Manual for
Turfgrass Maintenance
with Reduced Environmental Impacts

Prepared for the

Mississippi Watershed Management Organization

by

Fortin Consulting, Inc.

Version 2, June 2014

Version 2 Revisions Available by contacting Andrew Ronchak at andrew.ronchak@state.mn.us

Manual for Turfgrass Maintenance with Reduced Environmental Impacts

Prepared for the Mississippi Watershed Management Organization by:

Fortin Consulting, Inc.
215 Hamel Rd
Hamel, Minnesota 55340
(763) 478-3606
www.fortinconsulting.com

For more information or to obtain copies of this manual, visit the Minnesota Pollution Control Agency website at www.pca.state.mn.us/programs/summermaintenance.html.

Suggested Citation:
Mississippi Watershed Management Organization. 2014. *Manual for Turfgrass Maintenance with Reduced Environmental Impacts – Version 2, 91 p.*

Project Managers:
Mississippi Watershed Management Organization – Jenny Winkelman
Fortin Consulting, Inc. – Connie Fortin

Acknowledgments

This manual is dedicated to helping Minnesotans protect the environment. If you are involved in turfgrass maintenance, you have an important role to play in protecting our natural resources.

The *Turfgrass Maintenance with Reduced Environmental Impacts Manual* is based on the *Turfgrass Maintenance with Reduced Environmental Impacts* training class and associated materials. The course and manual were developed and funded by the Mississippi Watershed Management Organization. Content was created and reviewed through extensive collaboration with local experts. Thanks to the following for their valuable input in the production of this document.

Project Funding:

Mississippi Watershed Management Organization

Project Sponsors:

Mississippi Watershed Management Organization
Minnesota Pollution Control Agency

Technical Expert Committee:

Carolyn Dindorf – Fortin Consulting, Inc.
Bob Mugaas – University of Minnesota Extension
Jim Weber - University of Minnesota Landcare
Andrew Ronchak – Minnesota Pollution Control Agency
Brad Tabke – Quercus, Inc. and the Minnesota Nursery and Landscape Association
Brady Panitzke – City of Saint Anthony Village Public Works Department
Brad Fortin – City of White Bear Lake Parks Department
Angie Hong – East Metro Water Resources Education Program
Collie Graddick – Minnesota Department of Agriculture
Jeff Jensen – Tessman Company & the Minnesota Landscape Association
Kari Oquist – Mississippi Watershed Management Organization
Kathleen Schaefer – Minnesota Department of Transportation, University of Minnesota Circuit Training and Assistance Program, Mn Local Technical Assistance Program
Scott Roberts – TruGreen Corporation
Christine Wicks – Minnesota Department of Agriculture

Additional Review Provided by:

Ron Struss, Carol Durden, Joe Zachman and Collie Graddick- Mn Dept. of Agriculture

Manual Compiled by:

Kathryn Farber, Connie Fortin and Carolyn Dindorf – Fortin Consulting, Inc.

Special thanks to Bob Mugaas of the University of Minnesota Extension for all of his assistance, input, and guidance above and beyond the call of the technical expert committee.


MWMO
Protect it. Pass it on.
MISSISSIPPI
WATERSHED
MANAGEMENT
ORGANIZATION


Minnesota Pollution
Control Agency


UNIVERSITY OF MINNESOTA
EXTENSION


FORTIN
CONSULTING, INC.
serving the environment


UNIVERSITY OF MINNESOTA


City of White Bear Lake Minnesota
Founded 1881


QUERCUS, INC.


East-Metro
Water Resource Education Program


Saint Anthony
Village


CTAP
Circuit Training and
Assistance Program


MINNESOTA DEPARTMENT
OF AGRICULTURE


MNLA
Minnesota Nursery &
Landscape Association


Your Supplier For Growth
THE
TESSMAN
COMPANY
Since 1960

Table of Contents

Purpose of this Manual

The purpose of this manual is to accompany the *Turfgrass Maintenance with Reduced Environmental Impacts* training class, which delivers practical advice to those who manage turfgrass (golf courses and athletic fields excluded). The manual and class are designed to show how to reduce the environmental impact from turfgrass maintenance without reducing the level of service. This manual is not intended to take the place of the training class, but to enhance the class and to be used as a tool after leaving the class.

This manual will help you make better, proactive, cost-effective choices in turfgrass maintenance. It will give you knowledge to become a leader in the turfgrass industry by operating more efficiently and being more environmentally conscious. Understanding your goals for managing green areas will help you better maintain healthy turfgrass and meet your expectations as well as those of your customers/public. There is no single maintenance approach that will fulfill all of the various uses for turfgrass; different strategies are needed for different conditions and different outcomes. We encourage you to continue to test, document, and refine the practices from this manual.

For information on upcoming *Turfgrass Maintenance with Reduced Environmental Impacts* training classes or for a list of individuals certified, go to the Minnesota Pollution Control Agency website listed in the Resources section of this manual.

DISCLAIMER: The content of this manual includes emerging research. Future updates are likely. For the most current version of the manual, go to www.pca.state.mn.us/programs/summermaintenance.html.

Throughout the manual you will find this fish symbol. The fish indicates a tip that will help you reduce environmental impacts.

You will also find cost-saving tips highlighted with a dollar symbol.

Plant health tips are noted with this plant symbol.

Background Information

Good Business Choices

Customer service is the key to success. Your customers want reliable service. Providing a well-planned and executed turfgrass maintenance program will make a positive impression on your customer. Your customers want someone educated on turfgrass maintenance. You are educating yourself on best practices for turfgrass maintenance with this manual.

Save time and money: Use the right amount of material at the right time, and use less material in the long run.

Certification in turfgrass maintenance is a good reflection on you and your organization.

The public and your clientele want safe, aestheticallly pleasing, and well-groomed green areas to view, to walk on, to sit on, and more. By understanding the materials you use, optimal application times and rates, and non-chemical ways to enhance your turfgrass, you can have nice looking, functional, turfgrass as well as satisfied patrons.

Your customers want affordable turfgrass maintenance. By following better maintenance practices, you can reduce the time needed to maintain each property, the frequency of maintenance, the amount of chemical used to maintain healthy turfgrass, and the associated costs.

The public and your clients want to protect our lakes and rivers. They want environmentally responsible maintenance professionals. Understanding the potential impacts of your work and adopting best practices will help you become more environmentally responsible. With your new knowledge, you can also educate the public and your customers on the importance of responsible turfgrass maintenance.

To protect our surface waters, use less chemical, prevent erosion, and sweep up grass clippings and other vegetative debris.

Turfgrass Maintenance and the Health of Minnesota Waters

Forests, prairies, and the land of 10,000 lakes—Minnesotans love the outdoors, even when it's just the backyard. The way we maintain our lawns, parks, and public spaces, however, can affect the natural world in surprising ways. You probably know that pesticides and fertilizers are powerful chemicals that can injure wildlife if overused. But, did you know that simple maintenance activities such as mowing and watering have an equally large impact on our lakes, rivers, and even drinking water? Our actions on the land affect water quality and water quantity.

Turfgrass is the largest irrigated crop in the United States, covering more than 49,000 square miles. (Lindsey, 2005). Turfgrass surrounds us; we have installed it like outdoor carpeting throughout the state.

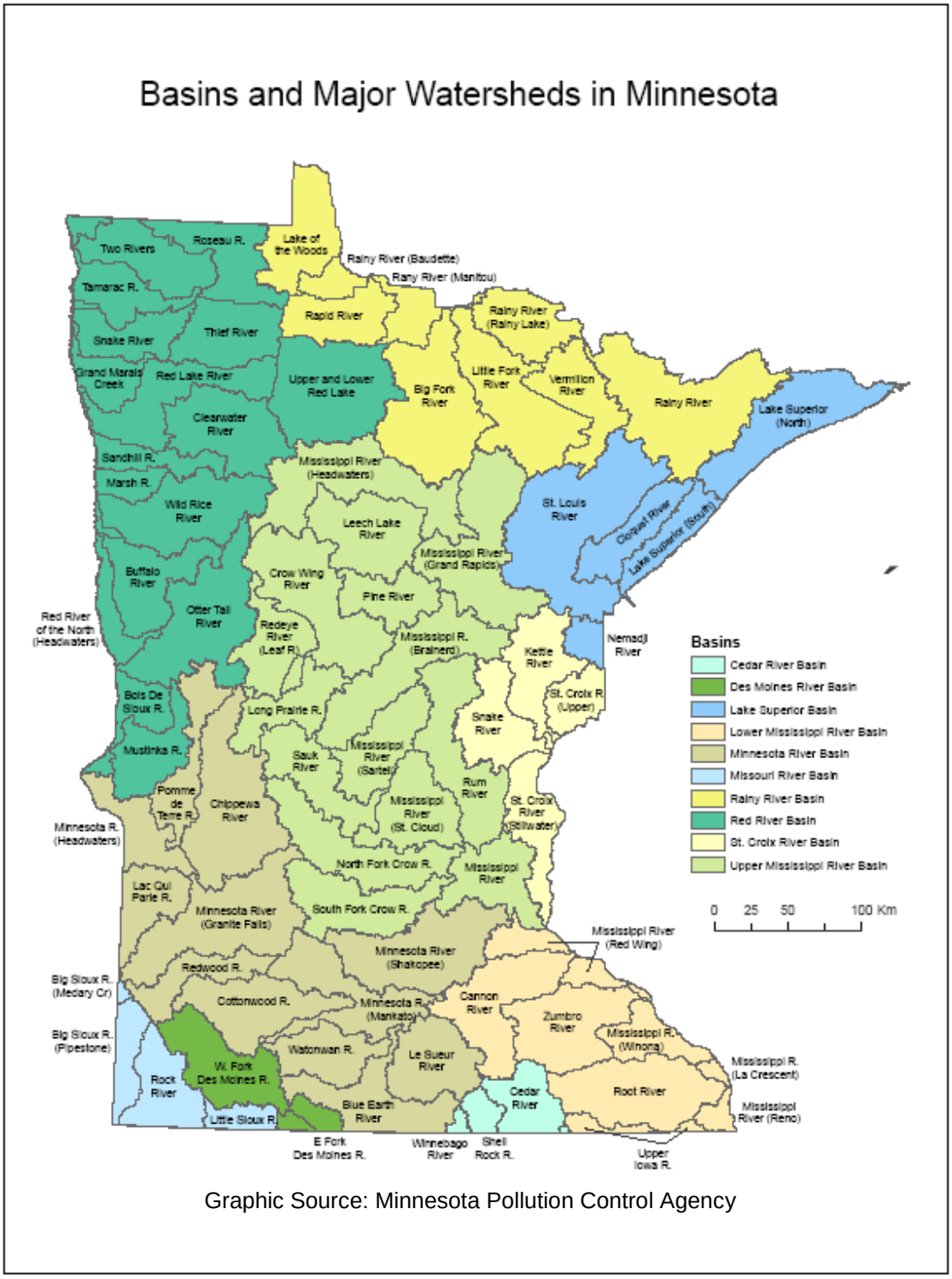
Since turfgrass is not native to Minnesota, however, it requires care to keep it healthy and attractive. When we don't use sound, research-based information to determine how much fertilizer, pesticides, and water the turfgrass needs, we can pollute our lake, rivers and groundwater and may overuse precious resources.

