs, and channels.
- 25 ❖ Leave riparian buffers unfertilized and in a natural state.
- 26 ❖ Install stream buffers to restore natural water flows and flooding controls.
- 27 ❖ Install buffers in play areas to stabilize and restore natural areas that attract wildlife species.
- 28 ❖ Use turf and native plantings to enhance buffer areas; increase the height of cut if mowing in  
29 buffer areas.
- 30 ❖ Separate constructed wetlands from managed turf areas with native vegetation or structural  
31 buffers.



## 1    **3    PLANNING, DESIGN, AND CONSTRUCTION**

2    Building a new golf course or renovating an existing one requires careful protection of natural  
3    resources during all phases of planning, design, and construction. Implementing BMPs should  
4    result in an environmentally sustainable golf course that operates efficiently and cost effectively.

### **BMP Principles for Planning, Design, and Construction**

- Follow best practices anytime soil is disturbed to avoid erosion and sedimentation.
- Maintain existing habitat to the extent possible during all phases of planning, design, and construction to preserve biodiversity.
- Manage stormwater by implementing a “treatment train” approach to prevent nonpoint source pollution from runoff.

### 5    **3.1    Regulatory Considerations**

6    Regulations are in place at the local, state, and national levels that impact planning, design, and  
7    construction activities on New York's golf courses. Before beginning any golf course  
8    construction or renovation work, consultation with the appropriate regulatory agencies is  
9    necessary. For a new golf course development or a renovation project, New York State requires  
10   that a licensed golf course designer guide the site analysis process to ensure regulatory  
11   compliance. If new wells must be installed, experts should be consulted for proper siting in the  
12   design plan, and all setback and other regulatory requirements must be followed.

#### 13   **3.1.1    Stormwater Permits**

14   The Environmental Protection Agency (EPA) protects streams, rivers, and lakes from  
15   construction pollution under the Clean Water Act (CWA). In concert with federal water quality  
16   regulations, the NYS Department of Environmental Conservation (NYSDEC) issues individual  
17   and general permits for activities associated with stormwater discharges, including construction  
18   activities. Construction projects that will involve soil disturbance of one or more acres must  
19   obtain coverage under the [State Pollutant Discharge Elimination System \(SPDES\) General](#)  
20   [Permit for Stormwater Discharges from Construction Activity](#) from NYSDEC. Permittees are  
21   required to develop a Stormwater Pollution Prevention Plan (SWPPP) to prevent discharges of  
22   construction-related pollutants to surface water. See the [New York State Stormwater](#)  
23   [Management Design Manual](#), updated in 2015, for more information.

#### 24   **3.1.2    Erosion and Sediment Control**

25   The NYSDEC Division of Water has regulatory oversight of the state's erosion and sediment  
26   control program. The 2016 [New York State Standards and Specifications for Erosion and](#)  
27   [Sediment Control](#) provides standards and specifications for the selection, design and  
28   implementation of erosion and sediment control practices for the development of Erosion and

1 Sediment Control Plans for the SPDES General Permit for Stormwater Discharges from  
2 Construction Activity.

### 3 **3.1.3 Wetlands**

4 Activities that impact wetlands are regulated under sections 404 and 401 of the CWA. The U.S.  
5 Army Corps of Engineers (USACE) regulates dredging and filling of waters in the United States  
6 under Section 404 of the CWA. [Article 24 of New York Environmental Conservation Law](#)  
7 requires permits to conduct activities within a wetland and an adjacent area bordering a wetland.  
8 Physical disturbance, as well as application of chemicals (pesticides, herbicides, fungicides, even  
9 fertilizer), requires an Article 24 permit if the action is done in a state-regulated wetland or  
10 within a regulated adjacent area (typically 100 feet from wetland boundary).

### 11 **3.1.4 Water Withdrawal**

12 NYSDEC requires water withdrawal permits and annual reporting for any system capable of  
13 withdrawing more than 100,000 gallons of groundwater or surface water per day. Any  
14 withdrawal must also ensure that the existing best use of the waterbody from which the water is  
15 taken, such as protection of aquatic life, is not impaired. For more information on reporting and  
16 regulations in New York, see the [Water Withdrawal Permits and Reporting web page](#).

### 17 **3.1.5 Coastal Areas**

18 Land disturbance activities within a designated coastal area may be regulated at the federal, state,  
19 and local levels. NYSDEC has two programs focused on the protection of coastal erosion:

- 20 • Coastal Erosion Hazard Area (CEHA) [permit program](#), which provides written approval  
21 of regulated activities or land disturbance within the coastal erosion hazards areas under  
22 DEC's jurisdiction.
- 23 • USACE's Civil Works Program. DEC works with USACE to study erosion problems  
24 along coastlines and to develop solutions.

25 [Coastal communities with local CEHA ordinance laws](#) need to complete the [Local Coastal](#)  
26 [Erosion Management Program Annual Assessment Form](#).

### 27 **3.1.6 Listed Species**

28 The State Endangered Species Act (ECL § 11-0535) regulations are codified in 6 NYCRR Part  
29 182 and administered by NYSDEC. The [NY Natural Heritage Program](#), a partnership between  
30 NYSDEC and the State University of New York College of Environmental Science and Forestry,  
31 provides information on [listed species and species of special concern](#) and [ecological](#)  
32 [communities](#) in the state. The Natural Heritage Program should be consulted prior to  
33 construction activities.

## 34 **3.2 Planning, Design, and Construction Overview**

35 Proper planning is the first step to any construction or renovation project. Good planning also  
36 incorporates conservation of natural resources into the project. The design should allow for

1 economic sustainability, while meeting stakeholder needs. Once designed, construction must be  
2 carried out in a way that minimizes environmental impacts. Maintaining a construction progress  
3 report helps to ensure regulatory compliance. Table 1 summarizes the steps and best practices for  
4 each phase of the planning, design, and construction process.

### 5 **3.3 Planning and Design Considerations**

#### 6 **3.3.1 Wetlands**

7 In some instances, wetlands and streams can be improved or restored during golf course  
8 construction. For example, a highly degraded stream or wetland can sometimes be reshaped,  
9 rehabilitated, or replaced entirely to meet project goals and improve ecological function.  
10 Qualified environmental consultants can evaluate the overall benefit of stream enhancement or  
11 restoration and assist with permitting issues, which may include a federal 404 permit and/or state  
12 401 certification.

#### 13 **3.3.2 Constructed Wetlands**

14 Constructed aquatic ecosystems simulate the role of natural wetlands with respect to water  
15 purification. Like natural wetlands, they feature poorly drained soils and rooted emergent  
16 hydrophytes, which simulate the role of natural wetlands in water purification. These structures  
17 efficiently remove certain pollutants (nitrogen, phosphorus, metals, sediment, and other  
18 suspended solids) and can treat wastewater, such as discharges from equipment wash pads before  
19 the water enters streams, natural wetlands, or other surface water. Once these areas are  
20 constructed, however, they are considered wetlands and regulated as such.

#### 21 **3.3.3 Floodplains**

22 Any substantial disturbance to a floodplain, including clearing and grading, generally requires an  
23 engineering analysis to demonstrate minimal impact on the base flood elevation in accordance  
24 with local ordinances. Depending on the complexity of the encroachment, this analysis may be as  
25 simple as a comparison of cut and fill quantities within the floodplain or as complex as a detailed  
26 floodplain model of the entire watershed. A complex analysis may require a Federal Emergency  
27 Management Agency (FEMA) review along with potential revision to the floodplain mapping.  
28 See [NYSDEC's Floodplain Management web page](#) for more information and links to other  
29 sources of information.

#### 30 **3.3.4 Pond Location and Design**

31 Designing a new pond requires considerations such as the size of the drainage area, water supply,  
32 soil types, and water depth. In addition to potentially serving as an irrigation water source, ponds  
33 support aquatic life. Therefore, construction of ponds should consider the needs of [aquatic](#)  
34 [ecosystems](#), such as discouraging excessive growth of aquatic vegetation, supplying sufficient  
35 dissolved oxygen (DO) to support aquatic species, etc. Careful design may significantly reduce  
36 future operating expenses for pond and aquatic plant management.

Table 1. Best practices for golf course planning, design, and construction

Planning	
Step	Description
<i>Assemble Team</i>	The team should include, but not be limited to, a golf course architect, golf course superintendent, clubhouse architect, irrigation engineer, environmental engineer, energy analyst, economic consultant, civil engineer, soil scientist, golf course builder, and a legal team. For new golf courses, a licensed golf course designer is required by law to guide the site analysis process.
<i>Define Objectives</i>	Identify realistic goals, formulate a timeline, etc.
<i>Conduct a Feasibility Study</i>	Evaluate finances, environmental issues, water availability and sources, and energy, materials, and labor needs. Identify applicable government regulations.
<i>Select and Analyze Site</i>	Site should meet project goals and expectations. Identify all strengths and weakness of each potential site. During site selection, any site constraints, such as the presence of listed species or valuable habitat, should be identified. New York State requires that a licensed golf course designer guide the site analysis process to ensure regulatory compliance.
Design	
<i>Retain a Project Manager/Superintendent</i>	This person is responsible for integrating sustainable practices in the development, maintenance, and operation of the course.
<i>Design the Course</i>	Existing native landscapes should remain intact as much as possible. Consider supplemental native vegetation to enhance existing vegetation alongside lengthy fairways and out-of-play areas. Nuisance, invasive, and exotic plants should be removed and replaced with native species adapted to the area.
	<b>Structural BMPs:</b> Incorporate structural BMPs into the design plan, identifying opportunities to detain stormwater and to improve water quality through stormwater volume reduction, filtering, and biological and chemical processes.
	<b>Greens:</b> Should have plenty of sunlight and be well drained. Greens should be big enough to have several hole locations that can handle expected traffic.
	Root zone material should be selected with United States Golf Association (USGA) specifications in mind, as published in <a href="#">A Guide to Constructing The USGA Putting Green</a> . Physical testing of these sands by an accredited laboratory prior to use is recommended.
	<b>Grass Selection:</b> Species should be selected based on climate, environmental, and site conditions and species adaptability to those conditions, including disease resistance, drought tolerance, spring greenup, and traffic tolerance.
	<b>Bunkers:</b> The number and size of bunkers depend on considerations, such as the resources available for daily maintenance. For each bunker consider: <ul style="list-style-type: none"> <li>• The need for drainage</li> <li>• Entry/exit points and how these will affect wear-and-tear patterns</li> <li>• The proper color, size and shape of bunker sands to meet needs</li> </ul>
	<b>Vegetative Filters:</b> Vegetative filters (conservation buffers, vegetated filter strips, swales, etc.) can be used throughout the golf course to act as natural biofilters to reduce stormwater flow and pollutant load. Turf areas are also effective filters.

<i>Design Irrigation System</i>	Hire a professional irrigation architect, if possible, to design the irrigation system. Keep in mind the different water needs of greens, tees, fairways, roughs, and native areas. Consider the topography, prevalent wind speeds, and wind direction when spacing the heads. Choose the most efficient type of irrigation system considering available resources.
<b>Construction</b>	
<i>Select Qualified Contractors</i>	Use only qualified contractors who are experienced in the special requirements of golf course construction, such as members of the <a href="#">Golf Course Builders Association of America</a> .
<i>Safeguard Environment</i>	Follow all design phase plans and environmental laws. Soil stabilization techniques should be rigorously employed to maximize sediment control and minimize soil erosion. Temporary construction compounds and pathways should be built in a manner that reduces environmental impacts.
<i>Install Irrigation System</i>	Installation should consider the need to move equipment and bury pipe while maintaining the original soil surface grade to minimize the potential for erosion.
<i>Establish Turfgrass</i>	Turfgrass establishment methods and timing should allow for the most efficient progress of work, while optimizing resources and preventing erosion from bare soils before grass is established.

### 1 3.3.5 Habitat Conservation

2 In addition to adhering to regulations that protect listed species, maintaining habitat to the extent  
3 possible during all phases of planning, design, and construction helps maintain biodiversity.  
4 Natural habitats provide food and shelter for numerous species, including mammals, birds, fish,  
5 amphibians, reptiles, insects, and native plants. A number of golf course management activities  
6 can maintain and enhance habitat, such as the following:

- 7 • Retaining natural buffer areas around wetlands and watercourses preserves habitat while  
8 protecting water quality for aquatic species.
- 9 • Planting native species provides food for animals and insects.
- 10 • Retaining dead trees to serve as nesting areas and providing nest boxes for birds, bees,  
11 and bats also enhances habitat quality.
- 12 • Removing exotic and invasive species improves habitat as well. The [New York Invasive  
13 Species Information](#) website provides lists of invasive species and species profiles which  
14 include control strategies.
- 15 • Creating corridors to connect natural areas (both on and off property).

16 The "Pollinator Protection" and "Landscape" chapters of this document provide additional  
17 recommendations and BMPs for enhancing habitat on the golf course.

## 18 3.4 Stormwater Management

19 The movement of water across the land surface (i.e. runoff) from either precipitation or irrigation  
20 that does not infiltrate into the ground is the conveying force behind nonpoint source pollution.  
21 In this section, stormwater management refers to the management of runoff from precipitation  
22 but applies to irrigation runoff as well. Stormwater management is the control and use of  
23 stormwater runoff and includes planning for runoff, maintaining stormwater systems, and  
24 regulating the collection, storage, and movement of stormwater. Principles of stormwater  
25 management on golf courses includes the following:

- 26 • Keep stormwater close to where it falls.
- 27 • Slow down stormwater runoff.
- 28 • Allow stormwater to infiltrate into the soil.

29 Stormwater management is best accomplished by a "treatment train" approach in which water is  
30 moved from one treatment to another by conveyances that themselves contribute to the  
31 treatment. These treatments include source controls, structural controls, and non-structural  
32 controls. An example of this treatment train approach is as follows: Stormwater is directed across  
33 vegetated filter strips, through a swale, into a retention pond, then out through another swale to a  
34 constructed wetland system.

### 35 3.4.1 Source Controls

36 The first car of the BMP treatment train are source controls to help prevent the generation of  
37 stormwater runoff or the introduction of pollutants into stormwater runoff. For example, during

1 construction or redesign activities, strict adherence to erosion and sedimentation controls helps to  
2 prevent, or at least minimize, the possibility for sediment and nutrients to impact water quality  
3 through runoff. After construction, reduction in the use of pesticides through an IPM program  
4 reduces the potential for off-site movement of pesticides.

### 5 **3.4.2 Structural Controls**

6 Structural controls are often the next car in the treatment train and are design and engineering  
7 features of the course created to remove, filter, retain, or reroute potential contaminants (e.g.  
8 nutrients, pesticides) carried in surface runoff. Descriptions of structural controls commonly used  
9 on golf courses and an evaluation of the effectiveness of each can be found on the NYS BMP  
10 [Structural Controls web page](#). Periodic inspection and maintenance of all structural controls are  
11 essential to ensure they function as designed; inspection and maintenance guidelines are  
12 published on the NYS BMP [Maintenance of Structural Controls web page](#).

13 In and around the clubhouse and other structures, opportunities to slow down the movement of  
14 water from impervious surfaces and allow for infiltration should be identified. For example,  
15 runoff from gutters and roof drains should flow into permeable areas. [Rain gardens](#) near these  
16 areas can be incorporated into the landscape design. Maximizing the use of pervious pavements,  
17 such as brick or concrete pavers separated by sand and planted with grass, allows stormwater to  
18 infiltrate into the soil as opposed to running off. Crushed stone and other permeable products are  
19 available for cart paths or parking lots.

### 20 **3.4.3 Non-Structural Controls**

21 Non-structural controls are the last car in the treatment train. Non-structural controls often mimic  
22 natural hydrology (e.g. constructed wetlands), hold stormwater (e.g. constructed wetlands and  
23 wet retention basins), and filter stormwater via vegetative practices (e.g. filter strips and grassed  
24 swales). Turfgrass areas are extremely effective in reducing soil losses compared to other  
25 cropping systems, due to the architecture of the turf canopy, the fibrous turf root system, and the  
26 development of a vast macropore soil structural system that encourages infiltration rather than  
27 runoff. Additionally, turf density, leaf texture, rooting strength, and canopy height physically  
28 restrain soil erosion and sediment loss by dissipating impact energy from rain and irrigation  
29 water droplets. A description of specific types of vegetative practices that serve as non-structural  
30 controls on golf courses is published on the NYS BMP [Vegetative Practices web page](#).

### 31 **3.4.4 Drainage**

32 Adequate drainage is necessary for healthy turfgrass. The drainage system should be part of the  
33 stormwater management approach, incorporating the containment and treatment features  
34 described above.

35 Subsurface drainage directs stormwater and can reduce runoff and leaching. Subsurface drainage  
36 is also installed to control a water table or to interrupt subsurface seepage or flow. Wherever  
37 possible, direct this drainage into vegetative areas for biological filtration or into infiltration  
38 basins to help control the potential loss of nutrients and pesticides from the golf course.

1 Drainage is only as good as the system's integrity. Damaged, improperly installed, or poorly  
2 maintained drainage systems negatively impact play and increase risks to water quality. The  
3 drainage system should be routinely inspected to ensure proper function. Roots and animal  
4 activity can easily clog drains and prevent proper functioning.

### 5 3.5 External Programs

6 Golf courses can gain valuable recognition for their environmental education and certification  
7 efforts. Examples of external designations include Audubon International's [Cooperative](#)  
8 [Sanctuary Program for Golf](#) and the Groundwater Foundation's [Groundwater Guardian Green](#)  
9 [Site](#) program.

### 10 3.6 Planning, Design, and Construction Best Management Practices

#### 11 **Planning, Design, and Construction Activities**

- 12 ❖ Retain riparian buffers along waterways to protect water quality and provide food, nesting  
13 sites, and cover for wildlife.
- 14 ❖ Rigorously employ soil stabilization techniques to maximize sediment control and minimize  
15 soil erosion.
- 16 ❖ Maintain appropriate silt fencing during construction to prevent erosion and sedimentation in  
17 accordance with the SWPPP.
- 18 ❖ When constructing drainage systems, pay close attention to engineering details such as  
19 subsoil preparation and the placement of gravel, slopes, and backfilling.

20

#### 21 **Stormwater Management**

- 22 ❖ Install retention basins to store water and reduce flooding at peak flows.
- 23 ❖ Install vegetated swales and slight berms around water edges, including retention basins, to  
24 slow water and allow for infiltration.
- 25 ❖ Discharge internal golf course drains through pretreatment zones and/or vegetative buffers to  
26 help remove nutrients and sediments. Do not discharge directly into an open waterbody.
- 27 ❖ Conduct an initial evaluation of the rate of dewatering of structural controls after large storms  
28 and the depth of sediment buildup for each structure.
- 29 ❖ Monitor each control structure regularly, at least once per year.
- 30 ❖ Maintain an inspection log for each control structure.
- 31 ❖ Remove sediment buildup, clean the inlets, and mow as needed to maintain performance of  
32 structural controls.
- 33 ❖ Inspect filter strips annually and examine for damage from foot or vehicle traffic,  
34 encroachment, gully erosion, or evidence of concentrated flows through or around the strip.
- 35 ❖ Maintain dense grass cover on grassed swales by mowing, spot-seeding, controlling weeds,  
36 and watering as needed.



- 1 ❖ Use depressed landscape islands in parking lots to catch, filter, and infiltrate water, instead of  
2 letting it run off.
- 3 ❖ Use elevated stormwater drain inlets in parking lots for hard rains. Such inlets can hold the  
4 treatment volume and settle out sediments, while allowing the overflow to drain away.
- 5 ❖ Maximize the use of pervious pavements, such as brick or concrete pavers separated by sand  
6 and planted with grass. Consider using crushed stone or other permeable products for cart  
7 paths or parking lots.
- 8 ❖ Eliminate or minimize directly connected impervious areas.
- 9 ❖ Ensure runoff from gutters and roof drains flows onto permeable areas, allowing the water to  
10 infiltrate near the point of generation.

## 1    **4    IRRIGATION**

2    Water is a fundamental element for physiological processes in turf such as photosynthesis,  
3    transpiration, and cooling, as well as for the diffusion and transport of nutrients. Precise water  
4    management is arguably the single most important turf practice for maintaining high quality golf  
5    turf. When the amount of water lost from the turf system by evapotranspiration (ET) exceeds the  
6    amount supplied by rainfall, the turf must be irrigated. Courses should maximize water use  
7    efficiency through proper irrigation, as this conserves water and decreases the likelihood of water  
8    quality impacts from runoff or leaching. Deliberate use includes having an efficient irrigation  
9    system, ensuring the system's proper function, using only the amount of irrigation water needed  
10   to maintain healthy turf in playing areas, and incorporating cultural practices that increase the  
11   water holding capacity of soil.

### **BMP Principles for Irrigation**

- Design and maintain irrigation systems to uniformly apply water to the intended area of management.
- Determine accurate supplemental water needs based on appropriate climate and soil data.
- Assess system efficiency through regular audits of application rate and uniformity.

#### 12   **4.1   Regulatory Considerations**

13   NYSDEC requires water withdrawal reporting for any system capable of withdrawing more than  
14   100,000 gallons groundwater or surface water per day. In accordance with the state water quality  
15   standards for flow, any withdrawal must also ensure that the existing best use of the waterbody  
16   from which the water is taken, such as protection of aquatic life, is not impaired. For more  
17   information on water withdrawal reporting and regulations in New York, see the [Water](#)  
18   [Withdrawal Permits and Reporting web page](#). During times of extended drought, water use  
19   restrictions may be issued at the local level.