It may not always be visible when we use too much pesticide, water or fertilizer in our lawns. However, by the time we see the harm done to our local waters, it is often difficult and expensive to correct. When we don't understand the connection between our maintenance practices on the land and the quality of our water, improper maintenance can continue for many years, polluting the lakes and rivers Minnesotans love. Everyone likes green lawns, not green lakes!

Understanding watersheds

A watershed is the land area that drains to specific surface water, such as a lake, river or stream. Minnesota is divided into ten large watersheds, called basins, which drain to Lake Superior and the Mississippi, Minnesota, Rainy, St. Croix, and Red rivers and Lake Superior. These larger basins can be divided into smaller watersheds, which can be subdivided even further, until you reach a neighborhood scale. Consider the lakes and streams in the watershed(s) where you live and work.

Watersheds act like giant funnels. Any rainwater that lands within the watershed washes pollutants off of the ground and carries them through stormsewers and ditches to a lake or river. Wherever you maintain turfgrass, you, may impact surface water. For example, if fertilizer spills on a hard surface and is not cleaned up, rain will eventually wash it into a lake, stream, or wetland. If it's on our streets today, it's in our rivers, lakes and wetlands tomorrow.

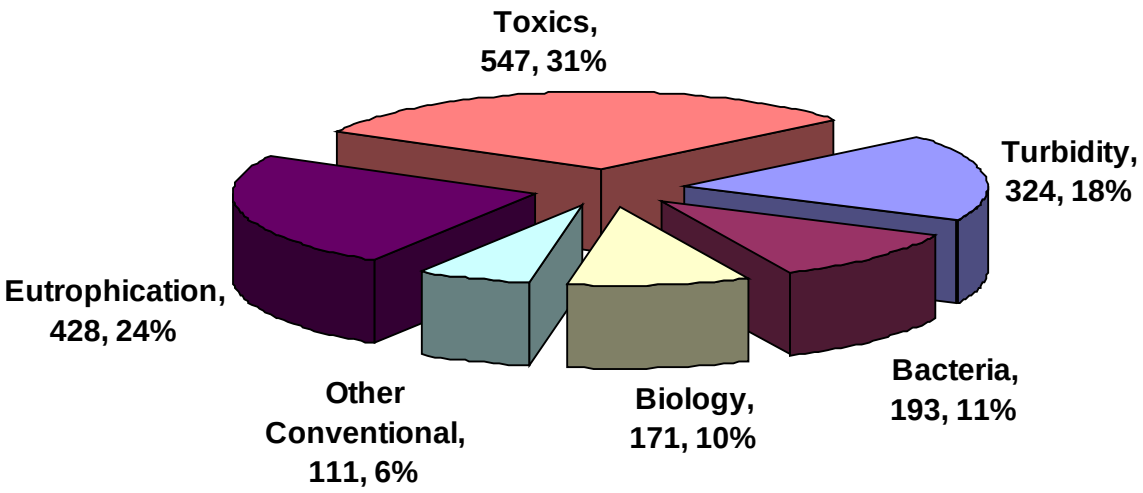


Graphic Source: Minnesota Pollution Control Agency

Impacts to our surface waters from turfgrass maintenance are more likely in developed areas where storm sewers (stormwater pipes) carry water and pollutants directly to nearby surface waters. Every time it rains, water washes down rooftops, driveways, lawns and landscapes, and streets, carrying grass clippings, fertilizer, and eroded soil into stormdrains. Storm sewers then carry the polluted runoff, untreated, directly to a local lake or river. Our storm sewers do not drain to a wastewater treatment plant. In some cases the polluted runoff is routed to a stormwater treatment pond, which can remove some pollutants, but most of the pollutants end up in the places we fish, swim, and play.

Status of Minnesota's lakes and streams

How are we doing at protecting Minnesota's lakes and streams? Of the lakes and rivers tested, 40 percent are polluted. Although turf maintenance is not the only cause of water pollution, it does contribute to eutrophication, which means too many nutrients in lakes and slow-moving rivers. In a eutrophic lake, algae, weeds, and other aquatic plants grow and multiply until the water turns green. In extreme cases, the plants consume all of the available oxygen in the water, leaving none for the fish, which eventually die. Algal blooms make the water smelly, keep people from enjoying fishing, swimming and boating, and in some cases, can even create conditions that are poisonous to children and pets. Turfgrass maintenance can also contribute to some of the other impairments, such as turbidity (muddiness related to soil particles), and biology (harm to aquatic life due to low oxygen and excessive nutrients and pesticides). Most of our waters are not even monitored for the numerous chemicals that are used in turfgrass care. As of 2010, over 3,000 lakes and river reaches are considered impaired because they do not meet water quality standards.



Draft 2010 TMDL List of Impairments
(1,774 total impairments)

Graph replicated from Minnesota Pollution Control Agency website (MPCA, n.d.)

The graph above shows common causes of impairments in Minnesota lakes and rivers. Eutophication, caused by excess nutrients, is a problem in about ¼ of the water bodies listed.

Those that maintain turfgrass are working directly on the land and collectively can have a great impact, positive or negative, on our waters. As someone who maintains turfgrass, you are a guardian of our Minnesota waters.

There are four aspects of turfgrass management that have the biggest impact on water resources: Fertilizer (nutrient) application, pesticide (particularly herbicide) application, irrigation, and maintaining dense ground cover. Without dense ground cover, excessive soil erosion and water runoff occurs, contributing sediment and other pollutants to our waters.

Fertilizer (nutrient) application

Three main nutrients are used on turfgrass: nitrogen, phosphorus, and potassium. When applied according to soil test recommendations and with the methods described in the Best Practices Matrix, we can reduce the amount of nutrients that could drain from turfgrass areas into streets and streams.

Nitrogen

Nitrogen is used to green up our turfgrass, but it can damage the environment when used at the wrong time of year, in excess amounts, or before a big rain or accidental watering. The United States Environmental Protection Agency (EPA) drinking water standard for nitrate (NO_3) nitrogen is 10 mg/l (parts per million).

Two of the most common impacts associated with nitrogen are:

- Groundwater contamination. Nitrogen can leach (wash out of soils) into the groundwater. High nitrogen levels are associated with Methemoglobinemia or "Blue Baby" syndrome, a potentially fatal condition in which the blood cannot carry enough oxygen. Infants under 6 months old are most susceptible.

- Surface water contamination. Most of Minnesota and much of the U.S. drains to the Gulf of Mexico via the Mississippi River, delivering nitrogen and phosphorus from agricultural and urban sources. Pollution from the entire Mississippi River basin has created a "dead zone" in the Gulf of Mexico, covering 6,000 to 8,000 square miles, where no fish or aquatic animals can survive due to low oxygen content (USEPA, 2009). The dead zone is larger than all the lakes and rivers in Minnesota. Several other large dead zones exist in oceans around the world.

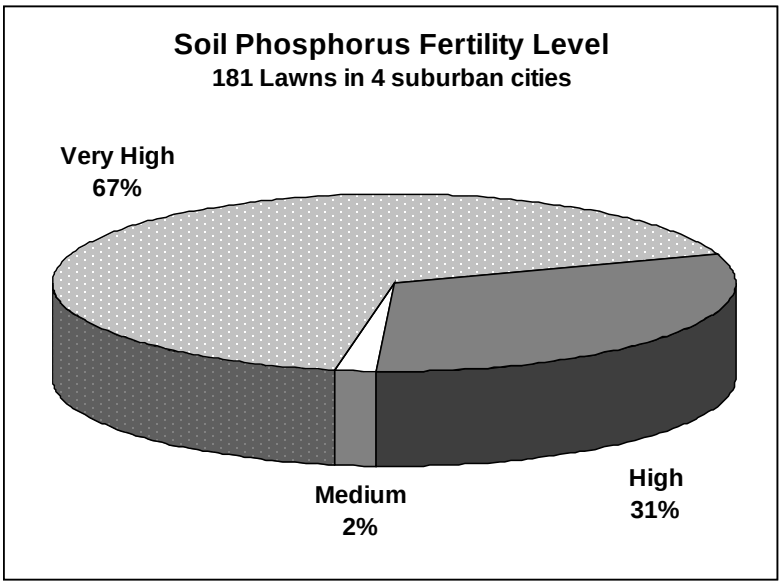
Graphic Source: Mississippi River Basin Panel (2010).
Dead zone added.

Phosphorus

Phosphorus is important for the healthy root development of turfgrass, but it also turns our lakes and rivers from blue to green when it washes off of the land and into the water. In much of Minnesota, our soils are rich in phosphorus. Usually, our lakes have enough of all the other

nutrients for plant and algae growth, except phosphorus. So, even a small amount of phosphorus can have big impact in Minnesota lakes. One pound of phosphorus can fertilize the growth of up to 500 pounds of algae (Wetzel, 1983). When we fertilize turfgrass improperly, we might also be inadvertently fertilizing our lakes.