#### 20   **4.2   Irrigation Water Supply**

21   Irrigation water must be dependable, reliable, and of sufficient quantity and quality to  
22   accommodate turf grow-in needs and ongoing maintenance. It must also pose no threat to public  
23   health.

##### 24   **4.2.1   Irrigation Water Sources**

25   Irrigation water can come from several sources:

- 26   • surface water from ponds, lakes, or stormwater detention ponds
- 27   • groundwater from wells
- 28   • recycled water sources

- any combined supplemental sources from rainwater and stormwater collection

Golf course designers and managers should identify and use alternative water supply sources to conserve freshwater drinking supplies whenever possible. The routine use of potable water is not a preferred practice. Municipal drinking water should be considered only when no acceptable alternatives exist. In the northeast, irrigating with recycled water may become more common as the cost of water increases and the availability of fresh water decreases, especially in large metropolitan areas. Recycled water is defined as any water that has been treated after human use and is suitable for limited reuse, including irrigation. Such water is also referred to as reclaimed water, wastewater, and effluent water. Using recycled water may also be part of a nutrient reduction strategy to meet the Total Maximum Daily Load (TMDL) in impaired watersheds.

For more information on the use of recycled water on golf courses, see [Guidelines for Using Recycled Wastewater for Golf Course Irrigation in the Northeast](#).

#### 4.2.2 Irrigation Water Quality

Nonpotable water irrigation sources (such as recycled water or storage and detention ponds) should be tested regularly to ensure that the quality is within acceptable limits to protect soil quality and turfgrass performance. In addition, wells along the shore that supply potable water might need to be tested for saltwater intrusion.

The [Irrigation Water Supply web page](#) of the NYS BMP website provides detailed information on irrigation water quality parameters, including the following tables:

- "Summary of Irrigation Water Quality Guidelines"
- "Relative salt tolerance of turf species in NYS"
- "Irrigation water restrictions related to soil water infiltration"

Additional parameters such as pH and micronutrients may be valuable for detailed evaluations of water quality.

For additional information, see the following:

- [Understanding Water Quality and Guidelines to Management](#), USGA Green Section Record.
- ["Irrigation Water Quality Guidelines for Turfgrass Sites,"](#) Penn State Extension.

#### 4.2.3 Irrigation Water Requirements

Seasonal and bulk water requirement analysis can be conducted to determine water requirements under normal and worst-case scenario (e.g. extended drought) conditions. For more information on calculating water requirements and example calculations, see Chapter 3 of [Environmental Best Management Practices for Virginia's Golf Courses](#). To conduct these analyses, the [National Centers for Environmental Information \(NCEI\)](#) (formerly known as the National Climate Data Center) provides historical climate data and statistics on precipitation across 10 regions in New York.

## 1 4.3 Irrigation System Design and Installation

### 2 4.3.1 Site Assessment

3 A site assessment of the entire facility should be conducted prior to developing a system design.  
4 The site assessment should include site-specific features, such as water sources; soil types (see  
5 the [Web Soil Survey](#) for identifying site specific soil types) and soil physical properties;  
6 microclimates; slopes; sun, wind and shade exposures; and a seasonal and bulk water  
7 requirement analysis. Examples of how site conditions impact irrigation system design include  
8 soil properties, which dictate how much water is needed to complete deep and infrequent cycles  
9 of replenishing water in the root zone, and wind exposures that increase transpiration losses and  
10 create greater water requirements.

11 The site assessment should also evaluate the impact of design elements, such as design features  
12 and concepts, planned or existing turfgrass varieties, and planned or existing drainage systems.  
13 The system design should include a general irrigation schedule with recommendations and  
14 instructions on modifying the schedule to meet these site-specific needs.

### 15 4.3.2 Design

16 Irrigation systems should be designed to meet site requirements, to provide efficient, uniform  
17 distribution of water, to conserve and protect water resources, and meet state and local code.  
18 Detailed BMPs for irrigation system design are published by the Irrigation Association in [2014](#)  
19 [Landscape Irrigation Best Management Practices](#).

20 For precise irrigation control, courses should consider using advanced irrigation control systems  
21 that can schedule each green, tee, and fairway separately and allow course managers to adjust for  
22 differences in microclimates and root zones. Weather stations that calculate and automatically  
23 program water replacement schedules also provide opportunities for more precise irrigation, as  
24 do soil moisture sensors placed in multiple locations. Additional features may include rain stop  
25 safety switches that either shut down the system in the event of rain or adjust schedules based on  
26 the amount of precipitation.

27 Where feasible, variable frequency drive (VFD) pumps and/or pump stations should be used.  
28 These systems only expend enough energy to meet the demands of the irrigation pump(s). VFD  
29 systems reduce water hammer to fitting, pipe, and sprinklers when systems are pressurized.

30 It is essential that all delivery systems install and maintain accurate metering devices. Being able  
31 to measure water use allows baselines to be established and progress in water conservation  
32 efforts to be tracked. Installation of water meters will become more critical as more regulatory  
33 and compliance obligations are imposed on users of water for irrigation.

### 34 4.3.3 Installation

35 To ensure maximum efficiency, the irrigation system must be installed per the design and  
36 specifications. The installer must ensure there is qualified supervision of the installation process  
37 and that a qualified irrigation specialist inspects and approves the system installation.

## 1 4.4 Irrigation System Maintenance and Performance

2 A properly working irrigation system is critical to ensure optimum operation. System checks and  
3 routine maintenance should be done for pumps, valves, programs, fittings, and sprinklers. A  
4 schedule of inspections and a plan for record keeping should be completed. Use of photography  
5 is especially helpful in recording installations/repairs of underground systems. The publication  
6 [2014 Landscape Irrigation Best Management Practices](#) can be consulted for devising a schedule  
7 and a plan for record keeping.

### 8 4.4.1 Seasonal Maintenance

9 Winterizing protects irrigation system pipes from damage due to water expanding and rupturing  
10 the pipe walls and fittings. Most New York golf courses need to drain or used compressed air to  
11 remove water from lateral and mainlines pipes before temperatures drop below freezing.

### 12 4.4.2 Performance

13 To ensure that it is performing as intended, an irrigation system should be calibrated regularly by  
14 conducting periodic irrigation audits, such as catch-can tests and an annual irrigation audit, to  
15 check actual water delivery and nozzle efficiency. Nozzles can wear over time. This will change  
16 irrigation output and distribution. Nozzles should be replaced, depending on the manufacturer's  
17 recommendation, to ensure proper function.

18 While routine inspection and audits can be performed by the golf course superintendent, a  
19 professional irrigation consultant is required for a detailed irrigation audit, which should be  
20 conducted according to the [Irrigation Audit Guidelines](#) published by the Irrigation Association.  
21 Ideally, this professional audit should be conducted at least once every five years.

## 22 4.5 Irrigation Management Decisions

23 Irrigation should be scheduled when soils reach 50% of the plant available water point, and the  
24 amount of water should replenish the root zone to field capacity. The infiltration rate, effective  
25 root zone depth, and estimated ET demand determine irrigation frequency and soak cycle needs.  
26 These are explained in the [Manage Irrigation web page](#) of the NYS BMP website, which  
27 includes information on estimating infiltration rates, calculating and using the potential  
28 evapotranspiration (PET), and monitoring soil moisture.

### 29 4.5.1 Deep and Infrequent Irrigation

30 Several studies have compared deep and infrequent irrigation (DI) to light and frequent (LF)  
31 schedules. DI was applied at signs of wilting and the soil was wetted to a depth of 9.5 inches. LF  
32 treatments watered daily to replace the ET lost and generally wetted the top 1.5-3.0 inches of  
33 soil. Both treatments were syringed as required to cool turf on hot days. The turf treated using DI  
34 had increased root and leaf carbohydrates, larger and deeper root masses, reduced thatch, and  
35 better overall quality throughout the season. This particular study only considered physiological  
36 factors and did not assess the risks of leaching.

1 Wetting soils below the root zone increases the risks of pushing nutrient and pesticide residues  
2 closer to groundwater. Other studies have demonstrated that turf pre-conditioned with deficit  
3 irrigation for a period of seven to 14 days withstands periods of drought and has a quicker  
4 recovery. Pre-conditioning improves stomatal conductance, transpiration rates, and  
5 photosynthetic capacity in subsequent periods of stress. However, letting soils dry completely  
6 has a negative effect on plants. Creeping bentgrass, perennial ryegrass, and tall fescue can be  
7 pre-conditioned replacing 60-80% of the water deficit. Kentucky bluegrass has much higher  
8 sensitivity to drought stress and should only be watered at 100% of deficit. Cool season turfgrass  
9 should not be watered below 40% of deficit. Even though Kentucky bluegrass has the greatest  
10 sensitivity to deficits, it has the highest resiliency to recover.

#### 11 4.6 Water Conservation

12 The increasing concentration of the US populations in urban and suburban areas is leading to  
13 concentrated demand for water resources. This urbanization has begun to challenge the supply of  
14 affordable and plentiful fresh (potable) water for irrigation in New York State. Water suppliers in  
15 most of the northeastern US must double the supply capacity to meet demand in the summer,  
16 resulting in high infrastructure costs. Therefore, economic, social, environmental, and political  
17 pressures dictate that water is used efficiently and conserved on New York's golf courses.

18 Golf course superintendents can maintain a landscape optimal for play, while conserving water,  
19 through effective course design and management. For example, reducing managed turf areas  
20 reduces water needs, maximizes rooting in areas that are irrigated, and improves the use of the  
21 water applied. In addition, a well-designed, properly maintained, and wisely used irrigation  
22 system ensures the uniform application of water and minimizes runoff.

23 Many irrigation BMPs result in more efficient water usage, such as improving the efficiency of  
24 irrigation systems. In addition, superintendents can reduce irrigation requirements through  
25 turfgrass management, such as minimizing maintained areas, maximizing rooting potential,  
26 reducing water lost through ET, and improving soil water storage where possible on sandy sites.

27 Turfgrass selection can also reduce irrigation requirements. The increased availability of  
28 improved turfgrass species and varieties provides an excellent opportunity to select the most well  
29 adapted turf to site conditions. If selected for drought tolerance, some turfgrass varieties require  
30 less water to survive and maintain playability.

31 The following NYS BMP case studies illustrate water conservation efforts undertaken at three  
32 different golf facilities in the state:

- 33 • [\*Precision Water Management\*](#), North Hempstead Country Club, Port Washington
- 34 • [\*Irrigation Upgrades for Water Conservation\*](#), Hollow Brook Golf Club, Cortland Manor
- 35 • [\*Conserving Water by Installing Quick Couplers\*](#), GlenArbor Golf Club, Bedford Hills

#### 1 4.6.1 Drought Planning

2 Extended droughts can occur in New York, and superintendents should be prepared to comply  
3 with any applicable local water use restrictions in times of drought and consider voluntarily  
4 restricting water use even when not required. NYSDEC publishes [current drought conditions](#) in  
5 New York and establishes four levels of state drought advisories (in increasing drought severity  
6 as follows: "watch," "warning," "emergency," and "disaster").

### 7 4.7 Irrigation Best Management Practices

#### 8 9 Irrigation Water Supply

- 10 ❖ Conduct a seasonal bulk water requirement analysis and a maximum bulk water requirement  
11 analysis.
- 12 ❖ Identify appropriate water supply sources that meet seasonal and bulk water allocations for  
13 grow-in and routine maintenance needs.
- 14 ❖ Use alternative water supplies/sources that are appropriate and sufficiently available to  
15 supplement water needs.
- 16 ❖ Reclaimed, effluent, and other nonpotable water supply mains must have a thorough cross-  
17 connection and backflow prevention device in place and operating correctly.
- 18 ❖ Post signs in accordance with local utility and state requirements when reclaimed water is in  
19 use.
- 20 ❖ Use salt-tolerant varieties of turf and plants to mitigate saline conditions resulting from an  
21 alternative water source, if necessary.
- 22 ❖ Assess irrigation water quality.
- 23 ❖ Account for the nutrients in irrigation water when making fertilizer calculations.
- 24 ❖ Monitor irrigation water regularly for dissolved salt content.
- 25 ❖ Design and/or maintain a system to meet a site's peak water requirements under normal  
26 conditions. Be flexible enough to adapt to various water demands and local restrictions.
- 27 ❖ Install and maintain accurate metering systems.

#### 28 29 Irrigation System Design and Installation

- 30 ❖ Conduct a thorough site assessment prior to designing the irrigation system.
- 31 ❖ Develop a written, site-specific Irrigation Management Plan.
- 32 ❖ Seek assistance from irrigation professionals, such as from Certified Golf Course Irrigation  
33 System designers and [WaterSense-certified](#) irrigation consultants, and follow established  
34 BMPs related to system design.
- 35 ❖ When possible, use precise irrigation control technologies.
- 36 ❖ Incorporate multiple nozzle configurations to add flexibility and enhance efficiency/  
37 distribution.

- 1 ❖ Install irrigation pipes away from the green surface to avoid more substantial damages should  
2 pipe failures occur.
- 3 ❖ Update multi-head control systems with single-head control systems to conserve water and to  
4 enhance efficiency.
- 5 ❖ Install manual quick-coupler valves for site specific irrigation so these areas can be hand-  
6 watered during severe droughts.
- 7 ❖ Install part-circle heads along lakes, ponds, wetlands margins, native areas, and tree trunks.
- 8 ❖ Use part-circle or adjustable heads to avoid overspray of impervious areas such as roadways,  
9 sidewalks, and parking areas.

## 10 **Irrigation System Maintenance and Performance**

- 11 ❖ Conduct visual inspections regularly to identify necessary repairs or corrective actions, which  
12 should be completed before further evaluation of system performance.
- 13 ❖ Inspect for water distribution interferences, such as trees and other obstructions.
- 14 ❖ Inspect for broken and misaligned heads.
- 15 ❖ Check that the rain sensor is present and functioning.
- 16 ❖ Inspect the backflow device to determine that it is in place and in good repair.
- 17 ❖ Record any modifications to the As-Builts, including head and nozzle choices.
- 18 ❖ Use photography to document any major underground installations/repairs.
- 19 ❖ As part of winter preparation, flush and drain above-ground irrigation system components that  
20 could hold water.
- 21 ❖ Remove water from all conveyances and supply and distribution devices that may freeze. Use  
22 compressed air or open the drain valves at the lowest point on the system.
- 23 ❖ Change filters, screens, and housing; remove drain plugs and ensure any water is removed  
24 from the system. Secure systems and close and lock covers/compartments doors to protect the  
25 system from vandalism and from animals seeking refuge.
- 26 ❖ Drain any above-ground pump casings that may have "trapped" water.
- 27 ❖ Record metering data before closing the system.
- 28 ❖ Secure or lock any remote irrigation components, including satellites.
- 29 ❖ Perform pump and engine servicing/repair before winterizing.
- 30 ❖ Recharge irrigation system in the spring with water and inspect for malfunctions.
- 31 ❖ Review efficiency of above-ground electric motors annually.
- 32 ❖ Evaluate pressure and flow to verify that the correct nozzles are being used and that the heads  
33 are performing according to the manufacturer's specifications.
- 34 ❖ Run catch-can tests to determine the uniformity of coverage and to accurately determine  
35 irrigation run times.
- 36 ❖ Conduct an annual irrigation audit to facilitate a high-quality maintenance and scheduling  
37 program for the irrigation system.
- 38 ❖ At least every five years, conduct a professional irrigation audit that follows established  
39 guidelines.

40



## **1 Irrigation Management Decisions**

- 2 ❖ Base plant water needs should be determined by ET rates, recent rainfall, recent temperature
- 3 extremes, and soil moisture.
- 4 ❖ Evaluate root zone depth on the course and do not irrigate beyond this depth.
- 5 ❖ Use infrequent, deep irrigation to supply sufficient water for plants and to encourage deep
- 6 rooting in fairways and roughs.
- 7 ❖ Monitor potential ET and calculate plant available water to improve irrigation precision.
- 8 ❖ Use soil moisture sensors to assist in scheduling or to create on-demand irrigation schedules.
- 9 ❖ Use multiple soil moisture sensors to reflect soil moisture levels.
- 10 ❖ Place soil moisture sensors in a representative location within the irrigation zone.
- 11 ❖ Use predictive models to estimate soil moisture and the best time to irrigate.
- 12 ❖ Use a journal to record the "indicator zones" that should be more closely monitored.
- 13 ❖ Calibrate older clock-control station timing devices periodically, and at least seasonally.
- 14 ❖ Avoid use of a global setting; make adjustments to watering times per head.
- 15 ❖ Adjust irrigation run times based on current local meteorological data.
- 16 ❖ Use a computed daily ET rate to adjust run times to meet the turf's moisture needs.
- 17 ❖ Manually adjust automated ET data to reflect wet and dry areas on the course.
- 18 ❖ Irrigation rates should not exceed the maximum ability of the soil to absorb and hold the water
- 19 applied at any one time.
- 20 ❖ Visually monitor for localized dry conditions or hot spots to identify poor irrigation efficiency
- 21 or a failed system device.

22

## **23 Water Conservation**

- 24 ❖ Use turf only where actually necessary, such as greens, tees, landing areas, etc.
- 25 ❖ Use native plants in landscaped areas to reduce water consumption.
- 26 ❖ Increase naturalized areas to reduce water consumption.
- 27 ❖ Choose plants for buffer strips that don't require supplemental irrigation.
- 28 ❖ Voluntarily reduce water use during times of drought.
- 29 ❖ Adhere to any local water use restrictions in time of drought.

## 1 5 WATER QUALITY MANAGEMENT AND MONITORING

2 Aligning water quality management programs, such as stormwater management and lake and  
3 pond management with established, research-based BMPs is the first step to protecting water  
4 quality. Establishing a water quality monitoring program is the next step. Routine monitoring can  
5 be used to measure water quality improvements and identify any areas where corrective actions  
6 should be taken.

### BMP Principles for Water Quality Management and Monitoring

- Manage lakes and ponds to maintain water quality, avoiding nutrient enrichment and maintaining dissolved oxygen levels.
- Assess current surface and groundwater quality.
- Conduct water quality assessments using accepted standards.
- Use an accredited laboratory for water quality assessment.
- Assess effectiveness of implemented BMP strategies.

### 9 5.1 Regulatory Considerations

#### 10 5.1.1 Surface Water Quality

11 The goal of all surface water quality protection programs is to ensure that all waters of the state  
12 meet water quality standards. The U.S. Clean Water Act requires states to classify all of the  
13 waters of the state according to their best uses and to adopt water quality standards in order to  
14 protect those best uses. The NYSDEC Division of Water utilizes the best uses and standards so  
15 established to [regulate surface water](#), land use associated with tidal and freshwater wetlands, and  
16 dams. Specifically, NYSDEC is charged with identifying impaired surface waterbodies (i.e.  
17 waters not meeting water quality standards), recommending mitigation, and establishing  
18 guidelines for enhanced protection through a variety of regulatory programs.

19 For surface water in New York not meeting the established state water quality standards,  
20 NYSDEC establishes [TMDLs](#) for the pollutant of concern causing the impairment (such as  
21 nitrogen, phosphorus, or sediments). NYSDEC has completed TMDLs for many waterbodies in  
22 New York State, including Long Island Sound, Lake Champlain, waters of the Croton River  
23 watershed, and a number of lake watersheds. The EPA may also require localities to develop  
24 Comprehensive Nutrient Management Plans (CNMPs) for activities in those impaired  
25 watersheds. Currently, CNMPs are focused on agricultural land use specifically related to the  
26 New York City Watershed Memorandum of Agreement. Note that state, federal, and local water  
27 quality regulations can change. Superintendents must remain informed about local, regional, and  
28 national policies and regulations.

1 **5.1.2 Groundwater Quality**

2 NYSDEC regulates groundwater, including setting groundwater quality and effluent standards.  
3 For more information, see [NYSDEC Division of Water regulations](#).

4 **5.1.3 Drinking Water**

5 The Safe Drinking Water Act (SDWA), passed in 1974, is the main federal law that ensures the  
6 quality of Americans' drinking water. The New York State Department of Health (NYSDOH)  
7 established standards for drinking water quality that are more stringent than EPA standards and  
8 must be complied with. For more information, see the [NYSDOH Drinking Water Protection](#)  
9 [Program](#).

10 **5.1.4 Freshwater Wetlands**

11 Article 24 of New York Environmental Conservation Law requires permits to conduct activities  
12 within a wetland and an adjacent area bordering the wetland. Physical disturbance, as well as  
13 applications of chemicals (pesticides, herbicides, fungicides, even fertilizer), requires an Article  
14 24 permit if the action is done in a state-regulated wetland or within the regulated adjacent area  
15 (typically 100 feet from the wetland boundary).

16 **5.1.5 Dams**

17 NYSDEC's [Dam Safety Section](#) conducts safety inspection of dams; technical review of  
18 proposed dam construction or modification; monitoring of remedial work for compliance with  
19 dam safety criteria; and emergency preparedness. Any construction, modifications, or repairs of  
20 a dam requires consultation with the Dam Safety Section.