Fertilizer is important for healthy turfgrass, but to minimize damage to our surface waters, fertilizer use should be based on turfgrass needs. Most of our soils in Minnesota have adequate phosphorus and do not require any addition from fertilizer. A study of 181 lawns in four Twin Cities' suburban communities found 98% of the lawns had high or very high phosphorus while only 2% had medium phosphorus levels (Three Rivers Park District, 1999). Many of our soils statewide also have adequate phosphorus.



Data from Three Rivers Park District, 1999

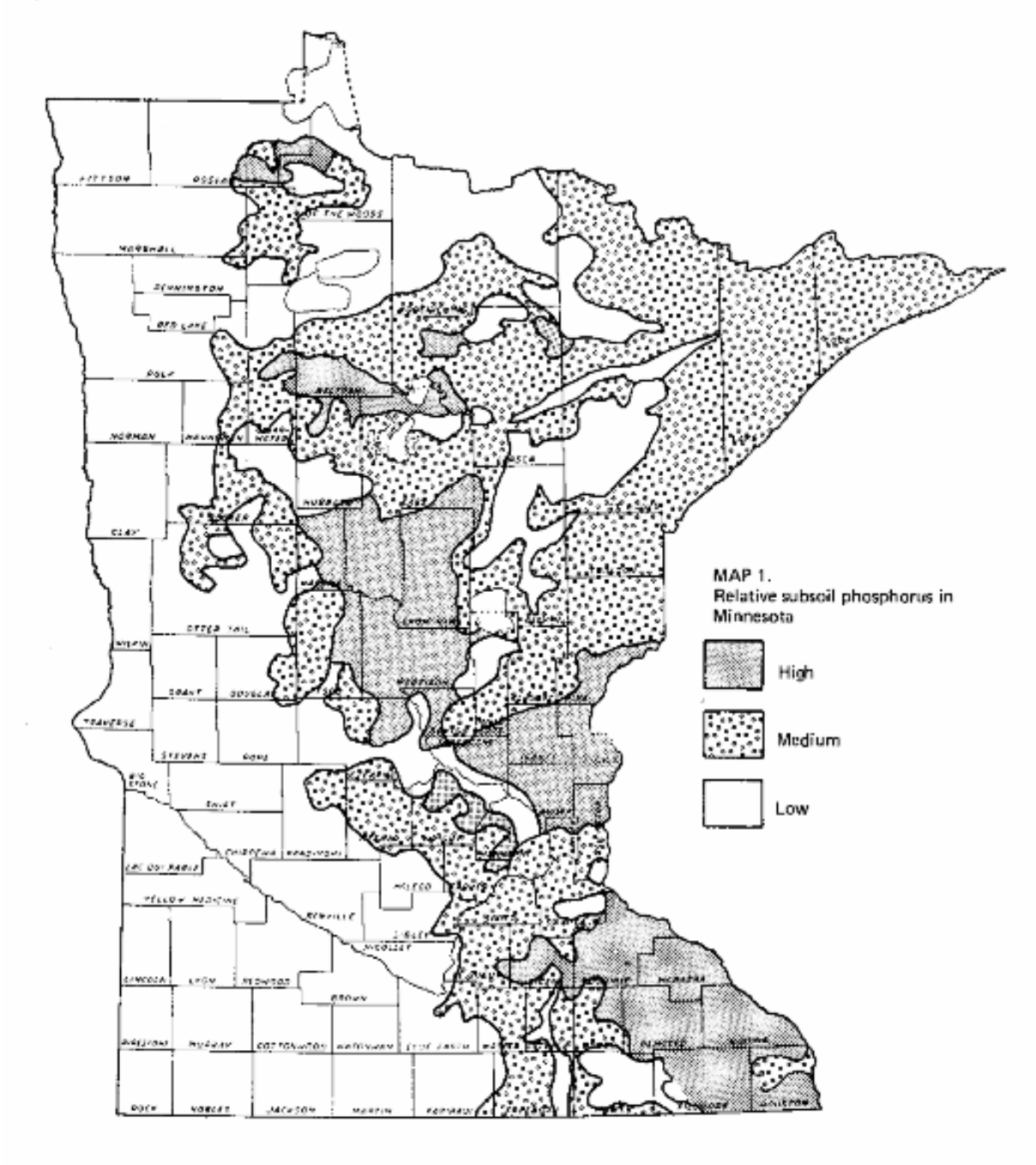
For these reasons, Minnesota adopted a law that prohibits the use of phosphorus lawn fertilizer, except when establishing a new lawn or if a soil test indicates that phosphorus is deficient. See "The Law" in the back of the manual to learn more about the Phosphorus Lawn Fertilizer law. To learn more about testing your soils to determine exact nutrient needs, see the Nutrients and Water section of this manual.

Phosphorus tightly binds to very tiny soil particles. Nonetheless, under certain conditions phosphorus can be lost from the turfgrass area, primarily through runoff and on rare occasions through leaching. Some of those conditions include:

- Excessive applications
- Application on frozen soils
- Application on high-phosphorus soils
- Misapplications to hard surfaces
- Erosion from thin grass/bare soil areas

Fertilizers aren't the only source of phosphorus to our lakes. Grass clippings, leaves, and organic debris also contain phosphorus. When left on sidewalks and streets, they are easily washed into nearby lakes and rivers, contributing to pollution problems. A five-gallon bucket of clippings can fertilize about 15–25 pounds of algae and may decrease oxygen levels in lakes and rivers. For this reason, it is important to keep leaves and clippings off of paved surfaces. Take care, also, to wash mowers and other equipment inside or over vegetated

areas so that soil, grass clippings, oil and greases aren't washed into the stormsewer. Neglected turfgrass areas can cause soils, with attached nutrients and pesticides, to erode and contaminate our waters.



Phosphorus soil levels in Minnesota
(University of Minnesota Extension, 1989)

Potassium

Potassium is an important component of fertilizers. It is generally immobile in soils and is not considered an environmental concern. However, if it reaches water, it is toxic to aquatic life.

Herbicide application

Should we use herbicides to control weeds in turfgrass? Where should we draw the line? This is a decision based on many factors, a decision for each of us to make. Most importantly, we must understand that by using chemicals to control undesirable plants, we are placing our waters at risk. Not all chemicals applied stay on target and degrade into harmless substances. Many herbicides journey far beyond the target they were intended to control. Some are toxic to fish and other aquatic life, birds and mammals.

A few herbicide facts:

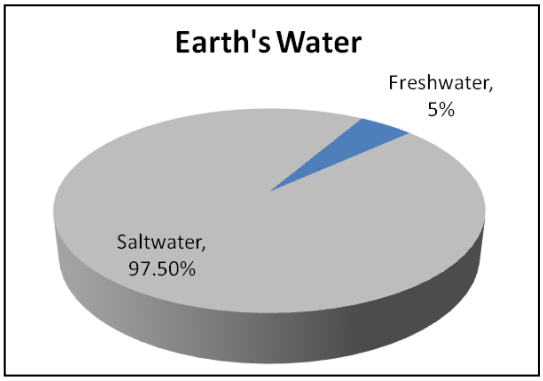
- 1.4 million pounds of pesticides are sold for turf and ornamental/ garden and lawn uses in Minnesota each year (Average from 2007-2011; MDA, 2013).
- 13 of the 18 most commonly used turfgrass pesticides have been found in groundwater or surface water in the Great Lakes Basin (Greater Madison Healthy Lawn Team, Inc., 2009).
- Pesticides were found in 56.7% of 30 wells tested in the Twin Cities Metro Area. Most were herbicides (Fong, 2000). Ongoing monitoring shows pesticides in low concentrations in urban area wells (MDA 2011, MDA 2012).
- Some of the most commonly used turfgrass herbicides containing 2,4-D, glyphosate, MCPP, dicamba, MCPA and diquat can be toxic to fish and/or aquatic invertebrates, especially if accidentally applied or spilled directly into water (see individual labels). Take care to keep products from leaving turfgrass in runoff and follow label instructions for rinsing and disposing of waste from application equipment (MDA PMU, 2013; MDA, 2010).
- Dicamba, 2,4-D, MCPA, and MCPP are found in most broadleaf herbicides and widely used in “weed & feed” products. These are all found in surface water (Minnesota Department of Agriculture, 2008 and 2012), though generally at concentrations well below levels of concern.
- Surfactants, or surface-acting agents, are used to help chemicals penetrate the plant surface. They are wetting agents that work by reducing surface tension and allowing the chemical to spread out and penetrate the leaf better. Some surfactants pose environmental and/or health risks:
    - o May be harmful to fish. Some surfactants affect the slime layer and gills of fish, and some are toxic to fish and other aquatic life.
    - o A few are possible endocrine disruptors (USEPA, 2001).
- Glyphosate (Example products: Round-up, Rodeo)
    - o Slightly toxic to wild birds. Surfactant is toxic to fish.
    - o Rodeo is a Glyphosate mixture without the surfactant, and is approved for water use.

In addition to threatening fish and wildlife, pesticides pose a concern for pets and humans. Children and pets are exposed to pesticides used on turfgrass. Some herbicides are even tracked into homes and can be found in dust from floors or mats at entryways and in carpet for up to one year (Greater Madison Healthy Lawn Team, Inc, 2003; Greater Madison Healthy Lawn Team, Inc., 2009; Nishioka, 1996). Some are slightly toxic to humans and mammals

(Extension Toxicology Network, 1993). Proper labeling of treated areas can prevent some exposure to pesticides. Signage may be required by some cities (see the Resources section). Those who use herbicides need a thorough understanding of the weed life cycle so that weed control takes place at the weed's most vulnerable time. And a thorough understanding of herbicides, application rates and methods is required to use the most effective control substance and method while reducing environmental and human health risks. Everyone should focus on reducing pesticide use. The Weeds and Weed Control section and the Best Practices Matrix in this manual provide practical guidance for reducing environmental impacts of herbicides.

Irrigation

Even in Minnesota, freshwater is limited and precious. The more we use for irrigation and other purposes, the less clean water we will have for our children, grandchildren, and future generations. Freshwater accounts for only 2.5% of the water on this planet (Ward, 2009). Of that 2.5%, less than 1% is available for our use. When we over-pump groundwater for irrigation, we reduce municipal water supplies and the base flow in streams. We are using our valuable, clean drinking water for cosmetic irrigation.