21 **5.1.6 Water Withdrawal**

22 New York State requires annual water usage reports for any system capable of withdrawing more  
23 than 100,000 gallons groundwater or surface water per day. In accordance with the water quality  
24 standard for flow, any withdrawal must also ensure that the existing best use of the waterbody  
25 from which the water is taken, such as protection of aquatic life, is not impaired. Reports for the  
26 prior year are due on March 31 of each year. Recycled water is exempted from this reporting  
27 requirement. For more information, see [Water Withdrawal Permits and Reporting](#) on the  
28 NYSDEC website.

29 **5.1.7 Fertilizers**

30 In New York, the Dishwater Detergent and Nutrient Runoff Law became effective in January  
31 2012. See the "Nutrient Management" chapter of this document for more information on  
32 fertilizer regulations.

33 **5.1.8 Pesticides**

34 The New York State Environmental Conservation Law (ECL), Article 33, Part 325, establishes  
35 statutory authority to NYSDEC to regulate pesticides and pesticide use, including the use of

1 aquatic pesticides. See the "Pesticide Management" chapter of this document for more  
2 information on pesticide regulations.

### 3 **5.1.9 Grass Carp**

4 In New York State, stocking of diploid grass carp in ponds for the control of aquatic plants is  
5 prohibited, but the stocking of triploid (sterile) grass carp is allowed with a permit from the  
6 NYSDEC [Division of Fish and Wildlife](#). For more information, see the [Triploid Grass Carp in  
7 New York Ponds web page](#).

## 8 **5.2 Stormwater Management**

9 As discussed in Section 3.4 of this document, stormwater management typically refers to the  
10 management of runoff from precipitation, though it applies to irrigation runoff as well.  
11 Stormwater management includes planning for runoff, maintaining stormwater systems, and  
12 regulating the collection, storage, and movement of stormwater. The principles of stormwater  
13 management – keeping stormwater close to where it falls, slowing down stormwater runoff, and  
14 allowing it to infiltrate into the soil – are the most effective ways to protect surface water quality.

## 15 **5.3 Lake and Pond Management**

16 The management of lakes and ponds should include a clear statement of goals and priorities to  
17 guide the development of the BMPs necessary to meet those goals. Some of the issues  
18 superintendents should address to maintain the water quality of golf course lakes and ponds  
19 include:

- 20 • low DO levels
- 21 • aquatic plant management
- 22 • near-shore management zones

### 24 **5.3.1 Dissolved Oxygen**

25 Dissolved oxygen is the amount of oxygen present in water and is measured in milligrams per  
26 liter (mg/L). Adequate DO levels are required to sustain life in aquatic organisms and vary by  
27 species, the organism's life stage, and water temperature.

28 The amount of DO that water can hold depends on the physical conditions of the body of water  
29 (water temperature, rate of flow, oxygen mixing, etc.) and photosynthetic activity. Colder water  
30 has higher DO levels than warmer water. Dissolved oxygen levels also differ by time of day and  
31 by season as water temperatures fluctuate. Similarly, a difference in DO levels may occur at  
32 different depths in deeper surface water if the water stratifies into thermal layers. Fast-flowing  
33 streams hold more oxygen than impounded water. Lastly, photosynthetic activity also influences  
34 DO levels. As aquatic plants and algae photosynthesize during the day, they release oxygen. At  
35 night, photosynthesis slows down considerably or even stops, and algae and plants pull oxygen  
36 from the water. In impoundments with excessive plant and algae growth, several cloudy days in

1 a row can increase the potential for fish kills due to low DO during warm weather. Therefore,  
2 preventing excessive aquatic growth helps to maintain DO levels. The use of artificial aeration  
3 (diffusers) can also be used to maintain adequate DO, especially in small impoundments or  
4 ponds.

### 5 **5.3.2 Aquatic Plants**

6 Aquatic plants include algae and vascular plants and are natural parts of aquatic ecosystems.  
7 Phytoplankton, or algae, give water its green appearance and provide the base for the food chain  
8 in ponds. Tiny animals called zooplankton use phytoplankton as a food source. Large aquatic  
9 plants (aquatic macrophytes) can grow rooted to the bottom and supported by the water  
10 (submersed plants), rooted to the bottom or shoreline and extended above the water surface  
11 (emerged plants), rooted to the bottom with their leaves floating on the water surface (floating-  
12 leaved plants), or free-floating on the water surface (floating plants).

13 Aquatic plants growing on a littoral shelf may help protect receiving waters from the pollutants  
14 present in surface water runoff. Ideally, littoral zones should have a slope of about 1 foot vertical  
15 to 6-10 feet horizontal to provide the best substrate for aquatic plant growth. In open areas,  
16 floating-leaved and floating plants suppress phytoplankton because they absorb nutrients from  
17 the pond water and create shade.

18 Particularly in shallow or nutrient-enriched ponds, aquatic plant growth can become excessive.  
19 Non-native plants, in particular, can aggressively colonize aquatic environments. The excessive  
20 growth of any aquatic plant requires management. Following the principles laid out in the  
21 "Integrated Pest Management" chapter of this document, a number of controls should be  
22 considered to deal with excessive aquatic plant growth, including:

- 23 • prevention, such as reducing nutrient enrichment and avoiding the introduction of  
24 invasive species
- 25 • cultural practices, such as benthic barriers to prevent vascular plant growth
- 26 • mechanical removal
- 27 • chemical control

28 Grass carp are sometimes used as biological control to control aquatic plants. As discussed in the  
29 Regulatory Considerations section earlier in this chapter, stocking of triploid grass carp requires  
30 a permit.

31 For more on pond management, see the NYSDEC's [\*A Primer on Aquatic Plant Management in\*](#)  
32 [\*New York State\*](#).

### 33 **5.3.3 Shoreline Management**

34 Special management zones should be established around the edges of lakes and ponds. The  
35 management specifications should include a setback distance when applying fertilizers, as well  
36 as reduced mowing. Grass clippings should be collected and composted elsewhere at the facility,  
37 as the phosphorus and nitrogen in clippings can otherwise impact water quality.

### 1 5.3.4 Waterfowl

2 The deposits of fecal matter by resident and migrating waterfowl (Canada Geese, mute swans,  
3 and others) may contribute to water quality impairment through nutrient enrichment. The overall  
4 impact of bird feces on water quality, however, depends on numerous factors, such as the size,  
5 depth, and natural chemistry of the water body; avian populations and behavior; and the rate at  
6 which other nutrient sources enter the water body ([Unckless and Makarewicz, 2007](#)).

7 On golf courses, shallow ponds with significant populations of waterfowl are most likely to be  
8 affected. In these cases, annual phosphorus loading by waterfowl can be calculated using the  
9 days per year that each species spent on any lake or reservoir. Leaving an unmowed buffer  
10 around shorelines has been known to discourage geese from congregating on shorelines. For  
11 more information, see [Managing Canada Goose Damage](#).

## 12 5.4 Water Quality Monitoring

13 Golf course superintendents wanting to develop and implement a water quality monitoring  
14 program to document the water quality conditions should first review available baseline water  
15 quality data. Baseline data can be assessed to determine the likely origin of contaminants,  
16 measure the extent of sedimentation and nutrient inputs, and estimate the potential impacts to  
17 surface water and groundwater. Following implementation of BMPs, routine monitoring can be  
18 used to measure water quality improvements and identify any areas where corrective actions  
19 should be taken.

20 Water quality monitoring can also demonstrate the presence of issues in water as it enters a golf  
21 course property. In Suffolk County, for example, extensive laboratory testing for contaminants  
22 has shown that groundwater entering the golf course already has extremely high nitrate levels  
23 [near or greater than the regulatory limit](#). The county also collects surface water samples and  
24 shares the test reports with superintendents.

### 25 5.4.1 Sources of Existing Information

26 Several sources of existing surface and groundwater monitoring data may be available,  
27 including:

- 28 • [Soil and Water Conservation Districts in NYS](#) – Comprehensive water quality  
29 management programs; may be willing to test surface water and assist in installation of  
30 groundwater monitoring wells.
- 31 • NYSDEC – Conducts a [groundwater monitoring program](#) in coordination with United  
32 States Geological Survey (USGS).
- 33 • [New York Water Science Center](#) – USGS program that publishes water quality  
34 monitoring information.
- 35 • County Water Authorities – Maintain and test community water wells and may have  
36 additional test data from other points within the watershed.

## 1 5.4.2 Developing a Water Quality Monitoring Program

2 Developing a water quality monitoring program can include both groundwater and surface water  
3 monitoring. The data from this periodic monitoring can be used to identify issues that may need  
4 corrective actions. In addition, water quality monitoring of irrigation sources (particularly water  
5 supply wells and storage lakes) provides valuable agronomic information that can inform  
6 nutrient and liming programs. A water quality monitoring plan should identify appropriate  
7 sampling locations, frequency, and monitoring parameters.

8 Groundwater monitoring from wells located at the hydrologic entrance and exit from the course  
9 may be the best way to evaluate a golf course's impact on water quality. If groundwater  
10 monitoring data from these locations is not available from existing sources, monitoring wells can  
11 be installed by private companies. Installing groundwater monitoring wells can be relatively  
12 expensive, but the expense may be justified in certain cases where the origin of contamination  
13 can only be determined through comparison of water quality entering and exiting the property.  
14 To identify the appropriate site for monitoring wells, groundwater flow is required. In some areas  
15 of New York, groundwater flow maps have been developed, but may not be available at a fine  
16 enough scale for an individual golf course. Experienced environmental engineering firms or the  
17 USGS can assist in determining suitable monitoring well locations.

18 Testing protocols can be simplified to test only those parameters that are directly influenced by  
19 course management, including organic and inorganic levels of nitrogen and phosphorus and a  
20 pesticide screen for certain pesticides used on the course. NYSDEC pesticide reports provide the  
21 necessary documentation for pesticides used. The USGS also offers contract services to advise  
22 on sampling and testing of water samples. County Soil & Water Conservation District (SWCD)  
23 offices can also provide guidance on groundwater testing programs.

24 Surface water monitoring can include the laboratory testing of a number of different physical and  
25 chemical parameters to assess water quality. In addition, the sampling of macrobenthic  
26 invertebrates can be used as a relative assessment tool for stream health. Sampling of surface  
27 water can be conducted by golf course staff or volunteer monitoring groups.

28 The [\*Environmental Best Management Practices for Virginia's Golf Courses\*](#) includes a detailed  
29 chapter on water quality monitoring and an example of a water quality monitoring report.

## 30 5.5 Water Quality Management and Monitoring Best Management Practices

### 31 Stormwater Management

- 32 ❖ Follow a treatment train approach to manage stormwater, integrating source controls with  
33 structural and non-structural controls.

34

### 35 Lake and Pond Management

- 36 ❖ Develop a comprehensive management plan that includes strategies to prevent and control  
37 the growth of nuisance aquatic vegetation.

- 1 ❖ Establish minimum DO thresholds to prevent fish kills, which occur at levels of 2-3 mg/L.
- 2 ❖ Reduce stress on fish by keeping DO levels at 5-10 mg/L.
- 3 ❖ Use artificial aeration (diffusers) if needed to maintain adequate DO, especially those
- 4 waterbodies less than 6 feet in depth, and especially at night during the warmer months.
- 5 ❖ Keep phosphorus rich material (e.g. natural or synthetic fertilizers, organic tissues like grass
- 6 clippings, or unprotected topsoil) from entering surface water.
- 7 ❖ Install desirable native plants to naturally buffer DO loss and fluctuation.
- 8 ❖ To control excessive aquatic plant growth, use an IPM approach that incorporates prevention,
- 9 cultural practices, and mechanical removal methods in addition to chemical control.
- 10 ❖ To reduce the risk of DO depletion, use an algaecide containing hydrogen peroxide instead of
- 11 one with copper or endoathall.
- 12 ❖ Dredge or remove sediment as needed to improve aquatic habitat.
- 13 ❖ Reverse-grade around the waterbody perimeters to control surface water runoff and to reduce
- 14 nutrient loads.
- 15 ❖ Discourage large numbers of waterfowl from colonizing golf course waterbodies.
- 16 ❖ Use a multi-faceted, IPM approach to control nuisance animals.

17

### 18 **Water Quality Monitoring**

- 19 ❖ Review existing sources of groundwater and surface water quality information.
- 20 ❖ Develop a water quality monitoring program.
- 21 ❖ Establish baseline quality levels for water.
- 22 ❖ Identify appropriate sampling locations and sample at the same locations in the future.
- 23 ❖ Visually monitor/assess any specific changes in surface waterbodies.
- 24 ❖ Follow recommended sample collection and analytical procedures.
- 25 ❖ Conduct seasonal water quality sampling. The recommendation is four times per year.
- 26 ❖ Use an accredited laboratory for water quality assessment, using accepted standards.
- 27 ❖ Compare water quality monitoring results to benchmark quality standards.
- 28 ❖ Use corrective measures when necessary.



## 1 **6 NUTRIENT MANAGEMENT**

2 All plants require nutrients to sustain growth and development. Certain essential nutrients are  
3 classified as either macro- or micronutrients, based on the amount needed by plants rather than  
4 their importance for plant growth. Macronutrients include [nitrogen \(N\)](#), [phosphorus \(P\)](#),  
5 potassium (K), calcium (Ca), sulfur (S), and magnesium (Mg). Micronutrients include iron, zinc,  
6 copper, chlorine, nickel, molybdenum, boron, and manganese. Micronutrients are required in  
7 significantly lower amounts than macronutrients. However, a deficiency or excess of these  
8 micronutrients can have a profound influence on plant growth.

9  
10 Proper nutrient management usually includes the following steps:

- 11 • Determine plant needs (such as light levels, traffic levels, irrigated or not, and expected  
12 visual quality).
- 13 • Assess the soil reservoir for availability (soil testing).
- 14 • Determine nutrient needs and select the proper source of nutrient fertilizer (most are  
15 combination products).
- 16 • Decide the rate, timing, and frequency of application.

17  
18 Golf course managers must ensure that all supplemental fertilizer is handled and applied to  
19 maximize plant response and minimize off-site movement. N and P re the most important  
20 macronutrients to manage correctly because they are critical to both plant health and water  
21 quality.

### 22 **6.1 Nutrient Availability and Soil pH**

23 The pH of a soil influences the entire soil chemical environment and fundamentally determines  
24 nutrient availability, fertilizer response, and soil biology. In general, a neutral pH is considered  
25 adequate for most turfgrass needs; however, slightly more acidic pH can allow for increased  
26 levels of metal ions to become soluble and is often favored as a means of increasing the  
27 competitiveness of creeping bentgrass and fine fescue over annual bluegrass. More information  
28 on soil pH can be found on the [Nutrient Availability and pH web page](#) on the NYS BMP  
29 website.

### 30 **6.2 Soil Testing**

31 Soil testing is the beginning of precise nutrient management programs for all nutrients other than  
32 nitrogen. Soil testing can be used to determine nutrient levels, make fertilizer recommendations,  
33 and in some cases diagnose the cause of poor performing turf. Assessing the existing reservoir of  
34 available nutrients in the soil can minimize the need for supplemental applications of fertilizer,  
35 which saves money while protecting the environment.

36

1 Soil nutrient analysis aids in determining whether nutrient deficiencies exist, as many soils have  
2 various levels of nutrient holding capacity, often referred to as cation exchange capacity (CEC).  
3 For example, sand-based systems, which have only a limited amount of stored minerals, may  
4 demand more mineral additions. Determining supplemental nitrogen needs is typically not based  
5 on soil tests as the method of extracting N and the subsequent calibration with plant growth have  
6 not been established.

7  
8 Soil tests are required by the NYS Dishwasher Detergent and Fertilizer Law to confirm a need  
9 for phosphorus fertilization prior to its application. Research at Cornell University, however,  
10 concluded that no correlation exists between soil test phosphorus levels and runoff until  
11 phosphorus levels are 50-fold greater than the sufficiency level. A survey of soil test submissions  
12 to the Cornell University Nutrient Analysis Lab found that less than 3% of all submitted samples  
13 over a five-year period had phosphorus values at these levels.

14  
15 Information on soil sampling, laboratory analysis, interpreting test results, and supplemental  
16 plant analysis can be found on the [Soil Testing web page](#) on the NYS BMP website.

### 17 **6.3 Nutrient Management Planning**

18 Fertilizer programs are ultimately designed to supply nutrients to the turf as they become  
19 unavailable over time. The goal of a successful nutrient management program should be to  
20 sustain even levels of plant available nutrients for a uniform growth rate and to sustain adequate  
21 recuperative potential to meet expectations of quality and turf performance, while minimizing  
22 excessive growth and the risk of nutrient loss to the environment. One approach to achieving  
23 these goals is to utilize the [Minimum Level for Sustainable Nutrition \(MLSN\) Guidelines](#),  
24 developed by PACE Turf and the [Asian Turfgrass Center](#).

#### 25 **6.3.1 Nitrogen Fertilization**

27 Using the right product at the right time and at measured rates of application maximizes plant use  
28 of the fertilizer and minimizes the risk of nutrient leaching or runoff. However, determining  
29 these best practices requires an understanding of other important factors, such as soil issues,  
30 plant issues, product characteristics, and application considerations.

31  
32 Readily available N sources, such as water soluble N (WSN), provide rapid turfgrass growth and  
33 color responses, but are more prone to leaching, particularly in sand-based soils. Slow release N  
34 sources are more variable in N content and release characteristics. Most N sources can be applied  
35 in granular or liquid form. N fertilizer sources are discussed in detail on the Nitrogen Fertilizer  
36 Use web page on the NYS BMP website.

1 **Soil Issues**

- 2     ▪ Soil Type: Well-drained soils with coarse textures and high percolation rates have lower  
3 water holding capacity, greater infiltration, and higher risks of leaching.  
4
- 5     ▪ Organic Matter: Soils with low amounts of organic matter have lower biological capacity to  
6 assimilate nitrogen and are more susceptible to leaching.  
7

8 **Plant Issues**

- 9     ▪ Growth Phase: Newly seeded areas pose higher risks of leaching and runoff than well-  
10 established stands of turfgrass. Once established, the increased density of root mass  
11 increases nitrogen uptake while reducing the risk of leaching. Turfgrass in early stages of  
12 growth (1 to 20 years or more, depending on the organic matter starting point) has  
13 increasingly greater capacity to store and release nitrogen, reducing fertilizer requirements.  
14 The lower the amount of organic matter present in turfgrass, the longer the period of storage  
15 will be. As the site matures and the amount of organic matter accumulates (20 to 50 years),  
16 it poses a higher risk of leaching than younger turf.

17  
18 **Product Characteristics and Application**

- 19     ▪ Product: The best strategy for use of water soluble fertilizers is light rates of 0.5 lbs N/1,000  
20 sq. ft in general; 0.4 lbs N/1,000 sq. ft on sand; and no more than 0.7 lbs N/1,000 sq. ft on  
21 other soils (assuming no heavy rain events) and more frequent applications. This practice  
22 more closely matches plant uptake and ensures minimal leaching past the turf root zone.  
23
- 24     Water insoluble or slow release products, including organics or stabilized products, used  
25 properly, have a lower risk of impairing water quality through leaching and runoff. Release  
26 rates of combined fertilizer sources and applications can increase or "stack" the amount of  
27 available nitrogen. The combined total nitrogen can possibly leach nitrogen even if  
28 individual products would not.
- 29     ▪ Fertilizer Rate: Excessive applications of any nitrogen-based fertilizer product can create  
30 high soil nitrate levels (>1.0 ppm) susceptible to leaching.
- 31     ▪ Timing: Application of any nutrient to saturated soil or prior to heavy rainfall can lead to  
32 significant off-site movement. Applications made too early in the spring or too late in the  
33 fall result in higher soil nitrate levels, posing a greater risk to groundwater quality.  
34 Similarly, applications should be reduced during summer decline when plant uptake  
35 decreases. Research has not shown an appreciable difference in turf quality using different  
36 schedules of application. Applications made every month compared with split schedules of  
37 spring and fall, spring only or fall only show reasonable consistency. Light and frequent  
38 applications may provide the most consistent quality and limit the susceptibility of losses to

1 leaching and runoff. Low rates of N associated with light and frequent applications may  
2 require that applications be made using spray equipment to uniform coverage and response.

### 3 **6.3.2 Phosphorus Fertilization**

4 As with nitrogen, using the right phosphorus product at the right time and at measured rates of  
5 application maximizes plant use of the fertilizer and minimizes the risk of leaching or runoff.  
6 This requires considerations of soil and plant issues, as well as other sources of phosphorus that  
7 may need to be considered. Phosphorus can be supplied by a number of sources in fertilizers,  
8 biosolids, or as an integral by-product of other soil amendments, natural organic fertilizers, or  
9 bio-stimulants. These are discussed in detail on the [Phosphorus Fertilizer Use web page](#) of the  
10 NYS BMP website.

#### 11 **Soil Issues**

- 12
- 13
- 14 ▪ Phosphorus fixation increases with increasing clay content in the soil. The larger amount of  
15 surface area associated with clayey soils and the aluminium-iron minerals in the lattice help  
16 adsorb more P than other soils. In calcareous soils, the adsorption is associated with calcium  
17 carbonate (CaCO<sub>3</sub>).
- 18 ▪ Larger fertilizer additions are required to maintain a level of plant available P in finer soils  
19 compared with that in coarser, sandy soils. The risk of leaching P is highest in sandy soils.
- 20 ▪ The rate of biological activity, and therefore P mineralization, increases with increasing  
21 temperatures. Fertilizer applications should only be applied to active soils when soil  
22 temperatures are above 50° F.
- 23 ▪ Applying lime to acid soils increases the P solubility in acid soils, but over-liming can  
24 reduce P solubility. Sorption also occurs to calcium cations (Ca<sup>2+</sup>) but only at pH values up  
25 to 6.5. At higher pH values, Ca-P precipitates form.
- 26
- 27 ▪ Incorporating P into the soil when possible increases adsorption and reduces the amount of  
28 plant available P. Broadcasting P fertilizer on the surface leaves the fertilizer susceptible to  
29 runoff.
- 30

#### 31 **Plant Issues**

- 32
- 33 ▪ Returning clippings to the turf is a practical method of returning organic P back to the soil.  
34 Clippings may account for 0.10 to 0.35 lbs P per 1,000 sq. ft. If clippings are removed, the  
35 loss of P depletes available P for plant uptake.
- 36

#### 37 **Other Sources Issues**

- 38
- 39 ▪ Foliar applications at light rates may increase plant uptake. Unabsorbed foliar P, however,  
40 remains at risk for episodic losses due to runoff caused by heavy precipitation or excessive

1 irrigation. A light irrigation after P fertilizer application has been shown to reduce P runoff.

2

- 3 ▪ Phosphonate fungicides are chemically different from phosphonate fertilizers in that the  
4 fungicide provides a phosphite ion ( $\text{H}_2\text{PO}_3^-$ ) having one less oxygen atom. Potassium  
5 phosphite, also labeled as mono and di-potassium salts of phosphorus acid (Aliette, and  
6 Chipco Signature) are the most common examples of a phosphonate fungicides. No  
7 evidence suggests that the phosphite ion is used in the plants metabolism. Regardless, the  
8 amount of P supplied in any fungicide application is negligible.

## 9 6.4 Fertilizer Applications

10 Proper application of fertilizers is possible only with accurately calibrated sprayers or spreaders.  
11 Incorrectly calibrated equipment can easily apply too little or too much fertilizer, resulting in  
12 damaged turf, excess cost, and contamination of the environment. Therefore, sprayers and  
13 spreaders should be calibrated at first use and after every fourth application. The time it takes to  
14 calibrate application equipment is returned many fold in improved results.

15

16 An excellent resource for [spreader care and calibration can be found on the Penn State Extension](#)  
17 [site](#). Spreaders should also be thoroughly cleaned after use due to the high salt content that  
18 corrodes metal parts. However, the washwater will likely contain N or P and should be disposed  
19 of properly.

## 20 6.5 Nutrient Management Best Management Practices

### 21 Soil Testing

- 22 ❖ Maintain dense turf stand through proper nitrogen fertilization to reduce soil runoff.  
23 ❖ Because turf is extremely responsive to soil N status, evaluate changes in clipping yield  
24 during the growing season to estimate N availability.  
25 ❖ Monitor K and P by testing soil regularly.  
26 ❖ Conduct a soil test as required by the NYS Dishwasher Detergent and Fertilizer Law to  
27 confirm a need for phosphorus fertilization prior to its application.  
28 ❖ Sample when soils are biologically active. Fall sampling is most common and allows time to  
29 review results and apply lime and nutrients in advance of spring growth and to develop a  
30 season-long plan.  
31 ❖ Do not sample within the two months following heavy fertilizing or liming; sampling around  
32 frequent, light applications (spoon feeding) is acceptable.  
33 ❖ Test soils at the same time of year to allow for comparison of results from year to year.  
34 ❖ Because soils exhibit significant spatial variability, take a number of samples, combine, and  
35 then subsample. As a rule, a minimum of 10 sample locations should be sampled per acre.  
36 ❖ Sample areas with different soils and drainage separately. For instance, sample sand-based  
37 greens and tees separately from fairways and roughs.

- 1 ❖ Take the sample from the root zone (typically 4-6 inches deep) by removing the grass mat
- 2 from the top of the sample.
- 3 ❖ Used in conjunction with soil tests, analyzing plant tissues over time can be used to observe
- 4 trends that can be correlated to environmental and management factors.
- 5 ❖ On sand based areas, consider foliar testing as a diagnostic tool.
- 6

### 7 **Nutrient Management Planning**

- 8 ❖ Use N fertilizer to produce even growth rate. This increases golf course playability and
- 9 minimizes the risk to the environment, while excessive fertilization reduces playability and
- 10 increases the risk of N leaching.
- 11 ❖ Use water soluble fertilizers at light rates of 0.5 lbs N/1,000 sq. ft in general; 0.4 lbs N/1,000
- 12 sq. ft on sand; and no more than 0.7 lbs N/1,000 sq. ft on other soils (assuming no heavy rain
- 13 events) and more frequent applications.
- 14 ❖ Lightly irrigate after P fertilizer application to reduce the potential for P runoff.
- 15 ❖ Do not apply nutrients to saturated soil or prior to heavy rainfall, which can lead to significant
- 16 off-site movement.
- 17 ❖ Avoid N application too early in the spring or too late in the fall because it can increase soil
- 18 nitrate levels and can pose a greater risk to groundwater quality.
- 19 ❖ Reduce nutrient applications during summer decline when plant uptake decreases.
- 20

### 21 **Fertilizer Applications**

- 22 ❖ Choose the appropriate type of spreader for a given fertilizer.
- 23 ❖ Calibrate application equipment every first use and after every fourth application.
- 24

## 1 **7 CULTURAL PRACTICES**

2 Cultural practices support turfgrass density and therefore play an important role in preserving  
3 and protecting water quality. Ensuring that the turf is properly adapted, healthy, and dense and  
4 has adequate infiltration protects water quality because of the tendency of healthy turf to hold  
5 water and chemicals.

6 In particular, BMPs for golf course turf to preserve and protect water quality using cultural  
7 practices must be designed to sustain high turf shoot density. A dense turf reduces runoff and the  
8 negative effect of off-site movement of water and pollutants. A dense turf, however, accumulates  
9 surface organic matter that can restrict infiltration and lead to increased runoff. Maintaining the  
10 permeability of the turf surface is as important as maintaining turf density. Strategies for  
11 preventing excessive organic matter accumulation are important, but management through  
12 dilution and cultivation of the soil is key. This practice can include modifications to improve the  
13 root zone, balance adequate infiltration as means of reducing runoff, and promote adequate  
14 retention to prevent leaching.

### **BMP Principles for Cultural Practices**

- Use and manage turfgrass species and varieties adapted to macro and micro climatic conditions of your location.
- Maintain turf with high shoot density to minimize runoff and maximize infiltration.
- Manage the surface accumulation of organic matter to maintain a permeable system that minimizes runoff and maximizes subsurface retention.

15

### 16 **7.1 Turfgrass Species and Variety Selection**

17 The perennial nature of golf turf implies that when establishing or renovating a new turf area, it  
18 is critical to choose a well-adapted species and variety. Of course, putting surfaces are unique  
19 growing environments, but larger areas such as fairways could have grasses adapted to reduced  
20 nutrient levels and increased traffic tolerance, potentially reducing the nutrient loading. This is  
21 an important BMP for nutrient management. Additionally, natural areas that serve as landscape  
22 BMPs also require careful attention to finding a well-adapted species. Certain grasses adapted to  
23 low inputs, reduced mowing, and even submersion tolerance can be part of the selection criteria.  
24 Ultimately, it is vital to start out with a well-adapted species that will thrive, meet the functional  
25 and visual quality expectations, and be sustained using BMPs.

#### 26 **7.1.1 Species Selection**

27 When selecting species and cultivar, site specific characteristics, such as desired use, site and  
28 microclimate conditions, disease resistance, drought tolerance, and spring transition traits, should  
29 be considered. To evaluate different species and identify cultivars that perform well in this

1 region, extensive trials are conducted under the National Turfgrass Evaluation Program (NTEP).  
2 [Results of NTEP trials conducted and evaluated by Cornell](#) are available on the NTEP website.

### 3 **7.1.2 Climate**

4 Highly specific and often less than ideal microclimate conditions challenge many  
5 superintendents. A common microclimate is a putting surface location with light deficits and  
6 restricted air movement. In these situations, limited options exist for proper turf selection, as  
7 these climates simply cannot sustain any turf without significant inputs. Typically, in northern  
8 climates, these adverse site conditions lead to increases in weedy species such as annual  
9 bluegrass.

### 10 **7.1.3 Annual Bluegrass Invasion**

11 Over time, annual bluegrass becomes the dominant species in turf. This invasiveness is a result  
12 of the highly adaptive and prolific reproductive capacity of annual bluegrass that favors its  
13 competitive ability over other cool season turfgrass. Therefore, regular surface disruption when  
14 desirable turf is not actively growing selects for the invasive annual bluegrass. Every course that  
15 suffers a massive invasion of annual bluegrass must decide whether to renovate or manage  
16 typically when there is catastrophic failure. Renovation eradicates and then excludes annual  
17 bluegrass, hopefully with proper site modifications to allow perennial species to thrive. Others  
18 choose simply to manage the annual bluegrass that has colonized the location. This is a "pay me  
19 now or pay me later" situation in which management of the problem is less disruptive, though the  
20 inputs required to sustain adequate turf are costly.

21 Research shows that annual bluegrass requires courses to use significantly more inputs to  
22 provide acceptable quality golf turf, especially on putting greens, as compared to more perennial  
23 species such as bentgrass or fescues. Therefore, with respect to water quality protection, the less  
24 annual bluegrass being managed, the fewer inputs required and the lower the risk to water  
25 quality. While this solution may not be as practical on putting surfaces, the putting surfaces  
26 comprise less than 10% of the managed turf. It is fairway, rough, and tee areas where annual  
27 bluegrass challenges water quality preservation with large tracts of land being treated to sustain a  
28 weedy species.

## 29 **7.2 Turfgrass Establishment**

30 Establishing new turfgrass areas or renovating existing stands can create significant risk to water  
31 quality. During establishment, soil is exposed prior to seeding or sodding to ensure effective  
32 contact for water transfer from the soil to the plants. Therefore, practices should be implemented  
33 that reduce establishment time to full turfgrass cover and protect the soil from being transported  
34 in rain events during establishment.

### 35 **7.2.1 Erosion and Sediment Control During Establishment**

36 The loss of topsoil from a site can be a problem for numerous reasons. Soil carried by wind and  
37 water transports contaminants with it. For example, erosion can enrich surface water, where



1 phosphorus, and to a lesser extent nitrogen, can cause eutrophication. When sediments and soils  
2 enter water, they can also increase turbidity, which can have harmful effects on aquatic plants  
3 and animals. Therefore, control measures should be documented in an erosion and sediment  
4 control plan, put in place prior to any soil disturbance, and properly maintained.

### 5 **7.2.2 Nutritional and Irrigation Needs**

6 Minimizing the amount of fertilizer and chemicals used during the establishment phase is  
7 critical, as the establishing turf does not provide the needed uptake to prevent runoff and  
8 leaching. Newly establishing areas, especially from seed with soil exposed, should be irrigated  
9 carefully. Light, frequent amounts of water to keep the seedbed moist will encourage  
10 germination and seedling development. Once the turf density reaches 60-70% cover, irrigation  
11 can be reduced to more normal levels, as turf will begin to root and extract water and nutrients  
12 from the soil.

## 13 **7.3 Maintaining Turfgrass Density**

14 Turfgrass runoff research consistently concludes that maintaining high shoot density turf is the  
15 most effective means of reducing runoff volume. The distance traveled by rainfall or irrigation  
16 water increases as the number of shoots per unit area increases. In addition to the reduced runoff,  
17 the fibrous root system of turf has been shown to increase infiltration. The longer the water  
18 deposited on the turf surface is delayed from becoming runoff, the more likely that proper  
19 infiltration will occur. The combination of reduced runoff volume and increased infiltration is a  
20 primary aspect of water quality protection, thus maintaining a dense turf is vital. In addition,  
21 denser turf also provides a better playing surface.

### 22 **7.3.1 Mowing**

23 A turf is defined as low growing vegetation maintained under regular mowing and traffic.  
24 Conversely, areas not regularly mowed are not considered turf. Mowing is a significant selection  
25 tool and one that, when done properly, has a profound influence on turf density. A properly  
26 mowed turf maintains a high shoot density that limits surface water movement and sustains an  
27 adequate underground biomass to retain additional water and nutrients that infiltrate. Mowing  
28 practices require decisions regarding height, frequency, type of mower, and clipping  
29 management. Individually and collectively these practices, when performed properly, maximize  
30 turf density.

#### 31 *Mowing Height*

32 Height of cut is often determined by the function of the site, with additional emphasis on visual  
33 quality. Mowing height significantly affects rooting depth because the lower the turf is mowed,  
34 the shorter the root system, and therefore the greater concentration of surface rooting.  
35 Additionally, a lower height of cut requires more frequent mowing as leaf extension accelerates  
36 when turf is cut lower and tissue must be removed more frequently.

37

1 Ultimately, every turfgrass species has an ideal mowing height range and a mowing range that  
2 the species can tolerate. Maintaining turf within the ideal range maximizes density. As long as  
3 mowing heights remain within the tolerance range, however, adequate density is possible when  
4 other maintenance factors such as water and nutrients are provided in the optimal range.

#### 5 *Mowing Frequency*

6 The turf growth rate and height of cut dictate mowing frequency. In general, increasing mowing  
7 frequency increases turf density. Little evidence supports the accepted rule that no more than  
8 30% of the leaf tissue should be removed in a single mow. Instead, significant evidence indicates  
9 that some turf species such as tall and fine fescue and perennial ryegrass can have between 50  
10 and 75% of the tissue removed before any turf thinning occurs. Ultimately, increasing mowing  
11 frequency positively effects turf density, but will increase the energy consumption of the  
12 maintenance program.

#### 13 *Mower Selection*

14 Mower selection is based on the expected height of cut. Mowing heights at or below 1.5 inches  
15 are typically best achieved with a reel-type mower. Reel mowers allow for rapid clipping of  
16 turfgrass tissue at practical operating speeds with minimal turf damage (when properly adjusted).  
17 Mowing heights above 1.5 inches are best achieved with rotary impact mowers, also when blades  
18 are sharpened and properly balanced.

19 Any mistake in mower set up from blade sharpness to bedknife alignment can lead to increased  
20 stress from wounding and reduction in turf density. Therefore, the mower must be properly  
21 adjusted and set up to minimize leaf shredding and wounding for pathogens.

#### 22 **7.3.2 Clipping Management**

23 From a water quality perspective, grass clippings are a nutrient-rich resource and should be  
24 viewed as fertilizer and handled and applied with similar precaution. When managing clippings,  
25 consider them a nutritional resource and leave them on-site if possible. However, they must not  
26 be allowed to discharge into adjacent waterbodies or to clump on the surface and shade the turf.

27 Removal of clippings should only be performed if the function of the site dictates removal (such  
28 as ball roll on a putting surface). Some courses will remove clippings from fairways, distributing  
29 these clippings to driving ranges, clubhouse lawns or simply stockpiled as organic  
30 waste. However, when distributed the area should be large enough as accumulated clippings  
31 distributed over a relatively small area can significantly increase nitrate leaching. Clippings  
32 should not be composted near stormwater treatment structures or wetlands.

#### 33 **7.4 Organic Matter Management**

34 Turf is a perennial plant system that increases biomass as a result of growth and management.  
35 Biomass accumulates at the surface from the development and deposition of plant parts such as  
36 leaves, stems, and roots. Above-ground plant parts such as leaves and stems are often removed

1 and regrown as a result of frequent mowing. Underground plant parts such as stems (rhizomes)  
2 and roots cycle as living, dead, and decomposing organic matter.

3 The accumulation of organic matter in the top 3 to 6 inches of a turf system provides nutrient and  
4 water holding as well as cushioning and insulation. When organic matter accumulates at a rate  
5 greater than it degrades, however, it can restrict infiltration of water and gas exchange between  
6 the atmosphere and the pore space in soil. Excessive organic matter at the surface can become  
7 hydrophobic and increase runoff from the turf surface, which may also reduce the effectiveness  
8 of fertilizers and pesticides. Furthermore, excessive surface organic matter can promote surface  
9 rooting that interferes with the turf's use of water and mineral nutrients, which leads to increased  
10 potential for off-site movement of chemicals applied to turf. Many factors influence the  
11 accumulation of organic matter including turfgrass species, fertilization, and soil physical and  
12 chemical properties.

### 13 **7.4.1 Grass Type**

14 Creeping bentgrass and annual bluegrass are considered intermediate in their development of  
15 organic matter. They accumulate organic matter, but often that matter is not highly lignified  
16 tissue and, under warm moist soil conditions, it degrades. Still, these grasses accumulate organic  
17 matter at the surface at a rate greater than microorganisms can degrade and thus the  
18 accumulation requires dilution or mechanical removal.

### 19 **7.4.2 Fertilization**

20 Increase in biomass is a normal aspect of plant growth. Supplemental fertilization for functional  
21 and aesthetic purposes produces more biomass and more organic matter when compared to an  
22 unfertilized turf. The rate of decomposition also increases with supplemental fertilization, up to a  
23 point. Therefore, applying enough fertilizer to meet the visual and functional requirements of the  
24 turf, but not in excess of these requirements, is critical. Excess fertilization increases biomass  
25 production that leads to excess surface organic matter production, reduced infiltration, and  
26 increased runoff.

27 Organic matter is a food source for macro- and microorganisms. The soil food web requires an  
28 adequate amount of organic matter and microbial activity to function properly. Degradation of  
29 organic matter is maximized in a well-aerated, moist soil with temperatures greater than 65°F.  
30 For every ten degree Celsius increase in soil temperature, microbial activity increases tenfold;  
31 this principle is referred to as the “Q10”.

### 32 **7.4.3 Soil Management**

33 Poorly drained soils with high bulk density and predominance of fine particles that restrict soil  
34 gas exchange reduce microbial activity. These dense, cool soils also restrict rooting to the  
35 surface, which further exacerbates the surface organic matter problem. Maintaining a permeable  
36 soil surface sustains adequate microbial activity, good deep root development, and proper  
37 infiltration. Taken together, these practices lead to a turf surface less likely to create runoff and  
38 more able to retain chemicals applied to turf top prevent leaching.

1 **7.4.4 Cultivation Practices**

2 Cultivation practices – aeration practices and surface cultivation practices – disturb the soil or  
 3 thatch through the use of various implements to achieve important agronomic goals that include  
 4 relief of soil compaction, thatch/organic matter reduction, and improved water and air exchange.  
 5 However, cultivation can require significant time for recovery, thus disrupting play, and should  
 6 be used judiciously. Cultivation frequency should be based on traffic intensity, level of soil  
 7 compaction, and the amount of accumulation of excessive thatch and organic matter, which  
 8 reduces root growth, encourages disease, and creates undesirable playing conditions. Table 2  
 9 shows advantages/disadvantages of aeration practices.

11 *Table 2. Aeration practices*

Method	Compaction relief	Surface disruption	Water/air movement	Disruption of play
Hollow-tine aeration	High	Medium	High	Medium to High
Deep drilling	Medium	Medium	High	High
Solid-tine aeration	Low	Low	High	None to Medium
High-pressure water injection	None	Low	High	None to Low

12  
 13 Surface cultivation manages organic matter accumulation above the soil, reduces the formation  
 14 of leaf grain, improves infiltration, and improves surface consistency (Table 3). While these  
 15 methods are generally less disruptive than traditional aeration practices, they usually have a  
 16 limited to no impact on soil compaction relief.

18 *Table 3. Surface cultivation practices*

Method	Compaction relief	Surface disruption	Water/air movement	Disruption of play
Vertical mowing	Low	Medium – High	Medium	Low - High
Grooming	None	Very low	Very low	None
Spiking/slicing	None	Low	Low	None

19 **7.5 Topdressing**

20 Managing surface organic matter is best accomplished by prevention through proper fertilization  
 21 and soil management. Many common golf turf grasses, however, under routine maintenance and  
 22 adequate prevention still produce organic matter that requires some level of management. The  
 23 most effective means of managing surface organic matter is through regular applications of sand  
 24 or soil via topdressing. A light (0.1 to 0.2 inches) amount of material applied and integrated into

1 the surface of the turf dilutes the organic matter and creates a physical matrix that functions as a  
2 soil.

3 Topdressing is often performed in conjunction with some form of cultivation that either removes  
4 a core or makes a hole. The cultivation not only provides minor removal of the surface material  
5 but also creates space for topdressing to serve the purpose of dilution and creation of a pseudo-  
6 soil matrix.

7 Recent research suggests that under normal golf turf management, creeping bentgrass putting  
8 surfaces require 18-22 cubic feet of sand per 1,000 sq. ft per year to properly dilute surface  
9 organic matter. This application requires topdressing as frequently as every five days without any  
10 cultivation, to as many as 14 to 21 days with more routine cultivation. Ultimately, the goal of  
11 proper dilution is to ensure adequate infiltration while preserving sufficient retention of the turf  
12 system to prevent leaching.