Our supply of freshwater is limited.

The Metropolitan Council (Metropolitan Council, n.d.) recently released a report warning that underground aquifers in some parts of Minnesota will drop 10 to 20 feet in the next two decades. In many areas, these aquifers provide all of the water used for drinking, irrigation, and industry. Some communities, such as Woodbury and Cottage Grove, will no longer be able to safely pump water from wells if water levels drop 10 to 20 feet; they would then be drawing from unconfined aquifers, susceptible to contamination. In other communities, such as Forest Lake, Hugo, and Lake Elmo, the water table may drop enough to permanently dry up wetlands and streams.

In some parts of Minnesota, we are using freshwater faster than it can be replenished. Woodbury, for example, pumps an average of five million gallons of water per day during the winter, but can pump as much as 20 million gallons per day during the summer! Residents and businesses like to have green lawns in the summer, but the amount being used for irrigation is more than can be sustained for the next ten to twenty years. Similarly, Plymouth reported 3.5 times more water was used per day in July 2007 compared with December 2007, mainly due to irrigation.

It has been estimated that over 30 percent (possibly higher) of residential water consumption goes to watering turfgrass in the summer months (USEPA, n.d.; Metropolitan Council, n.d.). Drought summers mean even higher water usage. To avoid running out of water during peak use times, municipalities have been required to impose watering restrictions, build enormous holding tanks, and spend considerable sums of money on pumping and processing.

With excess groundwater use we may experience the following environmental impacts (excess groundwater use is described as using more than the Best Practices Matrix recommendations):

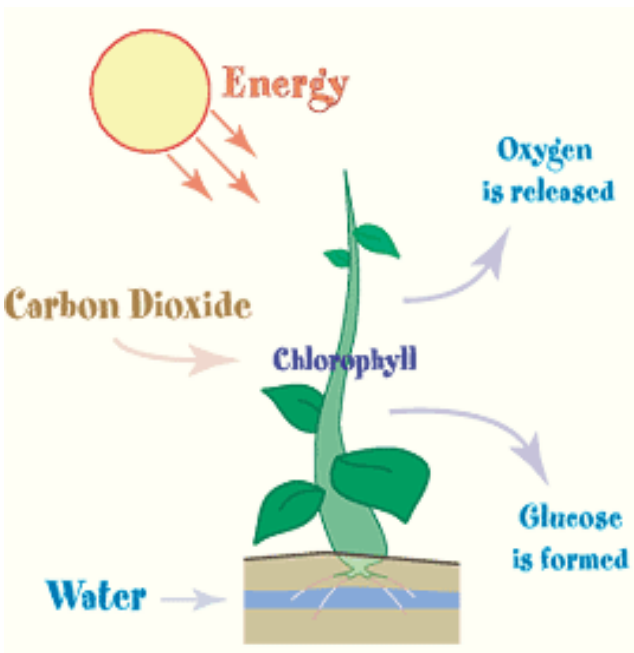
- Excess nutrients and pesticides may wash out of turfgrass areas and into surface water.
- Nutrients can be leached from plant root zones to deeper, inaccessible soil levels and to groundwater.
- Pesticides can be leached through soils to groundwater.
- In weaker stands of turfgrass, soils may erode and be carried to surface waters.
- The groundwater table may be lowered, impacting wells.
- Streams may be dry or drier in the summer due to loss of groundwater that provides base flow.
- Stream biota, such as fish and insects, may be harmed under dry or low water conditions.

It is true that natural precipitation can cause some of these same problems, but we have no control over precipitation. We can limit use of water by practicing responsible irrigation.

In Minnesota, most turfgrass stands can survive without watering, although they may enter a dormant "brown" stage during the summer. We are fortunate that in most areas of the state we receive adequate annual rainfall to keep turfgrass alive. Depending on your turfgrass quality expectations, additional water may be suggested. The amount of water required and the frequency of watering is covered in the Nutrients and Water section of this manual and in the Best Practices Matrix. These recommendations are scientifically based to provide adequate water for the plant and a variety of water conservation strategies for the user.

Turfgrass Biology

By understanding a bit of the science behind turfgrass growth, we can be more efficient in producing and maintaining healthy stands of turfgrass. As we base our decisions on this science, we will save money, save time, and protect the environment.



Graphic Source: Saviodsilva, n.d.

Photosynthesis:
Plants require sunlight, carbon dioxide and water to grow. That is why many plants, including many of our turfgrass species, do not thrive in the shade (lack of sunlight), or in very hot, dry places (lack of water) such as parking lot islands.

Use photosynthesis to your advantage:

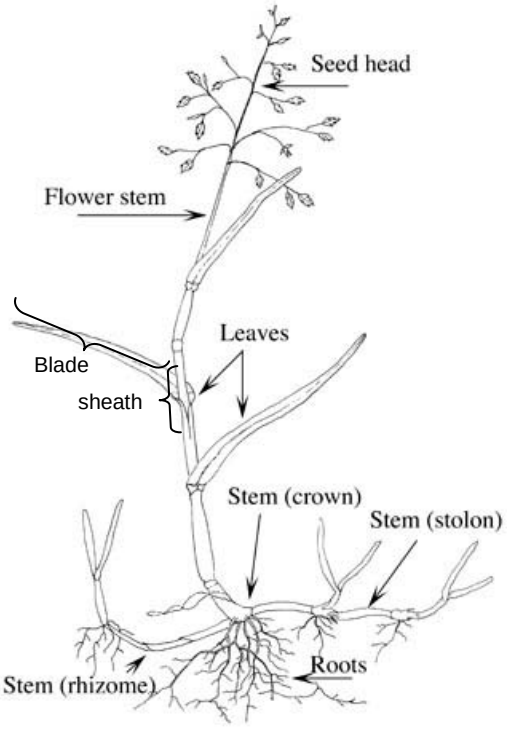
- The larger the plant, the more photosynthesis capability, i.e. free plant energy!

- It is always to your advantage to mow typical lawn grasses such as Kentucky bluegrass, perennial ryegrass, and the fine fescues, at a higher setting. See "Mowing" in the Cultural Practices section of the manual.

- Provide proper amount of water (see Irrigation section)
  - Enough water prevents wilt and allows photosynthesis to continue
  - Too much water results in “drowning” roots, which inhibits water uptake into the plant creating a “water deficit”. That can create a wilted condition, which in turn results in reduced intake of carbon dioxide and therefore reduced photosynthesis, resulting in less food for plant growth and survival. More importantly, excess irrigation wastes our drinking water.
- Select seed appropriate to sunlight conditions. Some turfgrass plants are able to be successful with less sunlight. See the Seeding section of the manual.
- Maximize sunlight in shady areas by trimming trees.

Life cycle of Turfgrass

Individual grass shoots don’t really begin their life cycle in the spring when Minnesota greens up. In fact, the life cycle of grass begins around the end of July and early August. As the shoot actively grows through the fall, it reaches a stage of maturity that will result in its sending up a flower stem come the following spring. After lying dormant and inactive during the winter months it begins a rapid period of growth in the spring with its primary emphasis on producing that flower stem. We often don’t see much of the flowering as we are continually mowing and removing most, if not all, of those flower stems. Nonetheless, once that shoot has flowered, it dies and turns brown. Visually, this leaves our lawn looking somewhat thinner than normal come the end of June or early July. Thankfully, not all shoots in a lawn flower in the same year. Those remaining begin the growth cycle all over again come late July and early August.



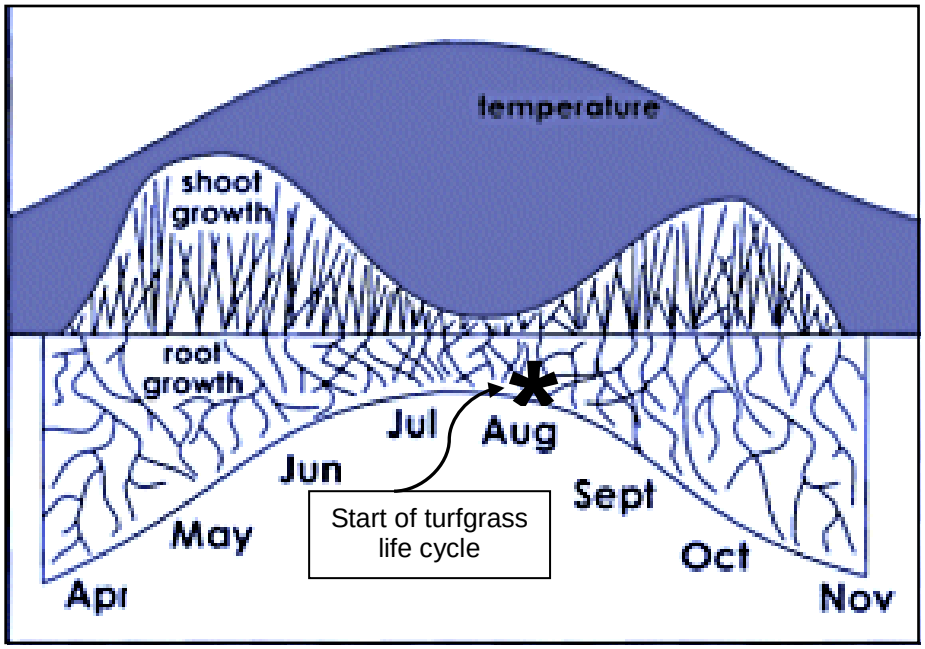
Graphic Source: Smith, n.d.

The practice of caring for turfgrass should be based on the science of turfgrass growth and development. On the following page is a lifecycle diagram of the turfgrass shoot. The fall portion of the lifecycle is very important, as that is the time when new shoots are produced (marked with an asterisk *) as well as other vegetative growth structures (i.e., rhizomes, tillers, stolons). This is also a time for vigorous root production, which helps support active shoot growth by absorbing water and nutrients necessary to sustain that growth. Later in the fall, root absorption continues, but the top growth slows down due to shorter days and cooler temperatures. At this time food from

A dense, healthy lawn reduces noise levels, cools the environment, and filters dust and pollen out of the air (University of Minnesota Extension, 2010).

photosynthesis is involved with nutrient storage and other needed plant products until active growth reinitiates the following spring (see Best Practices Matrix).

Cool Season Grasses



Adapted from graphic source: University of Minnesota, 2006

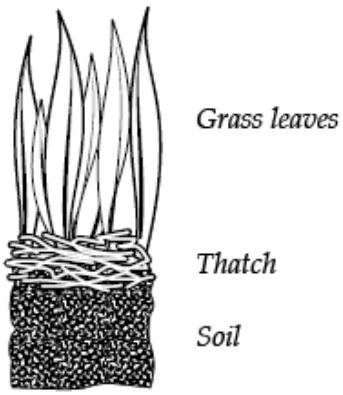
Example Cool Season Grasses:
- Kentucky bluegrass
- Fine fescue
- Perennial ryegrass

Healthy, vigorous plants depend on large, healthy root systems. Deeper, more robust root systems provide better access to nutrients and water and improve the chances of surviving a drought. Irrigation has a big influence on root depth. Frequent, shallow waterings encourage shorter root growth and can create excessively wet surface soil that, in turn, can lead to a variety of serious turfgrass diseases and increased stress. Infrequent deep waterings encourage deeper root growth, particularly during spring and fall. This will still keep the turfgrass green and actively growing without creating excessively wet conditions. It is also important to not apply more water than can seep into the soil at any one watering. For more information, see “Irrigation” in the Cultural Practices section.

As turfgrass grows and the blade is cut, the clipping falls to the soil surface where it provides a light "mulch" cover, providing much desired shade for the hot summer soils and, as it decomposes, provides nutrients. There is unwarranted concern that clippings cause thatch. Clippings decompose rather quickly and do not become incorporated into the thatch layer.

Thatch is a dark brown, felt-like layer just above the soil. It is normal and necessary. It is composed of both living and non-living plant parts. It is primarily a product of the continuing cycles of dying and replacement of shoots and roots. Thatch is not all bad. It protects the soil

from temperature changes, helps retain moisture, and gives the turfgrass some resiliency against wear and tear. Thatch is rarely a problem (see "Thatch" in the Cultural Practices section). However, where thatch accumulates beyond ½ to ¾ of an inch, it is considered undesirable because it can impede water, nutrient, and air penetration into the soil.



Fagerness, 2001

Since turfgrasses (especially when used in a lawn) are not native to Minnesota, they require our time and attention to maintain and care for them. Everyone has different expectations for their turfgrass. The Best Practices Matrix in this manual explains the basic care needed for minimal, average, and high quality turfgrass areas. These recommendations are based on turfgrass biology. The Best Practices Matrix recommendations should be followed as general guidance to reduce environmental impacts yet grow healthy turfgrass to meet expectations for its use and beauty.

To get more precise information on nutrient needs for your site, a soil test should be conducted and the soil-test recommendations followed. This will give custom guidance to your particular site, matching the soil chemistry with your turfgrass growth and development needs (see "Soil Testing" in Nutrients and Water section). This allows for top performance and minimizes environmental problems associated with incorrect application of fertilizers.

Setting and Managing Expectations

There are many different criteria for managing turfgrass areas and many preferences for turfgrass appearance. The key to successful management is to understand the conditions and use of the site and to set realistic expectations. The choices given in the Best Practices Matrix are minimal, average, and high turfgrass quality. Neither neglected nor perfect turfgrass is an ecologically sound choice, and neither is offered as an option in the Best Practices Matrix.

Performing site assessments will help you understand existing conditions and select an appropriate turfgrass quality level for each site you manage.

Site Assessment

One of the best things you can do to make informed decisions for managing a site is to assess and record its condition. Whether you maintain a city park or a private residence, each property has its own issues. This simple routine will help you make wise, informed decisions that benefit the turfgrass, protect the waters, and please the public/customers.

How often to assess?

All new sites should have a thorough site assessment. Shorter assessments can be conducted periodically as you visit the sites. These mini assessments may include notes and photographs to document weeds in their blooming stage, erosion, irrigation patterns, traffic/use, and other clues that can help you improve your maintenance plan.

How to create a site assessment form:

You can use the Example Site Assessment form at the end of this section or create your own. If you wish to create your own, you can take the example form which is in electronic format on the Minnesota Pollution Control Agency (MPCA) website and change it to meet your needs. Print out a stack of these forms, place them on your clipboard and have them in your truck for use at anytime.

Gear to bring on a site assessment:

- Camera
- Clipboard
- Pencil
- Site assessment form
- Soil test kit (hand shovel, small bucket, soil sample form, new re-sealable zipper storage bag, waterproof marker, pen)
- Soil probe

Optional Gear:

- Sample bags/labels (for unknown plants)
- Tape measure/measuring wheel

- Flagging/flags
- GPS

How to conduct a site assessment:

- Name or number each site
- Put name or number on top of site assessment form
- Fill out site assessment form for each site
- Soil test (every 3 years)

Following your assessment, take time to analyze observations, create and communicate maintenance recommendations, follow your own recommendations, and continue to assess the site over the lifetime of your maintenance operations.

A site assessment will sharpen your observation skills.

It will train you to look for valuable clues about the overall health of the turfgrass. It will also guide you in judging if the site expectation is sustainable.

A site assessment will help inform everyone on your crew.

Documentation on the site's history, maintenance efforts, successes and failures, and current plan of action will improve transitions between personnel.

A site assessment will help manage each site more effectively.

Maintenance recommendations based on specific site conditions and turfgrass expectations will be more effective than those based on a one-plan-fits-all strategy. Problems can be identified and addressed before they become large concerns.

A site assessment will help track the success of maintenance practices.

You can improve faster if you record and track your operations and their results.
Did the herbicide treatment work? Did it harm anything else? How much herbicide was saved by calibrating equipment? Is the taller mowing height benefiting the health and thickness of the turfgrass?

Ongoing site observations should be recorded and maintenance efforts modified to match conditions.

Examples:

- A tree was removed, and now there is a sink hole.
- The irrigation system is spraying the sidewalk.
- Deer are damaging the new trees.
- A patch of dead grass has suddenly appeared where we filled the fertilizer spreader.

EXAMPLE:

Site Assessment

Site name: _____

Address: _____

_____

Phone: _____ Email: _____

Date:_____ Assessor:_____

Age of lawn _____ years
☐ Sketch ☐ Photo Lawn size _____ square feet
Dogs: ☐ Yes ☐ No Children: ☐ Yes ☐ No

Customer Expectations & Maintenance Practices

Lawn Condition: ☐ Minimal ☐ Average ☐ High
Clippings bagged: ☐ Yes ☐ No
Organics only: ☐ Yes ☐ No
Fertilizer: ☐ Yes Ratio_____ ☐ No
Herbicides: ☐ whole yard ☐ Spot treat (add sketch) ☐ No

Herbicide needed: ☐ pre-emergent ☐ broadleaf ☐ non-selective ☐ none
Irrigation system used: ☐ Yes ☐ No
Calibrated: ☐ Yes, Date_____ ☐ No
Water reaching hard surfaces: ☐ Yes ☐ No
Rain sensor: ☐ Yes ☐ No
Operating properly: ☐ Yes ☐ No
Proper spray head for the site: ☐ Yes ☐ No
Estimated water output: _____
Watering frequency: _____
Watering time of day: _____
System adjusted based on rainfall ☐ Yes ☐ No

Lawn Condition

Soil sample(s) collected: ☐ Yes ☐ No Date of last soil test _____

Soil Texture:
☐ Sandy (Coarse) Sand, loamy sand, sandy loam; Description: gritty- can feel granules
☐ Rich (Medium) Loam, silt loam; Description: dark, smoother soil with higher organic matter, can form ball when wet, but falls apart
☐ Fine (clay loam, silty clay loam, silty clay and clay) Can form a ribbon between your fingers.

☐ Compacted ☐ somewhat compacted ☐ not compacted (Test with soil probe or screwdriver: if you can only push it in a couple of inches or less, soils are likely compacted)

Type of turf grasses: ☐ Kentucky bluegrass ☐ ryegrass ☐ fine fescue
Condition of grass: ☐ blade damage ☐ good ☐_____

Thatch depth: _____" Rooting depth: _____"

Lawn density: ☐ thin ☐ average ☐ high

Weed severity: ☐ many ☐ some ☐ few

Predominant Weeds: _____
_____
Diseases:_____

Sun exposure: ☐ full sun_____
☐ part sun_____
☐ shade _____

Overall Turf Health: ☐ poor ☐ acceptable ☐ good

Other observations
Erosion problems_____
Intensity of Use_____
Wet Areas_____
Steep Areas_____
Weed or pest problems on nearby properties_____

Sketch/Notes:

Recommendations (☐ see additional page):

Basic Identification of Common Turfgrasses

Fine Fescues

- Medium green
- Very narrow wiry blade
- Very narrow wiry blade, leaf folded or creased in half – opens slightly as it matures
- Leaf tip comes to a needle-like point
- Grows in tufts or slowly expanding patches
- Best shade tolerance of the three major turfgrasses thus often found in the shady areas

Kentucky Bluegrass

- Medium to dark green color often slightly bluish green
- Upper leaf surface dull, flat green while lower leaf surface is slightly more glossy
- Medium blade width, leaf folded or creased in half
- Leaf tip shaped like the front end of a canoe or boat
- Not bunchy in growth habit
- Best adapted to sunnier conditions, spreads by vigorous rhizome growth

Rye grass

- Medium to dark green in color
- Upper leaf surface dull green while lower surface is a very shiny, glossy green – distinctly more so than either fine fescues or Kentucky bluegrass
- Medium blade width, prominent mid-vein down middle of leaf
- Leaf tip more pointed – not distinctly boat shaped as in Kentucky bluegrass or needle-like as in fine fescue
- Tufted growth habit – no rhizome production
- Best adapted to sunnier conditions
- Extremely susceptible to crown rust under low nitrogen fertility conditions

Best Practices Matrix

The Best Practices Matrix offers ecologically sound advice without compromising turfgrass quality expectations. It is a compressed summary of maintenance recommendations and is included in the front pocket of this manual for easy access.