## 13 7.6 Cultural Practices Best Management Practices

### 14 **Turfgrass Species and Variety Selection**

- 15 ❖ Select species and cultivars that are adapted to the desired use, taking note of disease  
16 resistance, spring transition and greenup, drought tolerance, and other traits such as shade  
17 and wear tolerance utilizing NTEP data.

### 19 **Turfgrass Establishment**

- 20 ❖ Ensure erosion and sediment control devices are in place and properly maintained when  
21 establishing new turfgrass stands.
- 22 ❖ Use mulch (e.g. hydromulch, loose straw from a clean source, strawmats) for soil  
23 stabilization.
- 24 ❖ Prepare seed/sod bed to maximize success.
- 25 ❖ Fill gaps in sod seams with soil or sand to provide a uniform surface.
- 26 ❖ Use selective pre-emergence herbicides to reduce weed competition and improve the chance  
27 of success with seeding establishment during the spring.
- 28 ❖ Use light and frequent nutrient applications, unless a slow-release nitrogen source is applied.
- 29 ❖ Mow turf to the desired mowing height as soon as practical to promote density and  
30 maturation.

### 32 **Maintaining Turfgrass Density**

- 33 ❖ Raise HOC by at least 30% in heavily shaded areas to improve turf health.
- 34 ❖ Increase HOC in times of stress such as heat, drought, or prolonged cloudy weather to  
35 increase photosynthetic capacity and rooting depth of plants.

- 1 ❖ If turf becomes too tall, it should not be mowed down to the desired height all at once. Tall  
2 grass should be mowed frequently and HOC gradually decreased until the desired HOC is  
3 achieved.
- 4 ❖ Mowing frequency should increase during periods of rapid growth and decrease during dry,  
5 stressful periods.
- 6 ❖ Rarely use inefficient mowing patterns (e.g. 9-3) on areas other than putting greens to save  
7 time, fuel, and labor.
- 8 ❖ Use proper mowing equipment.
- 9 ❖ Regularly sharpen and adjust blades.
- 10 ❖ Routinely use plant growth regulators, if needed, to improve overall turf health in shaded  
11 environments.
- 12

### 13 **Organic Matter Management**

- 14 ❖ Returning clippings to turf as a practical method of returning organic P back to the soil.  
15 Clippings may account for 0.10 to 0.35 lbs P per 1,000 sq. ft.
- 16 ❖ Remove clippings only if the function of the site dictates removal (such as ball roll on a  
17 putting surface).
- 18 ❖ Accumulated clippings distributed over a relatively small area can significantly increase  
19 nitrate leaching, therefore distribute any collected clippings to driving ranges, clubhouse  
20 lawns, or compost.
- 21 ❖ Clippings can be a significant source of phosphorus movement off-site, and thus clippings  
22 should not be placed in or near stormwater treatment structures or wetlands.
- 23 ❖ When organic matter levels are excessive, core aeration programs should be designed to  
24 remove 15- 20% of the surface area and to minimize grain formation.
- 25 ❖ High-traffic areas may require a minimum of two to four core aerations annually.
- 26 ❖ Core aeration should be conducted only when grasses are actively growing to aid in quick  
27 recovery of surface density; midsummer for buffalograss and spring/fall for cool season  
28 grasses.
- 29 ❖ Aeration events should be as deep as practical to prevent development of compacted layers in  
30 the soil profile as a result of cultivation.
- 31 ❖ Consider timing of core aeration to avoid time of *Poa annua* (annual bluegrass) seed head  
32 formation.
- 33 ❖ Backfill holes with new root-zone materials if a drill-and-fill machine is used.
- 34 ❖ High pressure water injection can be applied once every 3-4 weeks throughout the summer.
- 35 ❖ Initiate vertical mowing when thatch level reaches 0.25-0.5" in depth. Shallow vertical  
36 mowing should be completed at least monthly on putting greens to prevent excessive thatch  
37 accumulation.
- 38 ❖ Vertical mowing depth for thatch removal should reach the bottom of the thatch layer and  
39 extend into the surface of the soil beneath the thatch.
- 40 ❖ Aggressive or deep vertical mowing should not be used when the turf is growing slowly.

- 1 ❖ Frequent shallow vertical mowing on putting greens prevents excessive thatch buildup and
- 2 grain formation.

3

#### 4 **Topdressing**

- 5 ❖ Use light and frequent topdressing applications following aeration.
- 6 ❖ Creeping bentgrass putting surfaces will typically require 18-22 cubic feet of sand per 1,000
- 7 sq. ft per year to properly dilute surface organic matter.
- 8 ❖ Use sand particle size distribution similar to the existing soil, to avoid layering.
- 9 ❖ Know the sand source and ensure the sand is weed-free, uniform, and of appropriate quality.

## 1 **8 INTEGRATED PEST MANAGEMENT**

2 Sooner or later, pests can become a problem, especially when turf is stressed, such as when heat,  
3 drought, or high humidity conditions persist. Pesticides alone will not control pests; a more  
4 effective approach is to develop an Integrated Pest Management (IPM) program to reduce pest  
5 damage and reliance on pesticides. IPM is a sustainable approach to managing pests by  
6 combining biological, cultural, physical, and chemical tools in a way that minimizes economic,  
7 health, and environmental risks and maintains turfgrass quality.

8 By following the latest research, managers can have high quality playing surfaces with minimal  
9 impact on the environment. [Research at Bethpage State Park](#) has shown that IPM can result in 33-  
10 96% less environmental impact without reducing course quality and does not cost more than  
11 conventional management ([Rossi and Grant, 2009](#)). The NYS BMP case study [Reducing](#)  
12 [Environmental Impact of Pest Management](#) at Soaring Eagles Golf Course shows how IPM  
13 methods have reduced pesticide usage.

### **BMP Principles for IPM**

- Conduct thorough assessments of pest pressure.
- Establish appropriate pest thresholds for managed turf areas.
- Identify and correct growing environments that exacerbate pest pressure.
- Implement sanitation, exclusion, and cultural practices to minimize pest pressure.
- Determine least-toxic pest control programs including preventive approaches.
- Assess control program effectiveness using established monitoring practices.
- Recognize environmental fate of pesticides and choose pesticides using a selection strategy that includes an evaluation of pesticide characteristics and potential for non-target effects.

#### 14 **8.1 Regulatory Considerations**

15 As described in detail in the next chapter ("Pesticide Management"), pesticide usage must follow  
16 state and federal regulatory requirements.

#### 17 **8.2 IPM Overview**

18 Progressive IPM programs follow seven steps. These steps include the use of pesticides, when  
19 needed and used a tool to increase or maintain economic value of the property being managed.

20 When chemical control is needed, selection and evaluation considerations can be used to help  
21 select an appropriate pesticide that can be used safely on the site in question while being  
22 protective of the environment.

23 Although IPM permeates all aspects of course management and planning, it can be thought of in  
24 the following steps:



- 1 Step 1 – Planning
- 2 Step 2 – Identification and Monitoring
- 3 Step 3 – Course Management
- 4 Step 4 – Evaluation & Analysis
- 5 Step 5 – Intervention
- 6 Step 6 – Record Keeping
- 7 Step 7 – Communication

8 Each of the seven steps are discussed in detail on the [Seven IPM Steps](#) web page of the NYS  
9 BMP website. Additional information on IPM can be found in these resources and publications:

- 10 ▪ [New York State Integrated Pest Management Program](#)
- 11 ▪ [Reducing Chemical Use on Golf Course Turf: Redefining IPM](#), New York State Integrated  
12 Pest Management Program
- 13 ▪ [2017 Cornell Guide for Commercial Turfgrass Management](#), Cornell University  
14 Cooperative Extension
- 15 ▪ [Reducing the Risks of Golf Course Management: The Bethpage Project](#), Cornell University  
16 Cooperative Extension

### 17 **8.3 Management Options**

18 An IPM manager uses a mix of preventive and reactive strategies to manage pest problems.  
19 Course management decisions and cultural practices are ongoing, while reactive measures are  
20 decided and implemented in season. Selecting from a number of management options according  
21 to incoming information instead of the calendar is a hallmark of an IPM manager.

#### 22 **8.3.1 Diversification**

23 Diversification of management options is key, using a variety of cultural, biological, physical,  
24 and possibly chemical strategies. The case against sole reliance on chemical approaches is  
25 obvious because it promotes resistance, and frequent use may subject applicators, golfers, and  
26 the environment to unnecessary risks. Similarly, reliance on any other single-tactic approach is  
27 also not recommended because if it fails, damage or turf loss is likely and that can lead to a  
28 negative effect on water quality. IPM's diversification of tactics allows for multiple layers of  
29 protection, and therefore better insurance against pests.

#### 30 **8.3.2 Cultural Practices**

31 Turfgrass is a perennial plant system in which cultural practices, especially irrigation, mowing,  
32 topdressing, aeration, and venting, greatly affect both short- and long-term plant health. Healthy  
33 plants and soil can better withstand pest pressure. Weak turf can be outcompeted by weeds that  
34 take advantage of bare ground or thin turf. Pathogens in particular can take advantage of weak,  
35 stressed, or otherwise unhealthy plants and cause disease. Unhealthy plants are also less able to  
36 fend off, compensate for, mask, or recover from insect damage. Examples of weed, disease, and  
37 insect pest issues are provided on the [Management Options web page](#) of the NYS BMP website.

1 **8.3.3 Use of Softer and Alternative Pesticides**

2 IPM encourages the use of pesticides as a "last resort" when other methods of pest control prove  
 3 to be inadequate. However, when pesticides are deemed necessary, an effective product least  
 4 likely to harm human health or the environment should be selected. Other management options  
 5 include using an alternative product, such as biological controls or reduced risk pesticides.

6 *Biological Control*

7 Biological control uses other living organisms to suppress or eliminate pests. Several organisms  
 8 are known to have some efficacy against turfgrass pests and have been marketed as pest control  
 9 products. These biological controls may act to suppress pest populations alone or work  
 10 synergistically with other natural, cultural, physical, or chemical management methods.  
 11 Examples of biological controls that are commercially available in New York State are provided  
 12 in Table 4 below.

14 *Table 4. Biological controls*

Beneficial Bacteria	Action
<i>Bacillus licheniformis</i>	Labeled for dollar spot management
<i>Bacillus subtilis</i>	Labeled for management of brown patch, dollar spot, powdery mildew, rust and anthracnose
<i>Pseudomonas aureofaciens</i> (strain TX-1)	Labeled for management of anthracnose, dollar spot, pink snow mold and Pythium
<i>Bacillus thuringiensis</i>	Labeled for management of caterpillars and white grubs in turf.
<i>Paenibacillus popilliae</i> and <i>Paenibacillus lentimorbus</i>	Cause "milky spore disease" and are labeled for management of Japanese beetle grubs in turf. Other strains cause milky spores in other species of grubs but are not commercially available.
Entomopathogenic Nematodes	Action
<i>Heterorhabditis bacteriophora</i> and <i>Steinernema feltiae</i>	Effective against white grubs
<i>Steinernema carpocapsae</i>	Effective against cutworms and possibly annual bluegrass weevils

15  
 16 *Reduced Risk Pesticides*

17 The EPA defines conventional "Reduced Risk" pesticides as having one or more of the following  
 18 advantages over existing products:

- 19 • low impact on human health
- 20 • low toxicity to non-target organisms (birds, fish, and plants)
- 21 • low potential for groundwater contamination
- 22 • lower use rates
- 23 • compatibility with IPM

1  
 2 A number of reduced risk pesticides can be used on turfgrass in NYS (Table 5). Biological  
 3 pesticides, which also have many of these desirable characteristics, are classified separately by  
 4 the EPA.

5 *Table 5. Reduced risk pesticides*

Category	Reduced Risk Pesticide
Fungicides	Azoxystrobin
	Boscalid
	Fludioxonil
	Trifloxystrobin
Herbicides	Bispyribac-sodium
	Carfentrazone-ethyl
	Mesotrione
	Penoxsulam
Insecticides	Chlorantraniliprole
	Spinosad

6 **8.4 Pesticide Selection**

7 Pesticides are an integral component of progressive IPM programs. The use of pesticides is  
 8 regulated by a number of state and federal agencies because of the concerns these compounds  
 9 pose for human health and the environment. Selection criteria and evaluation tools can assist in  
 10 selecting an appropriate pesticide when use is warranted while also protecting the environment.

11  
 12 When chemical control is needed, use the following criteria to help select the right pesticide:

- 13  
 14
- 15 • The pesticide must be registered for use in New York State.
  - 16 • It must be properly transported, handled, and stored.
  - 17 • It should be effective in treating the pest problem.
  - 18 • The frequency of pesticide usage should be considered with respect to the possibility of  
 19 chemical resistance.
  - 20 • Costs should be considered.
  - 21 • Environmental risk and potential for water quality impacts must be evaluated.

22 Each criteria to be considered in the pesticide selection process is explained in detail on the  
 23 [Selection Criteria web page](#) of the NYS BMP website.

24

## 1 8.5 IPM Best Management Practices

- 2 ❖ **IPM Overview** Identify key pests in the IPM plan.
- 3 ❖ Determine the pest's life cycle and know which life stage to target (e.g. for insect pests,
- 4 whether it is an egg, larva/nymph, pupa, or adult).
- 5 ❖ Train personnel how to regularly monitor pests by scouting or trapping.
- 6 ❖ Monitor prevailing environmental conditions for their potential impact on pest problems.
- 7 ❖ Observe and document turf conditions regularly, noting which pests are present, so that
- 8 informed decisions can be made regarding the damage the pests are causing and what control
- 9 strategies are necessary.
- 10 ❖ Identify alternative hosts and overwintering sites for key pests.
- 11 ❖ Assess pest damage when it occurs, noting particular problem areas, such as the edges of
- 12 fairways, shady areas, or poorly drained areas.
- 13 ❖ Document when the damage occurred. Note the time of day, date, and flowering stages of
- 14 nearby plants.
- 15 ❖ Establish injury and treatment thresholds levels for key pests and document them in the IPM
- 16 plan.
- 17 ❖ Document all pest control efforts, including non-chemical control methods and pesticide
- 18 usage, to plan future management actions.
- 19 ❖ Map pest outbreak locations to identify patterns and susceptible areas for future target
- 20 applications.
- 21 ❖ After treatment, determine whether the corrective actions reduced or prevented pest
- 22 populations, were economical, and minimized risks. Record and use this information when
- 23 making similar decisions in the future.

24

### 25 **Management Options**

- 26 ❖ Select turfgrass cultivars and species recommended for use in New York State and best
- 27 suited for the intended use and environmental conditions of the specific site.
- 28 ❖ Correct the soil's physical and chemical properties that may impact turfgrass health and its
- 29 ability to resist pests.
- 30 ❖ Evaluate the potential impact of the timing of cultural practices and nutrient applications on
- 31 the incidence of pest problems.
- 32 ❖ Implement proper cultural, irrigation, and turf management practices to reduce stress and
- 33 pressure of pest establishment.
- 34 ❖ Maintain a proper fertilization schedule to improve turf density and quality and reduce pest
- 35 populations.
- 36 ❖ Always use pest-free materials, such as in topdressing.
- 37 ❖ Address damage from turfgrass pests such as diseases, insects, nematodes, and animals to
- 38 prevent density/canopy loss to broadleaf weeds.
- 39 ❖ Divert traffic away from areas that are stressed by insects, nematodes, diseases, or weeds.
- 40 ❖ When nematode activity is suspected, an assay of soil and turfgrass roots is recommended to
- 41 determine the extent of the problem.

- 1 ❖ Identify areas on the golf course that can be modified to attract natural predators, provide  
2 habitat for them, and protect them from pesticide applications.
- 3 ❖ Install flowering plants that can provide parasitoids with nectar or sucking insects (aphids,  
4 mealybugs, and soft scales) with a honeydew source.

5

#### 6 **Pesticide Selection**

- 7 ❖ Apply a preventative pesticide to susceptible turfgrass when unacceptable levels of disease  
8 are likely to occur.
- 9 ❖ Evaluate use of biological control methods and reduced risk pesticides to treat the pest  
10 problem.
- 11 ❖ Use a defined pesticide selection process to select the most effective pesticide with the lowest  
12 toxicity and least potential for off-target movement.
- 13 ❖ Prioritize the selection of lower risk products whenever possible.
- 14 ❖ Select low or non-volatile pesticides.
- 15 ❖ Release insect-parasitic nematodes to naturally suppress insect pests such as white grubs.
- 16 ❖ Avoid applying pesticides to roughs, driving ranges, or other low-use areas to provide a  
17 refuge for beneficial organisms.
- 18 ❖ Rotate pesticide modes-of-action to reduce the likelihood of resistance, following guidelines  
19 and advice provided by the Fungicide Resistance Action Committee (FRAC), Herbicide  
20 Resistance Action Committee (HRAC), and Insecticide Resistance Action Committee  
21 (IRAC).

## 1    **9    PESTICIDE MANAGEMENT**

2    The storage and handling of pesticides on golf courses presents the greatest risk to water quality  
3    contamination because of the potential for an unintended release of a large volume of pesticide  
4    resulting in a point source of pollution to surface and/or groundwater. Therefore, the greatest  
5    attention to BMPs should be directed at storage and handling. In addition, the potential for  
6    pesticide nonpoint source pollution through runoff, leaching, or drift is minimized through proper  
7    handling and application. Adhering to pesticide regulations helps to ensure that all proper  
8    procedures are followed.

9  
10   For more information on the general use and management of pesticides, see:

- 11
- 12    ▪    [Pesticide Safety Education Program](#), Cornell University's Pesticide Management Education
- 13        Program
- 14    ▪    [NYSDEC Bureau of Pest Management Information Portal](#)
- 15    ▪    [Pesticides overview](#), Cornell University's College of Agriculture and Life Sciences'
- 16        Occupational & Environmental Health Program

### **BMP Principles for Pesticide Management**

- Ensure full compliance with existing pesticide regulations, including applicator and technician certification and following all label directions.
- Adapt or implement as many NYS Department of Environmental Conservation pesticide storage guidelines as possible.
- Assess site and weather conditions thoroughly before applying pesticides to avoid the potential for runoff, leaching, or drift.

### 17    **9.1    Pesticide Regulations**

18    The New York State Environmental Conservation Law (ECL), Article 33, Part 325, establishes  
19    statutory authority to the New York State Department of Environmental Conservation to regulate  
20    pesticides and pesticide use.

#### 21

#### 22    **9.1.1    Business Registration**

23    All businesses must register with the NYSDEC to commercially apply pesticides.

#### 24

#### 25    **9.1.2    Certified Applicators and Technicians**

26    The law requires commercial applicators and technicians applying pesticides to golf course turf to  
27    be certified in categories 3A (ornamentals, shade trees, and turf) or 3B (turf only). Commercial  
28    applicators must meet requirements in continuing education credits. Special supervisory

1 restrictions apply to technicians and apprentices.

2

### 3 **9.1.3 Labels**

4 When chemical controls are to be used, only pesticides registered for use in New York State  
5 are permitted. In addition to a listing by NYSDEC of registered pesticides, Cornell's pesticide  
6 Product Ingredient Manufacturer System (PIMS) lists all registered pesticides searchable by EPA  
7 registration number, common name, or active ingredient.

8

### 9 **9.1.4 Pesticide Reporting Law**

10 Applicators are required to file an annual report by February 1 each year summarizing their  
11 pesticide applications from the previous calendar year. These applicator reports are compiled each  
12 year in a summary report on sales and use around the state. NYSDEC is also monitoring water  
13 quality reports to assess pesticide levels in high-risk watersheds, aquifers, and wells across the  
14 state.

15

### 16 **9.1.5 Neighbor Notification**

17 The Environmental Conservation Law was amended to include the Neighbor Notification Law  
18 requiring a 48-hour notice to adjoining property owners prior to pesticide application. However,  
19 the requirement is only effective for counties that adopt the requirements into local ordinances;  
20 golf courses and sod farms are specifically exempted. Registered businesses should check with  
21 county officials or regional NYSDEC offices to see if specific local requirements apply.

22

### 23 **9.1.6 Pesticide Transport**

24 Off-property transport of pesticides must comply with New York State Department of  
25 Transportation regulations. Regulations require that the driver be trained for hazardous material  
26 transport. Drivers are required to carry the pesticide label and SDS sheet, have sufficient  
27 knowledge to handle any spills, and communicate with emergency responders in case of spills.  
28 Pesticides transported off the property or stored in a sprayer tank must be labeled with basic  
29 pesticide information as required under the Environmental Conservation Law.

30

### 31 **9.1.7 Aquatic Pesticide Applications**

32 The application of any pesticide to water, such as an aquatic herbicide used to control vegetation  
33 in golf course ponds, or any mosquito or other insect-related pesticide applied to water, must be  
34 covered under a SPDES [Pesticide General Permit](#).

35

### 36 **9.1.8 Additional Information**

37 For more information on pesticide regulations and guidelines, see:

38

- [NY Pesticide Business Registration](#)

39

- [Pesticides Registered in NY](#)

40

- [NY Pesticide Reporting Law](#)

41

- [NYSDEC Pesticide Storage Guidelines](#)

42

- [NYSDEC Policies on Backflow Prevention Devices](#)

- 1   ▪ [SPDES General Pesticide Permits](#)
- 2   ▪ [Clean Sweep NY](#)

### 3   9.3   Pesticide Storage

4   Storage and handling of pesticides in their concentrated form poses the highest potential risk to  
5   groundwater or surface water. For this reason, it is essential that facilities for storing and  
6   handling these products be properly sited, designed, constructed, and operated. In addition,  
7   storing large quantities of pesticides for long periods of time should be avoided. Adopting a "first  
8   in-first out" management system for pesticide purchase and storage helps to avoid a buildup of  
9   large quantities of chemicals.

10   All pesticides should be stored according to instructions on their labels. In addition to the label,  
11   Part 326.11 of the New York Codes, Rules and Regulations states: "No person shall store any  
12   restricted pesticide or empty containers thereof in such a manner as may be injurious to human,  
13   plant or animal life or to property or which unreasonably interferes with the comfortable  
14   enjoyment of life and property throughout such areas of the State as shall be affected thereby."  
15   Guidelines for chemical storage, including pesticide storage, are listed on the NYS BMP  
16   [Chemical Storage web page](#) and in the "Maintenance Operations" chapter of this document.

### 17   9.4   Mixing and Loading

18   Mixing should be avoided in areas where a spill, a leak or overflow could allow pesticides to get  
19   into water systems, such as near drinking water supplies or near surface water. No pesticide  
20   application equipment or mix tank should be filled directly from any source waters unless a back  
21   siphon prevention device is present. Mixing should not occur on gravel or other surfaces that  
22   allow spills to move quickly through the soil. Personnel should use the appropriate personal  
23   protective equipment (PPE) as described on the pesticide label when mixing and loading  
24   pesticides.

25  
26   All transfers of pesticides between containers, including mixing, loading, and equipment  
27   cleaning, should be conducted over a spill containment surface designed to intercept, retain, and  
28   recover spillage, leakage, and washwater. Containment needs depend on the quantities of  
29   pesticides that are being mixed and loaded but should be sufficient to contain any incidental  
30   spills.

### 31   9.5   Washing

32   Proper cleaning of equipment helps prevent residues from reaching surface water, groundwater,  
33   drainage pipes, or storm sewers. For equipment with pesticide residues, washing and rinsing of  
34   any equipment with pesticide residues should occur on a pad. Captured washwater can be used as  
35   a dilute pesticide per label, or it may be pumped into a rinsate storage tank for use in the next  
36   application and used as a dilute pesticide per the label.



1 For more information on pesticide equipment cleaning, see the following:

- 2 • [Cleaning Your Sprayer](#), Cornell University
- 3 • [Maintenance, Cleaning and Storage of Ground Sprayers](#), Montana State University

#### 4 9.6 Pesticide Applications

5 Golf course monitoring programs conducted in New York and several other states have indicated  
 6 little to no risk of water contamination from pesticides properly applied to golf turf, as described  
 7 in [Appendix B](#) of *Best Management Practices of New York State Golf Courses*. The application of  
 8 pesticides is generally made with low concentrations of active ingredients, often between 1% and  
 9 5% solutions. Simple attention to proper application procedures, especially avoiding direct  
 10 discharges into waterbodies or near wellheads, should typically suffice.

11  
 12 In addition to selecting an appropriate pesticide based on the selection criteria and evaluated using  
 13 available tools, a number of factors should be considered when applying pesticides to avoid water  
 14 quality impacts. For example, a number of site-specific considerations for the use of pesticides  
 15 should be evaluated using the results from the site analysis to identify areas where the risks of  
 16 pesticides reaching surface or groundwater are greater (such as steep slopes, shallow water tables,  
 17 and areas with frequently wet soils). In addition, pesticides should be applied accurately and with  
 18 care to avoid conditions that can increase the chances of runoff, leaching, and drift.

19 *Table 6. Factors contributing to greater risk for groundwater and surface water contamination. Source: USGA 1995*

Chemical	Soil	Site	Management
High solubility	Porous soil (sand)	Shallow water table	Incomplete planning
Low soil adsorption	Low organic matter	Sloping land	Misapplication
Long half-life (persistent)		Near surface water	Poor timing
Low volatility		Frequently wet soils	Over-irrigation

20

##### 21 9.6.1 Preventing Runoff and Leaching

22 Pesticides can be transported into water by several means:

23

- 24 ▪ surface runoff following precipitation events or irrigation
- 25 ▪ leaching through the soil horizon to reach groundwater
- 26 ▪ adsorption on eroded soil that reaches surface water

- 1     ▪   flowing directly to groundwater through sinkholes and permeable rock

2  
3   The use of vegetated buffers may be the single most important strategy mitigating the impact of  
4 runoff as these buffers can "capture" pesticides and prevent them from reaching waterways. In  
5 addition, the timing and location of applications should be thoroughly evaluated. Preventing  
6 runoff and leaching of pesticides is heavily influenced by weather and irrigation scheduling.  
7 Pesticide applications followed by heavy rain or irrigation can cause the pesticides to leach into  
8 groundwater. This leaching can occur even for nonpersistent pesticides (those with a short half-  
9 life). Pesticide applications on saturated soils following heavy rain or irrigation can also lead to  
10 surface runoff. In addition, avoid applying pesticides in sensitive areas.

### 11 12   **9.6.2 Preventing Drift**

13   Drift can potentially cause water quality impacts, damage to susceptible non-target crops, and a  
14 lower than intended rate to the turfgrass, thus reducing the effectiveness of the pesticide. Two  
15 types of drift occur: airborne (spray) drift and vapor drift. Spray drift is influenced by many  
16 interrelated factors including droplet size, nozzle type and size, sprayer design, weather  
17 conditions, and the operator. The amount of vapor drift depends upon a pesticide's volatility and  
18 atmospheric conditions such as humidity and temperature. Volatile turfgrass pesticides should be  
19 avoided. In some cases, the pesticide label may indicate low volatility. Low volatility, however,  
20 does not mean that a chemical will not volatilize under conducive conditions, such as high  
21 temperatures or low relative humidity. For more information, see [Appendix H: Preventing Drift](#)  
22 in *Best Management Practices of New York State Golf Courses*.

### 23   **9.7 Disposal**

24   There is usually no safe and legal way to dispose of pesticide leftover from professional  
25 applications. Therefore, all of the chemical must be used according to directions on the label.  
26 This includes washwater from pesticide equipment washing, which must be used in accordance  
27 with the label instructions.

28   Often pesticide storage facilities accumulate unusable or unwanted pesticide products. They can  
29 accumulate for a variety of reasons, such as mistakes made in calculating the amount of product  
30 needed or the launch of new product chemistries that may be more effective at controlling target  
31 pests. Disposing of these stockpiles properly may be challenging. Simply keeping them in  
32 storage eventually becomes problematic when packaging inevitably deteriorates or corrodes and  
33 creates a hazard. [CleanSweepNY](#) provides disposal services for unusable pesticides and other  
34 chemical wastes. Collection dates are scheduled and organized by NYSDEC with the  
35 collaboration of the New York State Department of Transportation.

## 1 9.8 Pesticide Container Management

2 Handling of empty pesticide containers must be done in accordance with label directions as well  
3 as with all federal, state, and local laws and regulations. Under the federal Resource  
4 Conservation and Recovery Act, a pesticide container is not empty until it has been properly  
5 rinsed. However, pesticide containers that have been properly rinsed can be handled and  
6 disposed of as non-hazardous solid waste. Federal law (FIFRA) and state law require pesticide  
7 applicators to rinse all empty pesticide containers before taking other container disposal steps.  
8 For more information on proper pesticide container disposal procedures, see [Pesticide](#)  
9 [Information Leaflet No. 13: Disposal of Pesticide Containers](#), University of Maryland Extension.

10 After following proper procedures (such as pressure rinsing, triple rinsing, puncturing, etc.),  
11 pesticide containers be either recycled through an approved program or disposed of by  
12 depositing them in a licensed sanitary landfill. The [Ag Container Recycling Council \(ACRC\)](#),  
13 provides an empty pesticide container recycling program in New York.

## 14 9.9 Pesticide Management Best Management Practices

### 15 Pesticide Storage and Handling

- 16 ❖ Use electronic or hard-copy forms and software tools to properly track pesticide inventory.
- 17 ❖ Keep and maintain records of all pesticides used in order to meet legal reporting  
18 requirements.
- 19 ❖ Follow pesticide labels for appropriate PPE.
- 20 ❖ Provide adequate PPE for all employees who work with pesticides, including equipment  
21 technicians who service pesticide application equipment.
- 22 ❖ Ensure that PPE is sized appropriately for each person using it.
- 23 ❖ Ensure that respirators are seal- and fit-tested properly and the person is thoroughly trained  
24 and has no medical limitations to respirator use.
- 25 ❖ Store PPE where it is easily accessible, but not in the pesticide storage area.
- 26 ❖ Forbid employees who apply pesticides from wearing facility uniforms home by providing  
27 laundering facilities or a uniform service.
- 28 ❖ Meet requirements for the [OSHA 1910.134 Respiratory Protection Program](#).
- 29 ❖ Do not transport pesticides in the passenger section of a vehicle.
- 30 ❖ Never leave pesticides unattended during transport.
- 31 ❖ Maintain an inventory of all pesticides used and the Safety Data Sheet (SDS) for each  
32 chemical.
- 33 ❖ Avoid purchasing large quantities of pesticides that require storage for more than six months.
- 34 ❖ Adopt the "first in-first out" principle, using the oldest products first to ensure that the  
35 product shelf life does not expire.
- 36 ❖ Locate pesticide storage facilities away from other structures to allow fire department access.

- 1 ❖ Store, mix, and load pesticides away from sites that directly link to surface water or  
2 groundwater (e.g. wells).
- 3 ❖ Store pesticides in a lockable concrete or metal building separate from other buildings.
- 4 ❖ Shelving should be made of sturdy plastic or reinforced metal.
- 5 ❖ Metal shelving should be kept painted to avoid corrosion. Wood shelving should never be  
6 used, because it may absorb spilled pesticides.
- 7 ❖ When storing pesticides on shelves, place liquid pesticides on lower shelves and dry  
8 formulations above them.
- 9 ❖ Store herbicides, insecticides, and fungicides in separate areas within the storage unit.
- 10 ❖ Storage facility floors should be impervious and sealed with a chemical-resistant paint.
- 11 ❖ Floors should have a continuous sill to retain spilled materials and should not have drains,  
12 although a sump may be included.
- 13 ❖ Sloped ramps should be provided at the entrance to allow the use of wheeled handcarts for  
14 moving material in and out of the storage area safely.
- 15 ❖ Automatic exhaust fans and an emergency wash area should be provided. Light and fan  
16 switches should be located outside the building, so that both can be turned on before  
17 employees enter the building and turned off after they leave the building.
- 18 ❖ Avoid temperature extremes inside the pesticide storage facility.
- 19 ❖ Annually review pesticide inventories and properly dispose of unusable and unwanted  
20 pesticides.

21

## 22 **Mixing and Loading**

- 23 ❖ Follow secondary containment requirements as required.
- 24 ❖ Load and mix pesticides over an impermeable surface, such as a concrete pad.
- 25 ❖ Mix pesticides at least 150 feet downslope from any well.
- 26 ❖ Mix materials according to label directions and in amounts that will be used for the  
27 application to avoid excess that will need disposal.
- 28 ❖ Either use anti-backflow devices when mixing pesticides or maintain a 6" air gap between  
29 mixing container and water source.

30

## 31 **Washing**

- 32 ❖ Pump the sump dry and then clean it at the end of each day. Liquids and sediments should  
33 also be removed from the sump and the pad whenever pesticide materials are changed to an  
34 incompatible product (i.e. one that cannot be legally applied to the same site).
- 35 ❖ Collect washwater (from both inside and outside the application equipment) and use it as a  
36 pesticide in accordance with the label instructions.
- 37 ❖ The rinsate may be applied as a pesticide (preferred) or stored for use for the next compatible  
38 application.

39

## 1 Pesticide Applications

- 2 ❖ Identify any areas on the course prone to leaching losses (e.g. shallow water tables, sand-  
3 based putting greens, coarse-textured soils, etc.) and do not use highly soluble pesticides in  
4 these areas.
- 5 ❖ If listed species or species of concern are present, specifically select pesticides that have no  
6 known effects on these species.
- 7 ❖ Check the forecast before applying pesticides and apply when conditions are favorable, such  
8 as minimal wind velocity, temperature inversions not forecast, rain not forecast, etc.
- 9 ❖ Follow the pesticide label to avoid drift.
- 10 ❖ Use spray additives within label guidelines.
- 11 ❖ Schedule the timing and amount of irrigation needed to water-in products (unless otherwise  
12 indicated on label) without over-irrigating.
- 13 ❖ If sites adjacent to the application area are planted with susceptible plants or crops, allow a  
14 buffer area between the two, or wait until winds are blowing away from the area of concern.
- 15 ❖ Follow the pesticide label for re-entry period requirements or recommendations following  
16 applications.
- 17 ❖ Allow all pesticide applications to dry thoroughly before allowing play to resume.
- 18 ❖ Use an appropriately sized applicator for the size of area being treated.
- 19 ❖ Ensure the spray technician is experienced, certified, and properly trained.
- 20 ❖ Properly calibrate all application equipment at the beginning of each season (at a minimum)  
21 or after equipment modifications.
- 22 ❖ Check pesticide application equipment daily when in use.
- 23 ❖ Use recommended spray volumes for the targeted pest to maximize efficacy.
- 24 ❖ Calibrate walk-behind applicators for each person making the application to take into  
25 consideration walking speed, etc.
- 26 ❖ Avoid high spray boom pressures; consider 45 PSI a maximum for conventional broadcast  
27 ground spraying.
- 28 ❖ Use drift-reduction nozzles that produce larger droplets when operated at low pressures.
- 29 ❖ Use wide-angle nozzles and low boom heights and keep boom stable.
- 30 ❖ When possible, use lower application speeds to avoid drift.

## 32 Disposal

- 33 ❖ Dispose of unused pesticides properly. See [CleanSweepNY](#) for collection days.

## 35 Pesticide Container Management

- 36 ❖ Rinse pesticide containers immediately in order to remove the most residue.
- 37 ❖ Rinse containers during the mixing and loading process and add rinsate water to the finished  
38 spray mix.
- 39 ❖ Rinse emptied pesticide containers by either triple rinsing or pressure rinsing.

- 1 ❖ Use refillable containers only for pesticides.
- 2 ❖ Recycle non-refillable containers when possible.
- 3 ❖ Puncture empty and rinsed pesticide containers prior to disposal and dispose of them
- 4 according to the label.

## 10 POLLINATOR PROTECTION

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. Most people are aware of managed honey bees, but there are also 450 wild pollinator species in New York State, including bees, wasps, beetles, flies, ants, moths, and butterflies. In the absence of these pollinators, many plant species, including the fruits and vegetables we eat, would fail to reproduce. These include economically important crops in the state, such as apples, blueberries, cherries, tomatoes, squash, and peppers, all of which are pollinator-dependent for good yields.

Both wild and managed bees are facing threats that can alter their health, abundance, and distribution. According to the [New York State Pollinator Protection Plan](#), "Over the past several years, the loss of managed pollinator colonies in the state has exceeded 50%. This is coupled with losses in the native pollinator community and the habitat that sustains them." Research indicates that some pesticides are harmful to pollinators and can have negative effects at the sub-individual level (such as gene expression or physiology), individual level (such as mortality, foraging, or learning), or even the colony level (such as colony growth, overwintering, or honey production).

Because of the potential for non-target effects of products used in golf course management, pesticide applicators need to be mindful of the impact that pesticides have on pollinator species and their habitat. In addition to adhering to best management practices related to pesticide applications, golf course managers can protect and enhance habitat on the course in a number of ways to help both wild pollinators and managed bees (including hives on the course or in surrounding areas). For more information, see the following: [New York State Integrated Pest Management Pollinator web page](#) and the [Pollinator Network @ Cornell](#).

### BMP Principles for Pollinator Protection

- Adhere to pest management practices that protect pollinators when selecting and applying chemical control.
- Preserve and enhance habitat on the golf course that provides for pollinator foraging and nesting.

#### 10.1 Regulatory Considerations

Pollinator protection language is a requirement for pesticide labels. Following the label is mandatory. Pesticide applicators must be aware of honey bee toxicity groups and be able to understand precautionary statements. In addition, they should be aware of the behavior of honey bees, wild bees and other pollinators that may visit golf courses and avoid applying pesticides

1 when and where these insects may be present. They should also understand the effects of  
2 pesticides on bees and other pollinators, as well as the routes of exposure. The USGA  
3 publication [Making Room for Native Pollinators](#) provides the basics of pollinator biology useful  
4 for pesticide applicators. The [Pollinator Partnership](#) has visual depictions of honey bee, solitary  
5 bee, colony and general pollinator life cycles that are useful as well.  
6

7 Recordkeeping may be required by law in order to use some pesticide products. In addition to  
8 legal requirements, more detailed records should be kept in accordance with IPM principles.  
9 keeping records of both pests and pest control activity provide information on past infestations  
10 and control effectiveness that can be referenced to inform future management actions.

## 11 10.2 Pest Management Practices that Reduce Impacts on Pollinators

12 It is important to minimize the impacts of pesticides on bees and beneficial arthropods. Pesticide  
13 applicators must use appropriate tools to help manage pests while safeguarding pollinators, the  
14 environment, and humans. As detailed in the NYS Pollinator Protection Plan, the state has  
15 committed to IPM on state lands "by managing pests on turf and ornamental plants solely  
16 through mechanical, sanitary, cultural or biological means to the maximum extent practicable"  
17 while recognizing that pesticide use is necessary under certain circumstances.  
18

19 Superintendents can utilize IPM best management practices for turf that protect pollinators by  
20 following these simple steps:  
21

- 22 • Identifying what is truly a pest (i.e. while solitary ground nesting bees and wasps might be  
23 alarming, most are harmless).
- 24 • Setting higher weed thresholds in low-use areas.
- 25 • Monitoring bee activity to avoid applying pesticides during peak activity times.  
26

27 When the use of pesticides is necessary, being mindful of pollinators requires focusing on  
28 minimizing exposure to non-target pollinators in play and non-play course areas.

## 29 10.3 Preserving and Enhancing Habitat on the Course

30 Habitat for pollinators includes foraging habitat and nesting sites. Pollinator-friendly habitat  
31 contains a diversity of blooming plants of different colors and heights, with blossoms throughout  
32 the entire growing season. Native plants are best, providing the most nutritious food source for  
33 native pollinators. Even plants we consider weeds provide important habitat. For example, red  
34 clover offers an important nectar and pollen source. Providing nesting sites for native species can  
35 be accomplished by taking simple steps in out-of-play areas, such as leaving stems and coarse  
36 woody debris and leaving exposed patches of well-drained soil, or by creating nesting areas such  
37 as wooden nesting boxes for hole nesting bees.  
38

39 Pollinator habitat on the golf course includes both areas renovated specifically with pollinators in



1 mind and existing out-of-play areas. For example, one of the most effective BMPs for protecting  
2 water quality also protects pollinator habitat: leaving a low/no management buffer strip around  
3 water courses and bodies of water. Opportunities for renovation can be used to enhance the  
4 habitat for pollinators with native plants, wildflowers, and flowering trees and shrubs. [Part 2 of](#)  
5 [our video case study](#) describes the process used to establish native areas during renovations at  
6 Rockville Links Club in Rockville Centre on Long Island. The NYS BMP case study [Enhancing](#)  
7 [Habitat for Native Pollinators with Low-to-No Maintenance Areas](#) at Rockland Country Club  
8 provides another example of the establishment process for a native area attractive to pollinators.  
9

10 For more information see:

- 11 • [Making Room For Native Pollinators](#), Xerces Society.
- 12 • [Pollen Specialist Bees of the Eastern United States](#)
- 13 • [Host plants for specialist bees of the Mid-Atlantic and Northeastern United States](#)
- 14 • [Monarchs in the Rough](#), a program sponsored by Audubon International and the  
15 Environmental Defense Fund to provide superintendents with regionally appropriate  
16 seeds to restore monarch butterfly habitat in out-of-play areas.

#### 17 10.4 Managed Bee Hives on the Course

18 Hosting honey bee hives on the golf course provide bees with valuable green space, especially in  
19 urban areas, and can be a positive public-relations tool. If embarking on this effort, consider:

- 20 • Partnering with an experienced local beekeeper. Proper beekeeping is time and  
21 knowledge intensive. A [list of beekeeper organizations in New York](#) is available. If not  
22 partnering with an experienced beekeeper, superintendents or other responsible staff  
23 should attend a beekeeping course.
- 24 • Ensuring enough food sources are available for both honey bees and wild pollinator  
25 species.
- 26 • Placing hives away from areas where golf course workers or golfers are active to avoid  
27 stings.
- 28 • Facing the hive exit in a direction away from in play areas of the course.
- 29 • Educating golfers via explanatory signs, newsletters, and sales of honey and other bee  
30 products.
- 31 • Calling in an experienced beekeeper if disease or parasites are suspected in order to  
32 identify and mitigate any health issues.

33  
34 For more information on how managed hives have been integrated at a golf course and related  
35 communications with club members, see [Part 3 of our video case study](#) at Rockville Links Club.