Using the Best Practices Matrix

The Best Practices Matrix offers practical guidelines based on your turfgrass quality expectations (minimal, average, high). It offers straightforward advice for cultural practices, fertilizing, and other typical turfgrass maintenance activities. It is divided into six sections, each with custom recommendations based on soil type and sun exposure.

To use the Best Practices Matrix in the field, download this file from the Minnesota Pollution Control Agency website (MPCA; www.pca.state.mn.us/programs/summermaintenance.html). Print it on colored paper (we recommend a different color for each site condition) for easy reference, laminate each sheet and connect them by punching a hole in the upper left corner and inserting a metal ring.

This page is intentionally blank.

Nutrients and Water

Nutrients

Turfgrass requires nutrients to perform everyday functions, such as growing strong shoots and roots, fighting disease, and competing against weeds. All plant nutrients except for carbon (C), hydrogen (H) and oxygen (O) are supplied by the soil. Occasionally the soil nutrients must be supplemented or the turfgrass plant will struggle.

Nitrogen (N), Phosphorus (P), and Potassium/Potash (K) are essential for turfgrass nutrition. There is benefit in providing nutrients to turfgrass in the proper amounts. Excess nutrients can leave soils and cause water quality problems in our lakes, rivers, and ground water. Conducting soil tests and following test recommendations allow us to apply the proper amount of nutrients. Learn about soil testing in the Nutrients and Water section of this manual.

Nitrogen (N), phosphorus (P) as phosphate (P_2O_5), and potassium (K) as potash (K_2O) are the three main nutrients displayed on the fertilizer bag. The percent, by weight, of these nutrients in the bag are always displayed in this order, (N-P-K).

Nitrogen (N)

Nitrogen is the component in fertilizer that stimulates growth and greens up your turfgrass. It aids in shoot and root growth and in turfgrass recovery from wear and tear.

- Nitrogen is the first nutrient listed on any fertilizer bag
- Turfgrass can only absorb a limited amount of nitrogen
- Leaching or runoff of unused nitrogen can harm water resources
- The EPA's drinking water standard requires less than 10 mg/L (ppm) of nitrate nitrogen

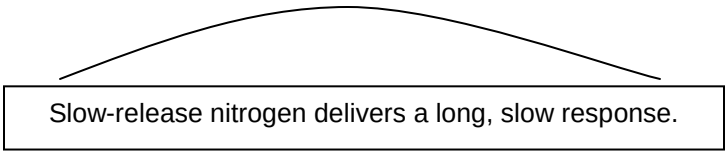
Slow- Release vs. Quick-Release Nitrogen

All turfgrass fertilizers contain nitrogen, which is available in either quick-release or slow-release forms. The Best Practices Matrix often recommends 35-50% slow-release nitrogen, which is safer for the environment when applied properly, is less work to apply over the course of the season, but may be more difficult to find and more expensive.

Slow-Release Nitrogen	Quick-Release Nitrogen
Releases slowly over time	Releases immediately
Low water solubility (called "insoluble")	Water soluble
Safer for water resources	Less safe for water resources
More even and prolonged release of nutrient to turfgrass	One time short burst of nutrients for the turfgrass (can result in too much N available too quickly)
Expensive	Inexpensive
May be more difficult to find (retail)	Easy to find

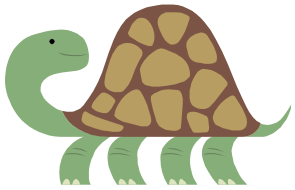
How to determine if your fertilizer contains slow or quick-release nitrogen
Nitrogen is listed in a variety of ways, and it can be confusing. Below is a list of common nitrogen sources based on their release characteristics.

<u>Sources of Slow-Release Nitrogen</u>:
Water Insoluble Nitrogen (WIN)



Organic/Natural –*
- Activated sewage sludge
- Animal manures
- Corn gluten meal
- Other natural products such as blood meal, bone meal, soy meal, feather meal, fish meal.

Synthetic –
- Stabilized nitrogen (look for "stabilized" listed on bag)
- Sulfur-coated urea
- Polymer-coated urea
- Polymer-coated sulfur-coated urea (PCSCU)
- Isobutylidene diurea (IBDU)
- Methylene ureas
- Ureaformaldehyde (Ureaform)

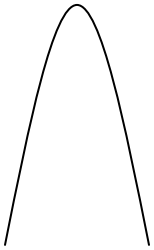


<u>Sources of Quick-Release Nitrogen</u>:
These are most common sources of nitrogen, and what is usually in the fertilizer bag.

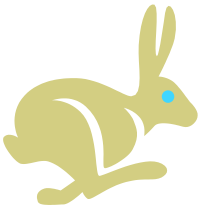
Synthetic Organic –
- Urea $CO(NH_2)_2$

Synthetic Inorganic –
Ammoniacal Forms
- Ammonium Nitrate (NH_4NO_3)
- Ammonium Sulfate $(NH_4)_2SO_4$
- Monoammonium phosphate $NH_4H_2PO_4$
- Diammonium phosphate $(NH_4)_2HPO_4$

Nitrate Forms
- Ammonium nitrate (NH_4NO_3)
- Potassium Nitrate KNO_3



Quick-release nitrogen delivers an immediate and brief response.



*Note: many natural sources also contain phosphorus which may prevent their use under Minnesota's Phosphorus Fertilizer Law.

To protect the environment and get the most out of your fertilizer, use fertilizer containing 35 to 50% slow-release N.

Phosphorus (P)

Phosphorus is essential for plant life. It aids root development, leaf growth, and shoot growth, all of which improve turfgrass density and reduce runoff. Most of the soils in Minnesota are rich in phosphorus and don't require additional P to adequately support an established turfgrass stand. Minnesota law prohibits the use of phosphorus lawn fertilizer on lawns and other turfgrass areas unless certain conditions exist.

Minnesota Statute 18C.60:
Use of phosphorus fertilizers on lawns and turf is prohibited, unless:

- A soil test or plant tissue test shows a need for phosphorus;
- A new lawn is being established by seed or laying sod;
- Phosphorus fertilizer is being applied on a golf course by trained staff;
- Phosphorus fertilizer is being applied on farms growing sod for sale.

For more information about phosphorus restrictions see "The Law" pages or contact the Minnesota Department of Agriculture (see the Resources section).

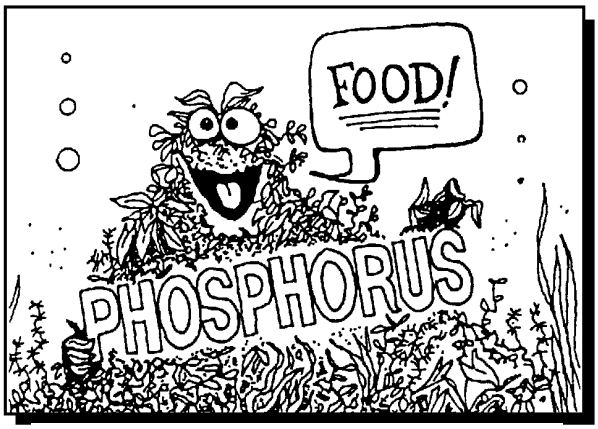
Phosphorus is a major source of pollution in lakes and rivers.

Phosphorus in our lakes and rivers increases production of algae and stimulates growth of aquatic vegetation. This spoils the lake view and harms aquatic life. As aquatic vegetation dies and biodegrades, oxygen needed by fish and other small aquatic life may be depleted. Nuisance algal blooms and excessive aquatic plant growth can also limit swimming, fishing, and boating. Turfgrass maintenance is one of many sources of phosphorus.

Causes of phosphorus pollution related to turfgrass maintenance:

Over-applying phosphorus fertilizer

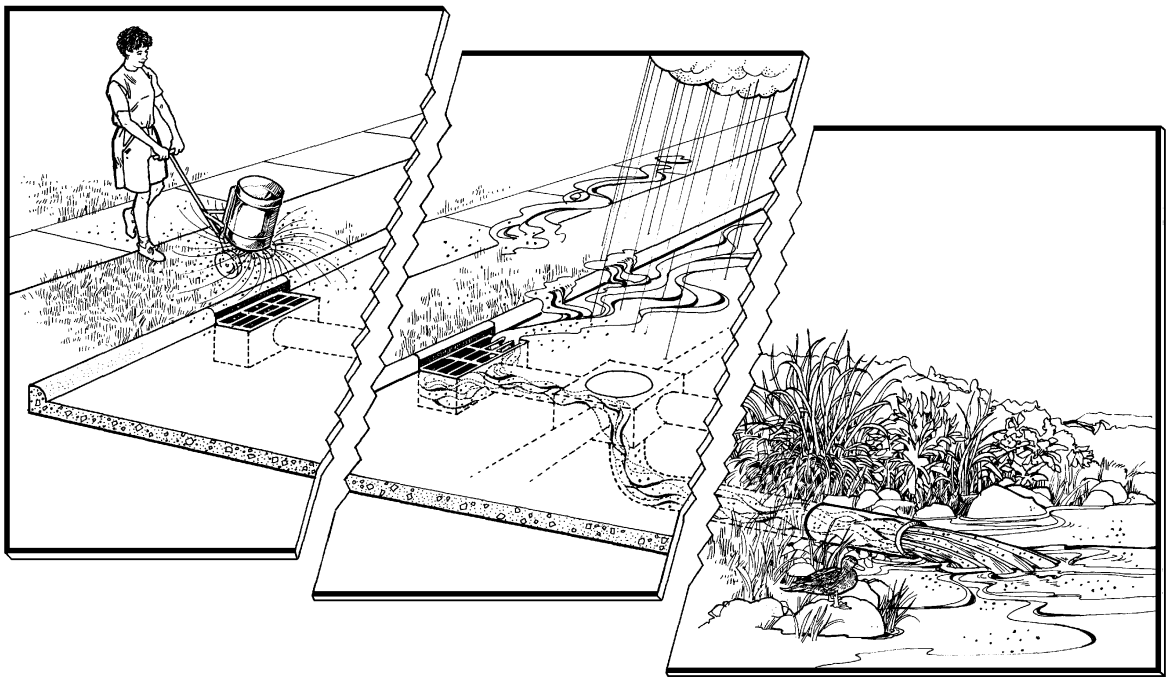
Plants will not absorb more phosphorus than they can use. Excess phosphorus that is applied to turfgrass can potentially run off the land and into the water. Research has shown that the largest amounts of runoff and phosphorus loss from a lawn occur when the ground is frozen (Bierman et. al, 2010). To minimize P runoff, apply on actively growing turfgrass and apply only what is needed based on a current soil test (not more than 3 years old).