## 1 10.5 Pollinator Protection Best Management Practices

### 2 **Pest Management Practices**

- 3 ❖ Follow label information directing the application of pesticide when plants may be in bloom
- 4 and follow all BMPs to avoid impacting pollinators.
- 5 ❖ Inform nearby beekeepers in advance of applying pesticides so they have the option of
- 6 moving their hives.
- 7 ❖ Use [drift reduction methods](#) to stay on target by using the latest spray technologies,
- 8 [selecting nozzles correctly](#), using backpack sprayers when possible, and monitoring
- 9 wind.
- 10 ❖ Do not apply pesticides when pollinators are active (spray at night, or in early
- 11 morning/late evening and when air is calm).
- 12 ❖ Before applying a pesticide, scout the area for both harmful and beneficial insect
- 13 populations, and use pesticides only when populations present exceed a damage
- 14 threshold.
- 15 ❖ Reduce preventive pesticide inputs to only areas with known chronic pest pressure.
- 16 ❖ If flowering weeds are prevalent, mow or remove them before applying pesticides.
- 17 ❖ Use pesticides that have a lower impact on pollinators.
- 18 ❖ Avoid applications during unusually low temperatures or when dew is present or
- 19 forecast.
- 20 ❖ When possible, use spray or granular formulations of pesticides that are known to be
- 21 less hazardous to bees (e.g. wettable powders).
- 22 ❖ Reduce planting dust from treated seeds: use wax treated seeds, use deflectors on
- 23 machinery, and be aware of dry/windy conditions.
- 24 ❖ Follow irrigation instructions carefully to ensure pesticides are washed from foliage
- 25 into soil. In addition, nonionic surfactant can help reduce the potential for drift.
- 26 ❖ Consider the use of biologicals (e.g. entomopathogens) and bio-based lures, baits, and
- 27 pheromones as alternatives to insecticides for pest management.
- 28

### 29 **Pollinator Habitat Preservation and Enhancement.**

- 30 ❖ Utilize native species when renovating out-of-play areas.
- 31 ❖ Choose flowers of different shapes, sizes, and colors.
- 32 ❖ Choose species that bloom at different times of the year.
- 33 ❖ Include both perennials and annuals in native plant areas.
- 34 ❖ Choose south-facing sites whenever possible for establishing native areas.
- 35 ❖ Leave stems and coarse woody debris in native areas for pollinator nesting.
- 36 ❖ Leave exposed patches of well-drained soil in native areas for pollinator nesting.
- 37 ❖ Consider joining the [Monarchs in the Rough](#) project.
- 38 ❖ Provide water sources with shallow sides to prevent pollinators from drowning.

## 11 MAINTENANCE OPERATIONS

New construction designs should consider combining storage, mixing, and washing operations in an integrated chemical management system. For existing facilities, updating these areas does not necessarily require a new building as many changes can be easily made. Information specific to pesticide storage and handling can be found in the "Pesticide Management" chapter of this document.

### BMP Principles for Maintenance Operations

- Assess potential point source pollution risk.
- Ensure compliance with regulatory requirements designed to prevent point source pollution.
- Manage organic and inorganic waste to minimize potential point source pollution.

#### 11.1 Regulatory Considerations

Every golf course has a central area for the maintenance and storage of equipment and supplies. These areas can potentially become point sources of pollution because of unintended releases of chemicals such as pesticides, fertilizers, or fuel during storage or handling of these materials. Containment measures in these areas can easily prevent chemicals from becoming point sources of pollution.

##### 11.1.2 New Maintenance Facilities Siting and Planning

The New York State Department of Health does not allow chemical storage or mixing and loading facilities within 100 feet of a potable well. Other requirements include local zoning for the siting of maintenance facility and operations, which vary by city and county. Requirements often include a minimum distance (set-back) from wetlands, surface wells, and property lines. The state's Freshwater Wetlands Act requires a 100-foot buffer around wetlands. Some townships have even broader requirements.

Local building inspectors should be consulted during planning for new facilities to outline the permitting process and local requirements. Also, consider meeting with a representative from a NYSDEC regional office and the local fire marshal. The NYSDEC requests a [State Environmental Quality Review \(SEQR\)](#) for new construction, which is administered by local governments. NYSDEC comments on SEQR, as do other interested and involved agencies.

##### 11.1.2 Chemical Storage

The NYSDEC currently offers [guidelines for chemical storage](#) and mixing and loading operations, as detailed later in this chapter. While there are currently only guidelines, regulations are in the process of being drafted. Please monitor the NYSBMP website for more information on

1 the potential changes.

2

### 3 **11.1.3 Backflow Prevention Devices**

4 NYSDEC regulations require the use of Backflow Prevention Devices when public water is used  
5 with pesticide application equipment.

6

### 7 **11.1.4 Hazardous Wastes**

8 Some of the wastes generated in maintenance facilities must be handled as hazardous wastes.

9 Examples of wastes that may be generated at a golf facility include, but are not limited to, the  
10 following:

11

- 12 • parts wash solvents
- 13 • waste gasoline
- 14 • cleaning materials
- 15 • paints
- 16 • waste oil
- 17 • lead-acid batteries
- 18 • aerosol cans
- 19 • spent fluorescent bulbs
- 20 • unusable pesticides and inner bag liners
- 21 • unusable herbicides and inner bag liners
- 22 • antifreeze

23

24 A waste is a hazardous waste if it exhibits a specific characteristic (ignitability, corrosivity,  
25 reactivity, toxicity) or if it is included in any of the four specifically listed categories of hazardous  
26 waste. Many waste fluorescent lamps are hazardous wastes due to their mercury content. Other  
27 examples of lamps that, when spent, are commonly classified as hazardous waste include: high-  
28 intensity discharge (HID), neon, mercury vapor, high pressure sodium, and metal halide lamps.

29

30 USEPA issued the Universal Waste Rule in 1995 to streamline compliance with hazardous waste  
31 regulations. This rule is designed to reduce the amount of hazardous waste in the municipal solid  
32 waste stream, to encourage the recycling and proper disposal of some common hazardous wastes  
33 and to reduce the regulatory burden on waste generators. Universal wastes include such items as  
34 hazardous batteries, hazardous mercury-containing thermostats, certain pesticides, and hazardous  
35 lamps. Although handlers of universal wastes must meet less stringent standards for storing,  
36 transporting, and collecting wastes, the wastes must comply with full hazardous waste  
37 requirements for final recycling, treatment, or disposal.

38 Therefore, every golf club is responsible (and liable) for the safe handling of the product and for  
39 the proper waste disposal by a reputable waste removal service. These services should be certified  
40 and bonded for transporting your waste to similarly accredited processing centers.

41

### 42 **11.1.5 Petroleum Storage**

1 NYS has [regulations for above and below ground storage of fuel and fuel oil](#) in Part 613 of the  
2 Environmental Conservation Law. Every facility manager should review this regulation carefully.  
3 The regulations require daily inspection logs be kept, as well as annual inspections. Counties and  
4 cities may also have their own fuel storage regulations.

## 5 **11.2 Design and Operation**

6 New construction designs should consider combining storage, mixing, and washing operations in  
7 an integrated chemical management system. Buildings and infrastructure should be designed to  
8 account for the traffic and usage. The resulting design will provide a much better envelope of the  
9 operations compared with separately constructed areas. Integrated designs often include fuel  
10 storage and filling stations within the same containment areas. For existing facilities, updating  
11 these areas does not necessarily require a new building as many changes can be easily made.  
12 Information specific to pesticides storage and handling can be found in the "Pesticide  
13 Management" chapter of this document.

### 14 **11.2.1 Storage**

15 The goal of an ideal storage facility is the safe siting and storage of potential contaminants that  
16 ensures a high level of water quality protection. Modular or independent containment units can be  
17 installed in many sizes. The units are typically self-contained, fireproof, and secure and can be  
18 temperature controlled with ventilation. Options for such units include fire suppression, eye  
19 washes, and safety showers. Floor drains should include a sump and a chemical pump to move the  
20 chemicals discharged to a waste tank as in the figure below. The material can be reclaimed,  
21 diluted to label concentrations, and applied to turf areas or collected for disposal using certified  
22 hazmat haulers.

23  
24 Below are [NYSDEC guidelines for pesticide storage](#) which can be applied to the storage of all  
25 chemicals. With respect to the storage of pesticides specifically, the pesticide label is the law and  
26 all pesticides should be stored according to instructions on their labels. In addition to the label,  
27 Part 326.11 of the New York Codes, Rules and Regulations states: "No person shall store any  
28 restricted pesticide or empty containers thereof in such a manner as may be injurious to human,  
29 plant or animal life or to property or which unreasonably interferes with the comfortable  
30 enjoyment of life and property throughout such areas of the State as shall be affected thereby."  
31 Pesticide storage areas should be designed and managed in a manner that prevents or minimizes  
32 the risk of injury, harm to the environment or any impact on the use or value of property.

33  
34 Guidelines are as follows:

- 35 • Storage facilities should be structurally separate from residential, office and general work  
36 areas; livestock quarters, food, feed or seed storage and water supply sources.

- 1 • Storage should be in separate buildings and at least 50 feet away from residential or farm  
2 property. Fencing is currently not stipulated but could be considered as an added  
3 precaution.
- 4 • Storage areas should have a raised berm on all sides and an impervious surface for  
5 containment.
- 6 • Facilities should be equipped with spill containment material and fire extinguishers.  
7 Suggested spill containment material includes absorbent spill containment pads,  
8 sweeping compound, brushes or brooms, a dust pan, a shovel, and a disposal container or  
9 bag.
- 10 • PPE should be available near but not within the storage area.
- 11 • The storage facility should be locked and properly posted with warnings.
- 12 • Annual updates should be provided to the local fire department and include a "Fire and  
13 Spill Response Plan." Additional precautions might include provisions of the National  
14 Fire Protection Association codes.
- 15 • Chemicals should be segregated by function (e.g. fungicide, insecticide, and herbicide)  
16 and hazard level. All flammable and "incompatible" materials should be stored  
17 separately.
- 18 • Mixing areas should be similarly bermed with impervious surfaces.
- 19 • Indoor mixing areas should be properly vented.
- 20 • Bulk containers, construed to be equal to or greater than 55 gallons, should be locked.  
21 Drains should be used to collect any spills into a containment area. The spill containment  
22 system should have a capacity equal to or greater than 25% of the volume of pesticides  
23 stored.
- 24 • A water supply and wash station are required at or adjacent to the facility for  
25 emergencies.
- 26 • A suitable first aid kit for pesticide poisoning should be nearby.
- 27 • Forced air vent systems capable of exchanging the air volume three to four times per hour  
28 should be considered, along with temperature control for keeping temperatures under 95°  
29 F and above freezing.
- 30 • Local fire departments should be made aware of the pesticides and fertilizers stored to  
31 help them prepare in the event of a fire.

32  
33 Very old or inadequate storage areas may or may not be out of compliance, but consider  
34 planning for improvements to implement these guidelines over time. Updating chemical storage  
35 areas does not necessarily require a new building. Many changes can be made to meet  
36 guidelines, such as:

- 37  
38 • impervious flooring

- 1 • flooring sloped to a drain
- 2 • curbing to contain at least 25% of the volume of liquid chemicals and fertilizers stored
- 3 • ventilation to exhaust any fumes in the event of a spill
- 4 • PPE for workers and emergency wash stations

5

### 6 **11.2.2 Mixing and Loading**

7 Mixing, loading, and washing areas should be well ventilated and should take place in contained  
8 areas that are bermed, have impervious surfaces, and roofed to prevent rainfall spreading pesticide  
9 residue. Pesticide storage and handling require additional considerations and are regulated by  
10 NYSDEC. See the [Pesticide Use web page](#) on the NYS BMP website for more information  
11 specific to mixing and loading of pesticides. In addition, pesticide labels provide information on  
12 required PPE that must be used during handling or use of pesticides. See [EPA's PPE for Pesticide  
13 Handler's web page](#) for more information.

14

15 Precautions should be in place to effectively respond to emergencies, such as the availability of  
16 proper PPE, spill response kits, and emergency wash stations. When mixing or loading, caution  
17 should be used and labels carefully reviewed to ensure that chemicals mixed together are  
18 compatible. Water used for mixing should be tested for pH to ensure that tank mixes do not expire  
19 prematurely due to alkaline hydrolysis. [NYSDEC regulations](#) require the use of Backflow  
20 Prevention Devices when public water is used.

## 21 **11.3 Waste Management**

### 22 **11.3.1 Pesticides**

23 Pesticide containers must be cleaned and disposed of or recycled properly. Procedures typically  
24 include triple rinsing nonflammable containers and either returning cleaned empty containers to  
25 the vendor or properly sealing and disposing of them in a sanitary landfill. Rinsate may be re-  
26 applied to turfgrass consistent with instructions on the label. Unused pesticides must be disposed  
27 of in accordance with state regulations, such as by returning to the supplier or disposing at an  
28 approved hazardous waste facility.

29

### 30 **11.3.2 Lubricants, Greases, Paints, and Solvents**

31 Lubricants, greases, paints, and solvents should be stored appropriately, typically in fireproof  
32 enclosures, separately from pesticides and fertilizers. Special cleaning stations are commercially  
33 available that contain and recycle solvents and degreasers.

34

35 In addition to any handling precautions specified on the product label or SDS sheet, added steps  
36 should be taken to prevent and contain any spills. Spills should be cleaned up using approved dry  
37 absorbents. Contaminated material should be stored in containers specially marked as hazardous

1 waste and disposed of using licensed waste haulers and hazmat processors.

2

### 3 **11.3.3 Organic Waste and Wastewater**

4 The release of organic waste, such as grass clippings, associated with equipment cleaning needs  
5 the same level of protection afforded liquid and granular nutrients and pesticides. When debris is  
6 removed from equipment, it should not be released into open surface water or in a location near  
7 well heads or shallow groundwater. Often, effective equipment cleaning areas can be maintained  
8 as mixing and loading areas with impervious flooring and drains that allow for some separation of  
9 organic solids and liquids.

10

11 When using a simple wash-pad and collection area, the wash-water should be dispersed along the  
12 land, preferably along a designed bio-filtration system. Closed system cleaning stations are  
13 available that separate clippings/solids and treat the washwater. The recycled water is reused as  
14 washwater. Another approach to wastewater treatment uses microbes to break down chemical  
15 compounds. Both types of systems may require additional purification steps to remove odors and  
16 harmful bacteria. These systems must be carefully sized to process the peak water volume  
17 anticipated for contaminant levels expected. The equipment varies in costs but increases with  
18 structural requirements and permits. Two NYS BMP case studies provide more information of  
19 two types of equipment washing areas: [Wash Load at Bedford Golf and Tennis Club](#) and  
20 [Opportunities for Improvement of Wash Pad Operations](#).

21

#### 22 *Clipping Management*

23 Nutrient BMPs recommend that clippings be widely redistributed to turf. Research has shown  
24 that nitrate levels in leachate increased to as much as 30 mg/L in areas that received four times  
25 the normal clippings return. Some clubs elect to collect clippings from fairways and then dump  
26 these clippings as yard waste. The accumulation of clippings and other yard wastes such a  
27 leaves, tree limbs, and other plant debris can be a substantial source of contamination to surface  
28 water and groundwater if placed close to water courses.

29

30 Clippings should be screened and collected when cleaning equipment in the maintenance area.  
31 They should not be allowed into the stream of wastewater. The inherent concentration of organic  
32 nitrogen and phosphorus, along with any pesticide residues, can contaminate the wastewater or  
33 reduce the effectiveness of wastewater treatment equipment. Ideally, clippings should be blown  
34 off using compressed air and then collected. If water is being used, sumps should screen and  
35 convey clippings and other solids prior to wastewater disposal or treatment. Many clubs have  
36 contracted with local composting companies to haul their organic waste. Material is generally  
37 accumulated in dumpsters and then frequently removed.

### 38 **11.4 Emergency Management**

39 Planning and preparations should be made for potential emergencies. Local emergency personnel  
40 such as local fire departments should be consulted, be notified about the locations of pesticide and



1 fertilizer storage, and be given regularly updated lists of chemicals stored. Storage areas should be  
2 properly placarded. Training and orientation should also be conducted with employees to review  
3 plans and preparations.

4  
5 New York State responds to reports of petroleum and other hazardous material releases through  
6 the Spill Response Program maintained by the NYSDEC. Spill response staff throughout the state  
7 investigate such spill reports and take action based on the type of material spilled, potential  
8 environmental damage, and safety risks to the public. Releases to the environment should be  
9 reported to the NYSDEC Spills Management Hotline at 1-800-457-7362. See the [Chemical and](#)  
10 [Petroleum Spills web page](#) on the NYSDEC website for more information on reporting of spills.

### 11 *Safety Data Sheets (SDS)*

12 The Hazard Communication Standard (HCS) (29 CFR 1910.1200(g), revised in 2012, requires  
13 that the chemical manufacturer, distributor, or importer provide SDS for each hazardous chemical  
14 to users to communicate information on these hazards. More information on SDS can be found on  
15 the [Hazard Communication Standard: Safety Data Sheets web page](#) of the OSHA website.

16  
17 An up-to-date file should be maintained with copies of all the SDS reports for all chemicals used,  
18 stored on the property, and made available to employees. Copies of these files can be provided to  
19 local fire departments and hospitals in case of any emergency.

### 20 *First Aid*

21 Adequate provisions should be provided to immediately treat any person exposed to chemicals.  
22 These include eye wash stations and showers. First aid kits should be available to treat skin  
23 contact, ingestion, or inhalation.

### 24 *Spill Management*

25 Cornell's Occupational and Environmental Health Department (OEHD) in the College of  
26 Agricultural Sciences has guidelines that can be used a template for spill management:

- 27
- 28 • Evacuate personnel from the immediate area of the spill.
  - 29 • Control the spill. Do not endanger yourself. To the extent possible, shut off the source  
30 and block the flow.
  - 31 • Call 911 if:
    - 32 ○ anyone is injured
    - 33 ○ the spill is too large for a local clean up
    - 34 ○ the spill migrates off-site
    - 35 ○ the spill threatens the health and safety of anyone
  - 36 • Identify the spilled material(s).
  - 37 • Barricade the area and notify others in surrounding areas not to enter the spill area.
  - 38 • Wait for help to arrive.
- 39

40 [Spill kits](#) can be used for incidental releases. Follow these procedures:

- 1 • Consult the appropriate SDS and label (for pesticides).
- 2 • Wear the appropriate PPE.
- 3 • Contain the spill. Prevent spread or escape from the area by using sorbents.
- 4 • Clean up the spill. Never hose down an area until the cleanup is completed.

5

6 To clean up pesticides:

- 7 • Recover as much product as possible in a reusable form. Store and use as intended.
- 8 Recover the rest of the product as a waste product by using an absorbent or sweeping
- 9 compound.
- 10 • When all recoverable material is secured, clean contaminated surface residues using
- 11 triple-rinse technique. For instance, a spill of liquid on the floor requires that the area be
- 12 damp-mopped three times.

13

14 To clean up all other chemicals:

- 15 • Small liquid spills can be cleaned up with a commercially available absorbent. Avoid
- 16 using paper towels; they increase the surface area and the rate of evaporation, increasing
- 17 the fire hazard.
- 18 • For acid or base spills, use a sorbent that will neutralize the liquids (trisodium phosphate,
- 19 sodium bicarbonate, or other commercially available products).
- 20 • Use a dustpan and brush to sweep up the absorbed spill. Wash the contaminated area with
- 21 soap and water.

## 22 11.5 Maintenance Operations Best Management Practices

### 23 Storage and Handling of Chemicals

- 24 ❖ Post warning signs on chemical storage buildings, and especially near any entry or exit areas.
- 25 ❖ Storage facilities must be secured and allow only authorized staff to have access.
- 26 ❖ Pesticide and fertilizer storage areas should preferably be located away from other buildings.
- 27 ❖ Floors should be sealed with chemical-resistant paint.
- 28 ❖ Floors should have a continuous sill to help contain any spills.
- 29 ❖ Shelves should be made of plastic or reinforced metal. Metal shelving should be coated with
- 30 paint to avoid corrosion. Wood should not be used due to its ability to absorb spilled
- 31 chemicals.
- 32 ❖ Exhaust fans and an emergency wash station should be provided.
- 33 ❖ Light and fan switches should be exteriorly installed to illuminate and ventilate the building.
- 34 ❖ Store chemicals in original containers.
- 35 ❖ Store chemicals so that the label is clearly visible. Loose labels should be refastened.
- 36 ❖ Store flammable chemicals separately from non-flammable chemicals.
- 37 ❖ Store liquid materials below dry materials to prevent contamination from a leak.
- 38 ❖ Use regulatory agency-approved, licensed contractors for the disposal of chemicals.

- 1 ❖ Provide adequate staff training pertaining to the risks and liabilities of chemical storage and
- 2 use.
- 3 ❖ Train staff and other management on how to access and use the facility's SDS database.
- 4 ❖ Maintain accurate inventory lists.