Graphic source: University of Wisconsin-Extension and the Wisconsin Department of Natural Resources

Spilling phosphorus fertilizer onto hard surfaces

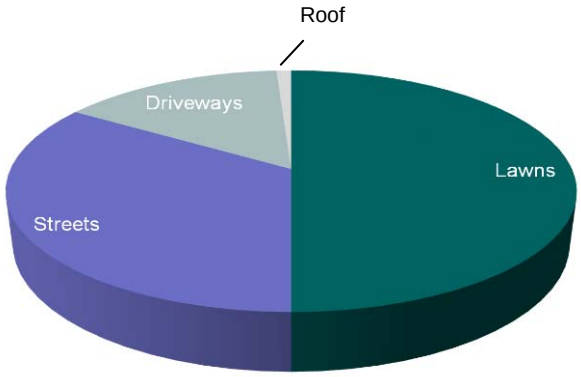
Minnesota State law requires that **any** fertilizer, whether it contains phosphorus or not, that spills onto a hard surface (side-walk, driveway, street) must be swept up immediately. Failure to do so is considered a petty misdemeanor. Use a deflector or drop spreader when applying along sidewalks and other narrow areas to prevent misapplication. Sweep up or blow any spills onto the turfgrass.



Graphic source: University of Wisconsin-Extension and the Wisconsin Department of Natural Resources

Grass clippings, leaves, and tree seeds on hard surfaces

All vegetation contains phosphorus. If left on hard surfaces, it will wash into stormdrains and into the lakes and rivers. As plant material breaks down and decomposes, nutrients can be released and potentially become available to algae and other plants. A few grass clippings in the street may appear harmless, but collectively they can increase the nutrient levels in our lakes resulting in more severe and frequent nuisance algal blooms.



Sources of Phosphorus runoff in Urban areas.
Data: Three Rivers Park District

Soil erosion

Phosphorus generally binds tightly to soil particles. Exposed and unprotected soil has a large potential to wash offsite when it rains. These tiny soil particles with phosphorus and potentially other contaminants attached are carried in stormwater to the stormdrain and piped into lakes and streams. Neglected turfgrass is more prone to erosion than well-managed turfgrass.

How to minimize phosphorus release into surface waters

Without a soil test:

- Use 0% phosphorus lawn fertilizers.

Where soil tests recommend phosphorus, or in starting new turfgrass areas:

- Calibrate equipment so that you are applying the proper amount.
- Follow soil test recommendations. Do not over-apply fertilizer.
- Immediately sweep up fertilizer that is misapplied onto hard surfaces.
- Gently water in the fertilizer. Do not over water.

How to dispose of phosphorus fertilizer *(for more information, see Disposal of Fertilizers in the Resources and References Section)*

If fertilizer contains pesticides:

- If purchased recently, return to distributor/store.
- Give to someone that can utilize it legally.
- Dispose at a household hazardous waste collection site.

If fertilizer does not contain pesticides:

- If purchased recently, return to distributor/store.
- Give to someone that can utilize it legally.
- Carefully use in gardens. Lawn fertilizer often has more nitrogen than standard garden fertilizers. Excess nitrogen can cause unwanted, rapid vegetative growth at the expense of fruit and vegetable production and can burn plants.
- Place fertilizer in the trash.

Potential Signs of phosphorus deficiency

- Slower, less vigorous growth
- Pale color in extreme deficiency
- More prone to weed invasion due to less competitive growth
- Purplish color on plant stem in the spring/early summer

Confirm suspected nutrient deficiencies with a soil test

Potassium (K)

Potassium is essential for plant growth and survival. It aids a plant's tolerance to stress, such as cold/hot temperatures, drought, wear, and pest problems.

Turfgrass color or density will not be affected unless the grass is truly deficient in potassium. However, once potassium deficiency occurs, a plant will struggle to survive and function during times of stress. Your best method for determining soil potassium levels is a soil test. Adequate potassium levels are important for the efficient use of nitrogen by the grass plant.

Soil Testing

Why take a Soil Test

Conduct a soil test to determine what additional soil nutrients your turfgrass will need. This is the best information you can get to improve the performance of your maintenance operations. A soil test is valid for three years. It will:

- analyze the makeup of your soil
- help you determine which formulation of fertilizer you should use
- help you calculate how much fertilizer you should apply
- tell you how frequently you should apply fertilizer
- allow use of phosphorus fertilizer (MN law) if a need is shown

How to conduct a soil test

1. You will need:
   - A clean plastic bucket. A metal container might contaminate the sample.
   - A clean garden trowel or soil probe.
   - A soil sample bag (new sealable container that will hold at least 2 cups of soil, zip-lock bags work well)
   - A soil test information sheet (example sheet below). See the Resources section under "Soil Test" for a website where you can print this sheet.
   - A pen or waterproof marker to label the soil bag
2. Determine the area to test. This should be an area of similar conditions. For example, the sunny upland picnic area.
3. Use a garden trowel to collect one small scoop of soil, place in bucket. Do not include turfgrass, leaf litter or other debris.
   - Dig 0-3" in existing grass with shallow root systems
   - Dig 0-6" in new grass or existing grass roots that extend deep into the soil
4. Dig soil from five or more random spots within the sample area.
5. If turfgrass areas are managed differently, tests should be submitted for each area.
6. Mix all of the soil together in the bucket.
7. Put <u>two cups</u> of the mixed sample into a new sample bag. Seal the bag.
8. Label the sample bag/container with your name, address, site number, and/or any other information that the lab requests.
9. Fill out the sample information sheet (example sheet below).
10. Send/deliver the sample and information sheet to your soil testing laboratory.
11. Pay fee required by lab.

Many labs offer soil testing. For information about the University of Minnesota Soil Testing Laboratory, and to obtain a soil sample information sheet, visit the website listed in the Resources section of this manual. A list of MDA Certified Soil Testing Laboratories is also found in the Resources section.

UNIVERSITY OF MINNESOTA
Soil Testing Laboratory

Send this information sheet with **ONE (1)** soil sample

PROFESSIONAL TURF
AND
LAWN, GARDEN and LANDSCAPE
SOIL ANALYSIS REQUEST FORM

MAIL SOIL TEST REPORT TO:

NAME _____

Address _____

City/St/Zip _____

Phone _____

Soil Location: County_____

Check for $ _____ enclosed

OPTIONAL REFERENCE:

_____

_____

_____

_____

_____

Please provide a name for this sample, consisting of no more than 4 numbers and/or letters.
Indicate this name on the sample container and record it here.

____ ____ ____ ____

The report you receive will use this name to identify your sample.

Fertilizer Recommendation Requested for:
(check only one)

New Lawn / Turf
- ❑ (101) Before seeding or sodding

Existing Grass
- ❑ (102) Home lawn
- ❑ (103) School / Industrial Grounds
- ❑ (104) Athletic field
- ❑ (105) Park / Cemetery
- ❑ (106) Golf tee
- ❑ (107) Golf fairway
- ❑ (108) Golf green

Gardens
- ❑ (110) Vegetable garden
- ❑ (111) Flower garden

Fruit
- ❑ (112) Tree fruits
- ❑ (113) Small fruits
- ❑ (114) Blueberries

Trees and Shrubs
- ❑ (115) Broadleaf
- ❑ (116) Evergreen
- ❑ (117) Azalea & Rhododendron

For Grass Only

Is grass watered regularly?
- ❑ (1) Yes
- ❑ (2) No

Are clippings removed?
- ❑ (1) Yes
- ❑ (2) No

Check Tests Requested

- ❑ **Regular test**, $17.00 – includes total organic matter, phosphorus, potassium, pH – lime requirement, and estimated texture.
- ❑ **Soluble salts**, $6 – testing for excessive salts
- ❑ **Lead test**, $16 -- (separate sample required)

*Additional tests, primarily of interest to land care professionals.
- ❑ Sulfur $7
- ❑ Calcium / Magnesium $7
- ❑ Nitrate $8
- ❑ Iron, Zinc, Copper, and Manganese $12
- ❑ Boron $7

Be advised – The Soil Testing Laboratory does not provide interpretation for trace element tests.

Tests provided by the University of Minnesota Soil Testing Laboratory are intended to aid in evaluating the fertility status and chemical condition of your soil. Based on these test results and the type of plants to be grown, you will receive fertilizer recommendations calculated to provide adequate levels of phosphorus and potassium for healthy plant growth, without adversely affecting the environment.

Problems with plants may be caused by factors other than soil fertility, e.g., disease, insects, insufficient light, soil moisture or compaction, or climatic conditions. An evaluation of soil fertility and pH is an important *first step* in diagnosing problems. If soil fertility is not found to be a problem, the other factors affecting plant growth should be evaluated to determine possible causes. Your County Extension Educator or Master Gardener can help if you need more information to diagnose your problem.

Because nitrogen is extremely mobile in soils, nitrogen recommendations are based on plant requirements and soil organic matter level as determined by the laboratory.

*_Trace element tests are generally not recommended for lawn and garden samples._
Research has shown that most soils in Minnesota contain adequate levels for plant growth.
Trace element tests may be useful to some land care professionals dealing with special problems.