5

6 **Equipment Washing**

- 7 ❖ Brush or blow off accumulated grass clippings from mowing equipment using compressed
- 8 air before washing.
- 9 ❖ Wash equipment on a concrete pad or asphalt pad that collects the water. After the collected
- 10 material dries, collect and dispose of it properly.
- 11 ❖ Washing areas for equipment not contaminated with pesticide residues should drain into
- 12 oil/water separators before draining into sanitary sewers or holding tanks.
- 13 ❖ Do not wash pesticide application equipment on pads with oil/water separators. Do not wash
- 14 near wells, surface water, or storm drains.
- 15 ❖ Do not wash mowing equipment on a pesticide mixing and loading pad. This keeps grass
- 16 clippings and other debris from becoming contaminated with pesticides.
- 17 ❖ Use spring-loaded spray nozzles to reduce water usage during washing.
- 18 ❖ Minimize the use of detergents. Use only biodegradable, non-phosphate detergents.
- 19 ❖ Use non-containment washwater for field irrigation.
- 20 ❖ Do not discharge non-contaminated wastewater during or immediately after a rainstorm,
- 21 since the added flow may exceed the permitted storage volume of the stormwater system.
- 22 ❖ Do not discharge washwater to surface water, groundwater, or susceptible/leachable soils
- 23 either directly or indirectly through ditches, storm drains, or canals.
- 24 ❖ Never discharge to a sanitary sewer system without written approval from the appropriate
- 25 entity.
- 26 ❖ Never discharge to a septic tank.
- 27 ❖ Solvents and degreasers should be used over a collection basin or pad that collects all used
- 28 material.

29

30 **Equipment Storage and Maintenance**

- 31 ❖ Store equipment in areas protected from rainfall. Rain can wash residues from equipment and
- 32 potentially contaminate the surrounding soil or water.
- 33 ❖ Perform equipment maintenance activities in a completely covered area with sealed
- 34 impervious surfaces.
- 35 ❖ Drains should either be sealed or connected to sanitary sewer systems with the approval of
- 36 local wastewater treatment plants.
- 37 ❖ Solvents and degreasers should be stored in locked metal cabinets away from any sources of
- 38 open flame.
- 39 ❖ Complete a chemical inventory and keep SDS of each on-site. A duplicate set of SDS should
- 40 be kept in locations away from the chemicals, but easily reached in an emergency.

- 1 ❖ Use PPE when working with solvents.
- 2 ❖ Use containers with dates and contents clearly marked when collecting used solvents and
- 3 degreasers.

#### 4

### 5 **Fueling Facilities**

- 6 ❖ Above-ground storage tanks (ASTs) for fuel are preferred as they are more easily monitored
- 7 for leaks as compared with underground storage tanks (USTs).
- 8 ❖ Fueling stations should be located under roofed areas with concrete pavement whenever
- 9 possible.
- 10 ❖ Fueling areas should also have spill containment and recovery facilities located near the
- 11 stations.
- 12 ❖ Develop a record-keeping process to monitor and detect leakage in USTs and ASTs.
- 13 ❖ Visually inspect any AST for leakage and structural integrity.
- 14 ❖ Secure fuel storage facilities and allow access only to authorized and properly trained staff.

#### 15

### 16 **Waste Handling**

- 17 ❖ Label containers for collecting used solvents, oils and degreasers.
- 18 ❖ Recycle lead-acid batteries. If not recycled, batteries are classified as hazardous waste.
- 19 ❖ Store old batteries on impervious surfaces in areas protected from rainfall.
- 20 ❖ Recycle used tires, paper products, plastic or glass containers, aluminum cans, and used
- 21 solvents, oils, and degreasers.
- 22 ❖ Provide a secure and specifically designated storage for the collection of recyclable waste
- 23 products.
- 24 ❖ Recycle or properly dispose of light bulbs and fluorescent tubes.

#### 25

### 26 **Emergency Preparedness**

- 27 ❖ Develop a facility emergency response plan that outlines the procedures to control, contain,
- 28 and clean up spilled materials.
- 29 ❖ Train all employees on the emergency response plan and emergency procedures.
- 30 ❖ Keep an appropriate spill containment kit in a readily available space.
- 31 ❖ For small liquid spills, use absorbents such as cat litter or sand and apply as a topdressing in
- 32 accordance with the label rates, or dispose of as a waste.
- 33 ❖ For small solid spills, sweep up and use as intended.
- 34 ❖ Ensure that SDS documents are present and that all employees have been properly trained on
- 35 their location and contents.
- 36 ❖ Report releases to the NYSDEC Spills Management Hotline at 1-800-457-7362 when
- 37 required.
- 38 ❖ For larger spills, follow guidance from the NYSDEC and [CHEMTREC](#) for cleanup and
- 39 disposal.

## 1 **12 LANDSCAPE**

2 The fundamental principle for the environmentally sound management of landscapes is "choose  
3 the right plant, in the right place." Ideal landscape plants are native and adapted specifically to  
4 the soil, degree and direction of slopes, precipitation type and amounts, wind direction and  
5 speed, light patterns, and microclimate. Susceptibility to major damage by insects and other pests  
6 is another selection criterion, as are the nutrient levels of the area. By using native or adapted  
7 plants that mimic natural ecosystems, landscapes that are designed for the specific location,  
8 management capabilities, and desired style can reduce overall management inputs, attract  
9 pollinators, provide multi-season interest, and enhance out-of-play areas.

### 10 **12.1 Planning and Design**

11 Planning begins with a careful assessment of existing conditions. Slopes and drainage patterns  
12 impact not only the playability of the course, but the survival of existing and proposed plants. A  
13 majority of the non-play areas on the golf course should remain in natural cover. Supplemental  
14 planting of native or adapted trees, shrubs, and herbaceous vegetation can enhance the habitat of  
15 wildlife, including non-game species, birds, and pollinators, in non-play natural areas.

16 Supplemental planting can also limit soil erosion and protect stream banks. Mimicking natural  
17 ecosystems by leaving dead trees (snags), brushy understory plants, and native grasses and forbs  
18 in these areas also reduces maintenance work by minimizing or eliminating the need to mow or  
19 apply fertilizer or pesticide.

20 Designs for higher-impact, higher-use landscape areas, such as around the clubhouse, should  
21 utilize natural drainage patterns and channel runoff away from impervious surfaces (e.g. paved  
22 areas), conserve water, and lower the nutritional input requirements once mature. Installing rain  
23 gardens in locations where they catch and temporarily hold water (such as near roofs and other  
24 impervious surfaces) helps control stormwater runoff, remove contaminants before releasing  
25 water into the surrounding soil or aquifer, and conserve water by reducing supplemental  
26 irrigation needs. For more information, see [Rain Gardens](#).

27 Golf courses are excellent facilities for zoning the landscape with designations of high-impact  
28 zones, transition zones, and perimeter zones, and for matching high-use and high-impact areas to  
29 plants and landscape styles that need more intense management.

#### 30 **12.1.1 High-use and High-impact Zones**

31 In high-use and high-impact zones, the design intent is to create highly ornamental, garden-like  
32 landscapes based primarily on visual impact and functionality, not necessarily related to the  
33 colors, patterns, and cycles of the native landscape. Regional flora should be given preference.  
34 Intervention and maintenance will be required to create and maintain a highly ordered aesthetic  
35 attractive on a small to medium scale, and evident even when viewed at close range. Well-  
36 defined, small-scale, high-visibility sites such as the clubhouse landscape and parking lot traffic  
37 islands are examples of high-use and high-impact zones. In such zones, these steps are  
38 recommended:

- 1       • Remove existing vegetation completely, except for desirable plants.
- 2       • Correct and maintain environmental conditions to facilitate plant growth. Such changes
- 3       may include tillage, soil amendment, soil replacement, or modification of topography and
- 4       drainage.
- 5       • Select the plant palette for multiple seasons of interest, resulting in plantings that are neat
- 6       and attractive on a small scale.
- 7       • Select plants based on their ability to survive drought, full sun, wind, salt, or other
- 8       cultural extremes as much as possible within the design parameters.
- 9       • Invest more in plant material to create immediate impact.
- 10      • Weed routinely.
- 11      • Provide supplemental watering whenever conditions would negatively impact the visual
- 12      effectiveness of the planting.
- 13      • Use mulch as a typical ground layer.

### 15   **12.1.2 Transition Zones**

16   The design intent in transition zones features ornamental landscapes inspired by the regional  
17   colors, patterns, and cycles of the native landscape, but is not necessarily based on plant  
18   community dynamics. These areas require a moderate level of intervention, sufficient to create  
19   and maintain an aesthetic order that is noticeable and attractive on a medium to large scale. The  
20   designs rely on well-defined groupings and masses to create ornamental impact, using regional  
21   plant associations when practical to suit this purpose.

22   This approach is appropriate for medium- to large-scale sites where cultural conditions are  
23   suitable, or suitable with moderate modifications, for a mix of regional and North American  
24   native species. This approach also works for moderate installation and maintenance budgets. It is  
25   appropriate in areas where native flora is a modest to minimal part of the local context.

26   Transition zone landscaping may occur on the course at tees or key junctions of paths. Creating  
27   transition zones can include these steps:

- 28      • Selectively or completely remove existing vegetation. In some cases, the existing
- 29      vegetation can be left as the ground layer.
- 30      • Correct and maintain environmental conditions to facilitate plant growth, which may
- 31      include soil modifications (e.g. change pH).
- 32      • Select the plant palette for multiple seasons of interest that match regional cycles,
- 33      organized on a medium to large scale.
- 34      • Restrict plants to species that tolerate drought, full sun, wind, salt, or other cultural
- 35      extremes.
- 36      • Spot-control aggressive weeds on a regular basis to supplement plant competition as the
- 37      primary method of weed control.
- 38      • Provide supplemental watering during establishment and only in extreme drought
- 39      conditions.
- 40      • Use mulch around planted specimens as needed, but the long-term ground layer will
- 41      develop from seeded, planted, or existing vegetation.

### 1 **12.1.3 Perimeter Zones**

2 The design intent is to develop attractive, naturalistic landscapes based directly on the regional  
3 ecology: the dynamics, patterns, colors, and cycles of native plant communities. A minimal level  
4 of intervention is required for these areas, just sufficient enough to create and maintain an  
5 aesthetic order that can be appreciated on a large scale. Though not intended to fully replicate  
6 native plant communities, regional plant associations and dynamics are conserved and enhanced.  
7 The low level of intervention allows for considerable natural growth and propagation of native  
8 plant species on site.

9 This approach is appropriate for large-scale sites where cultural conditions are suitable, or suitable  
10 with minor modification, for native species, and where the installation and maintenance budget is  
11 minimal. It is particularly appropriate in areas where native flora remains a significant part of the  
12 local context. This perimeter zone approach should be used in landscaped areas throughout the  
13 remainder of the course. Here are key steps to take in perimeter zones:

- 14 • Selectively remove existing vegetation to introduce aesthetic order or remove highly  
15 undesirable species. The existing vegetation is rarely completely removed.
- 16 • Only minimal modifications of environmental conditions are employed. Topography may  
17 be modified to provide sites conducive to the growth of regional vegetation.
- 18 • Select the plant palette to complement the surrounding vegetation in terms of patterns,  
19 color, and cycles. Select plants based in their likelihood to thrive in the existing  
20 conditions, with an understanding and awareness of site ecology and opportunities  
21 provided by cultural niches.
- 22 • Restrict plant selection to species that tolerate drought, full sun, wind, salt, or other  
23 cultural extremes.
- 24 • Planting desirable species is the primary method of weed control, but spot control of  
25 aggressive species that threaten the long-term survival of the site is also practiced.
- 26 • Provide supplemental watering during establishment only.
- 27 • Use mulch around planted specimens as needed, but the long-term ground layer will  
28 develop from seeded, planted, or existing vegetation.

### 29 **12.2 Site Inventory and Assessment**

30 Before developing a landscape plan, conduct an inventory of existing plants, their condition and  
31 quality, their contribution to the overall style of the course, and how they've been managed. For  
32 landscaped areas, conduct a soil analysis and a soil test. The soil analysis evaluates the structure  
33 and texture of the soil. If needed, soil amendments can improve the structure and texture of soil,  
34 increase its water-holding capacity, and reduce nutrient leaching. Soil amendments, such as  
35 landscape waste compost, can contribute to an overall healthier plant environment, allowing  
36 easier root development and fewer soil-related problems. Do not use peat moss as an amendment  
37 as it is both expensive and originates from peat bogs, which are non-renewable. Apply fertilizers  
38 based on the results of a soil test as described in the "Nutrient Management" chapter of this  
39 document.

## 1 12.3 Plant Selection

2 Select plants for landscape planting that grow in natural ecosystems in the area, especially in the  
3 perimeter zones and out-of-play areas. Native plants provide food and cover for native insects,  
4 birds, and other game and non-game wildlife. As land becomes developed, it is even more  
5 important to provide habitat and other ecosystem services (fresh water, clean air, carbon  
6 sequestration, etc.) in open, managed areas like golf courses. Golf courses have the opportunity  
7 to teach sustainable landscape design principles to players if responsible landscaping practices  
8 are appropriately modeled.

9 Native plant species also provide wildlife with habitat and food sources, such as native flower  
10 areas that benefit pollinators. After establishment, site-appropriate plants normally require little  
11 to no irrigation.

12 Consider design intentions, ultimate sizes and growth rates of trees, shrubs, and ground covers  
13 when selecting and placing landscape plant. This reduces the need for future pruning and debris  
14 removal. In addition, the adaptability of plants to a specific site is important. Site-specific  
15 characteristics to consider include sun exposure, light intensity, wind conditions, drainage, and  
16 temperatures.

17 For recommended plant species in New York, see:

- 18 • [Native Plant List for Pennsylvania, New York, and Northern New Jersey](#), published by  
19 the Plant Native.
- 20 • [List of native flowers, trees, shrubs and vines](#), published by NYSDEC.
- 21 • [Native Plants Suitable for Wildflower Gardens & Meadows or Traditional Gardens in the  
22 NY Finger Lakes](#), published by the Finger Lakes Native Plant Society.
- 23 • [Woody Plant Database](#), Cornell University.

24 The introduction of invasive or potentially invasive plants should be avoided and any existing  
25 invasive or noxious weed species should be controlled. The [New York Invasive Species  
26 Information](#) website provides lists of invasive species and species profiles which include control  
27 strategies.

## 28 12.4 Installation

29 During landscape bed construction, use native soil and break up any remaining hardpan or  
30 compaction from construction. Slope beds away from buildings, with a minimum percent slope  
31 of 2 percent for at least 10 feet. Resolve drainage issues and establish clear drainage patterns  
32 prior to installing plants. Install plants with higher moisture requirements at lower elevations and  
33 drought-tolerant plants at higher elevations.

34 For more information on planting trees and shrubs, see: [The Cornell Guide for Planting and  
35 Maintaining Trees and Shrubs](#).



## 1 12.5 Irrigation

2 Regardless of their ability to tolerate drought, all plants require supplemental irrigation during  
3 establishment. To increase water-use efficiency and improve plant establishment in landscaping,  
4 consider hand-watering individual plants for the first several months of the growing season.  
5 When it's needed, water plants in the early morning to conserve water and avoid water loss due  
6 to evaporation. Water new trees and shrubs at least once a week to a depth of one foot and more  
7 frequently during dry weather. When using a hose, allow the water to trickle out for at least an  
8 hour, and move the hose several times around the base of the tree. Watering bags are effective  
9 tools for applying water slowly. Apply at least five gallons when watering from a container,  
10 pouring it slowly over the back of a shovel to spread the water. Keep trees well-watered  
11 throughout the entire establishment period (one year or more depending on the caliper) with  
12 deep, slow watering.

13 If trees and shrubs are planted in an area with an existing irrigation system, assess the coverage  
14 to determine whether changes should be made to identify areas where efficiency can be  
15 improved. Carefully assess landscape watering patterns to minimize spray on impervious  
16 surfaces, blockage of spray by plants or other obstructions, and runoff on slopes, clay soils, or  
17 compacted sites. Focus on the irrigation of woody plants at or beyond the dripline to promote  
18 extensive rooting. Periodically throughout the growing season, check the performance of the  
19 landscape irrigation system.

## 20 12.6 Use of Mulch

21 Mulch conserves soil moisture, mitigates temperature extremes, and reduces weed competition.  
22 During the growing season, mulch also serves as a visual reminder to keep mowers and string  
23 trimmers away from shrub stems and tree trunks. In winter, mulch helps prevent soil cracks from  
24 forming and exposing roots to cold temperatures and winter desiccation. Organic mulches  
25 include herbicide-free grass clippings (though avoiding applying too deeply to avoid matting and  
26 heating the soil), shredded bark, bark chunks, composted sewage sludge, one-year-old wood  
27 chips, pine needles and composted, shredded leaves. Organic mulches are preferred, as non-  
28 organic mulches such as stone may add heat stress around annuals and perennials.

29 Annuals and perennials grow best with no more than 2 inches of mulch. Around trees and shrubs,  
30 mulch should be no more than 3 inches deep. With any planting, place mulch between the plants  
31 and not on top of the crown or against tree trunks or shrub canes. In the winter after the ground  
32 freezes, a deeper layer of coarse mulch (evergreen branches) over bulbs and other perennials can  
33 delay or prevent early growth and can be used to protect tender plants. Do not place a new layer  
34 of mulch over the old layer each year. Each spring, rake the old mulch to break up any hard crest  
35 and add only enough new mulch to maintain a 2-inch to 3-inch layer.

## 1 12.7 Pruning

2 Correctly pruning trees, shrubs, and herbaceous perennials has multiple benefits throughout a  
3 landscape or golf course. Trees and shrubs are pruned first for safety. Pruning in some cases can  
4 increase plant health and result in better growth in future seasons. Typically, the ideal time to  
5 prune trees in New York is in the late winter/early spring except in times of drought. Shrubs  
6 should be pruned based on their season of bloom (if the flowers are significant). Plants that  
7 bloom on second-year or old wood set their flower buds immediately after flowering and can be  
8 pruned for the month following bloom. Plants that bloom on new wood, or current-season wood,  
9 can be pruned in early spring prior to dormancy break.

10 For more information on pruning, see: [The Cornell Guide for Planting and Maintaining Trees](#)  
11 [and Shrubs](#) and [Pruning: An Illustrated Guide to Pruning Ornamental Trees and Shrubs](#).

## 12 12.8 Pest Management

13 The same principles and methods identified in the "Integrated Pest Management" chapter of this  
14 document can be applied to landscaped areas.

## 15 12.9 Landscape Best Management Practices

### 16 **Planning and Design Best Management Practices**

- 17 ❖ Leave the majority of non-play areas – the perimeter zone – in natural vegetation.
- 18 ❖ Enhance natural areas with supplemental plantings of native and adapted species.
- 19 ❖ In landscaped areas, use natural drainage patterns and directional site grading to channel  
20 runoff away from impervious surfaces onto planted areas such as grass swales, filter strips, or  
21 rain gardens.
- 22 ❖ Install rain gardens in locations where they can catch and temporarily hold runoff.
- 23 ❖ Minimize the amount of area covered by paved surfaces. Where feasible, use permeable  
24 materials such as bricks laid on sand, interlocking pavers or pervious pavers, porous  
25 concrete, mulch, or plants.

### 26

### 27 **Site Inventory and Assessment Best Management Practices**

- 28 ❖ Conduct an inventory of existing plants, their condition and quality, and their contribution to  
29 the overall style of the course.
- 30 ❖ Conduct a soil analysis before choosing specific plants for landscape areas.
- 31 ❖ Conduct a soil test before applying fertilizers. Modify pH if needed, based on soil test results.
- 32 ❖ Amend the soil to improve soil texture and increase water infiltration.

### 33 **Plant Selection Best Management Practices**

- 34 ❖ Select native species whenever possible; use adapted species or cultivars of native plants  
35 where appropriate.

- 1 ❖ Select trees, plants, and grass species to attract birds and pollinators seeking wild fruits,  
2 herbs, seeds, nesting materials, cover, and insects.
- 3 ❖ Know the ultimate sizes and growth rates of trees, shrubs, herbaceous plants, and ground  
4 covers.
- 5 ❖ Select plants recommended for your specific location.
- 6 ❖ Choose the most stress-tolerant species for a particular area.
- 7 ❖ Do not introduce invasive species into the landscape.
- 8 ❖ Control or remove existing invasive species and noxious weeds.

9

#### 10 **Landscape Irrigation Best Management Practices**

- 11 ❖ Irrigate frequently during establishment.
- 12 ❖ Water established plants based on their needs and, when needed, deeply and infrequently.
- 13 ❖ Irrigate in the early morning to conserve water.
- 14 ❖ Avoid water runoff onto impervious surfaces or slopes.
- 15 ❖ Evaluate landscape irrigation performance periodically.

16

#### 17 **Mulching Best Management Practices**

- 18 ❖ Use mulch in landscaped beds.
- 19 ❖ Use organic mulches whenever possible.
- 20 ❖ Use only herbicide-free grass clippings when using grass clippings as mulch.
- 21 ❖ Protect bulbs and other perennials in winter with a layer of coarse mulch (evergreen  
22 branches) to delay or prevent early growth.

23

1 **Pruning Best Management Practices**

- 2 ❖ Hire a certified arborist to prune trees as the correct pruning cuts are essential to good tree  
3 health.  
4 ❖ Maintain pruning equipment to ensure clean cuts and less risk of damage to the plant.  
5 ❖ Prune deciduous shade trees in late winter, except in times of extreme drought.  
6 ❖ Prune shrubs based on their season of bloom.

7

8 **Pest Management Best Management Practices**

- 9 ❖ Use IPM for landscaped areas.

10

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