REV 4/13

See next page or reverse side of this form for soil sampling information and mailing instructions

HOW TO TAKE A SOIL SAMPLE

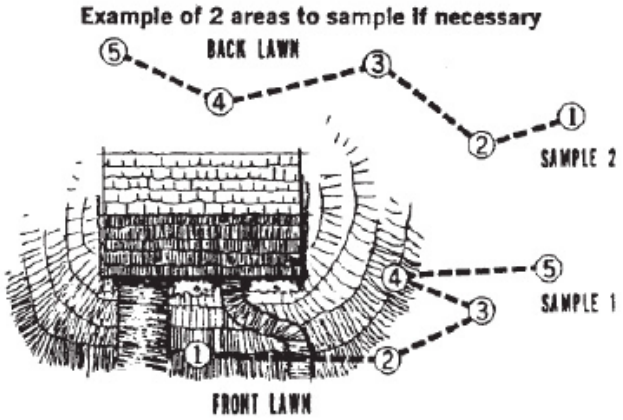
The quality of your result depends largely on the quality of your sample. To obtain a good soil sample, follow the directions below.

WHEN

Soil samples may be collected whenever soil conditions permit. When submitting your samples to the laboratory, check our website (**http://soiltest.cfans.umn.edu/**) for current turnaround times and more information.

WHERE

- If the area is fairly level and the soil appears to be uniform, collect one composite (mixed) sample.
- If your lawn or garden has large areas which differ in fertility, take one sample from each area. For example, you may want to sample the front lawn and the back lawn separately (see diagram).



- Do not combine soil from the lawn area and a garden in the same composite sample.
- Areas of special concern (under trees, near buildings, trouble spots) should be represented by separate samples.

HOW

Use a garden trowel, spade, sampling tube or soil auger. **Scrape away or discard any surface mat of grass or litter.** Sample the lawn or garden area to the sampling depth indicated below.

1) existing grass - sample 0-3"
2) new grass - sample 0-6"
3) gardens - sample 0-6"
4) trees/shrubs - sample 0-12"
5) lead test - **sample only surface 3/4"**

- Place the soil sample in a clean bucket or pan.
- Repeat sampling in several random locations *within the chosen area*. Mix soil well to make ONE *composite* sample for the entire area, and send or bring **2-3 CUPS** of the composite sample to the lab. Use a clean, leak-proof container (e.g. disposable food storage bag or tub) and place the container inside a *sturdy* mailer or shipping package. Please keep your paperwork *outside* of the soil container, but DO place the form(s) and payment inside the sealed mailer or shipping package.
- Label the sample container with your name, address and sample identification (**max = 4 characters**). Fill out the other side of this form **completely**, and *keep a record of your sample identification.*
- **Soluble salts test:** This test should be requested if:
  1) "black dirt" has been hauled in and poor growth is observed,
  2) there is possible damage from salt used on streets and sidewalks, **or** *excess application of fertilizer,*
  3) the grass looks burned even when adequate water is present,
  4) the soil is poorly drained and located in the south central or western part of the state.
  5) For golf greens, which must be heavily fertilized, salt content needs to be monitored and factored into making fertilizer recommendations.
- **Lead test:** Select only if lead contamination is suspected.

HOW TO SUBMIT SAMPLES

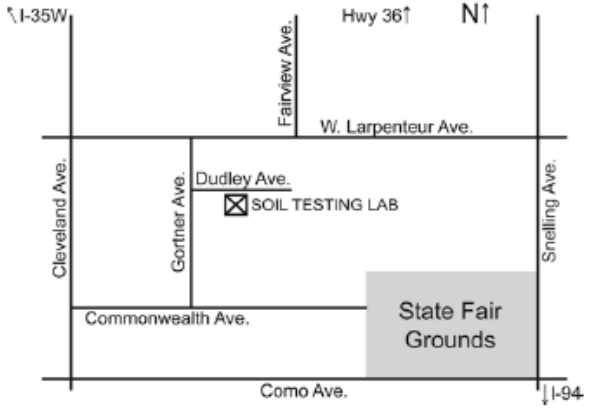
Soil samples may be delivered in person to Room 135 Crops Research Building, University of Minnesota (see map below), or mailed to:

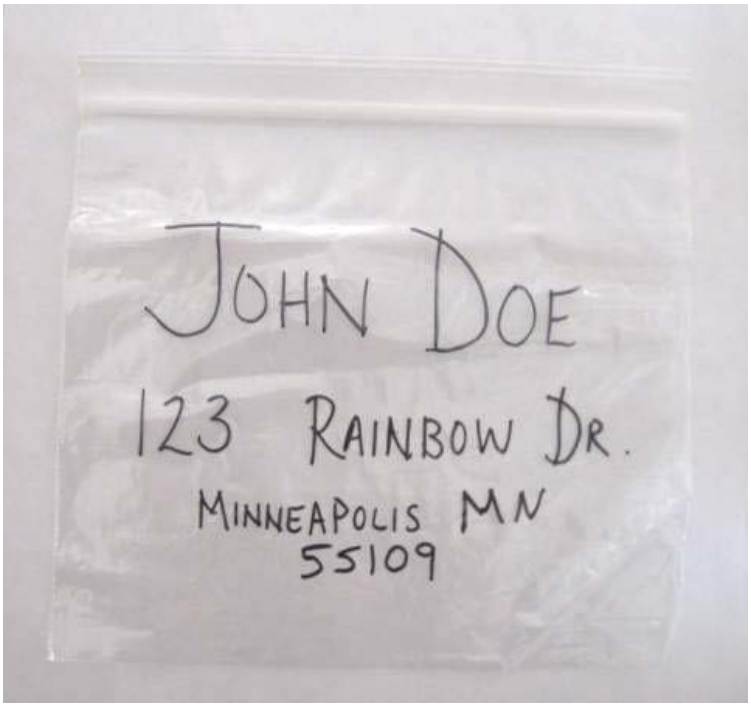
Soil Testing Laboratory
University of Minnesota
1902 Dudley Avenue
St. Paul, MN 55108

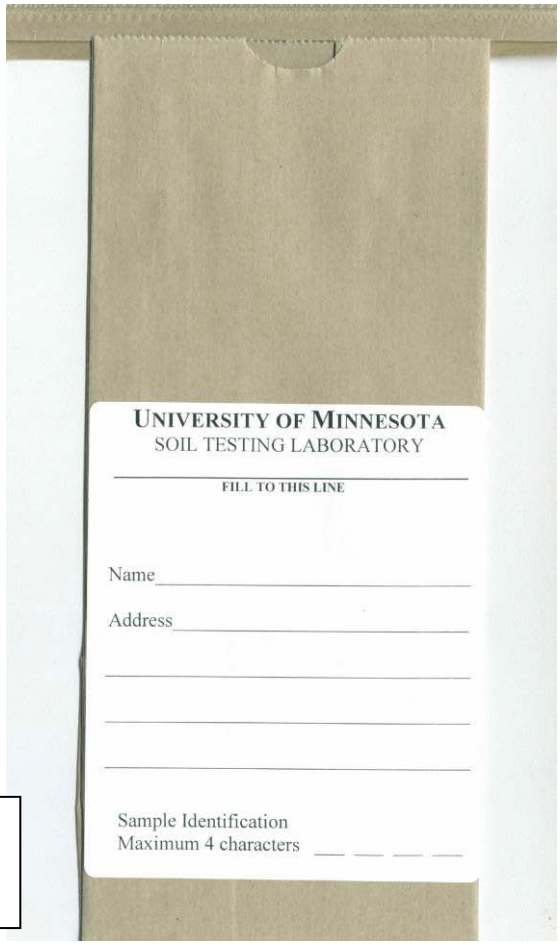
Website: http://soiltest.cfans.umn.edu

Phone: (612)625-3101

Enclose a separate form and full payment for each sample to be tested. You may send one check to cover the cost of multiple samples. Make checks payable to the University of Minnesota. **Do not send cash**. The University of Minnesota will not be responsible for cash sent through the mail. The sender pays the postage.







Examples of bags for collecting soil samples.

How to read a soil test result

The most important part of the soil test is the fertilizer recommendation. This will differ from site to site. This does not stand out on the soil test report. We have put an asterisk on the following sample soil test report to help you find the fertilizer recommendations. The example soil test report recommends a fertilizer ratio of 15-0-30 (15% N – 0% P_2O_5 – 30% K_2O).

Nitrogen

Since nitrogen can move out of the root zone with water or is released as a gas, soil tests do not include nitrogen analysis. Nitrogen recommendations are based on organic matter and maintenance practices, including clippings management and irrigation. The soil test indicates how much N per 1,000 square feet per year is recommended. Do not exceed this recommendation and do not apply more than 1 lb. N per application. The example soil test recommends 0.5 pounds of nitrogen (lbs N) per year per 1,000 sq. ft. This is a very small amount of N. The recommendation is based on soil analysis and the fact that this site is not irrigated (less N is washed away) and the grass clippings are left on the grass (N is created). The irrigation and grass clipping information is given just above the potash recommendations on the left center of the form. You provide this information when you submit your sample.

Annual Nitrogen recommendations

	Soil Organic Matter[1]		
Maintenance Practices	Low	Med. to High	Organic soil
	Amount of Nitrogen to apply (lb. N/1000 sq. ft.)		
Regular irrigation Clippings removed	3.0	2.5	2.0
Clippings not removed	2.5	2.0	1.5
No irrigation Clippings removed	2.0	1.5	1.0
Clippings not removed	1.5	1.0	0.5

[1] Low= <3.1%, Med= 3.1 to 4.5, High = 4.6 to 19%, Organic = >19%

Source: Rosen et. al., 2013 http://www.extension.umn.edu/distribution/horticulture/DG1731.html

Note that 0.5 lbs of N per year per 1,000 square feet is not the same as 0.5 lbs of fertilizer per 1,000 square feet. A calculation must be done to figure out how many pounds of fertilizer from your bag are needed. See instructions later in this section.

Organic Matter

The organic matter content of soils is important for several reasons, including:

- Improving soil structure, water infiltration, drainage and soil aeration on clay soils
- Acting as a reservoir of available plant nutrients
- Increasing the water holding capacity of sand soils (University of MN Extension, n.d.)

Soil pH

The soil test provides a pH reading for your soils. pH is a measure of the acidity of the soils. The optimum pH for most plants and soil microorganisms is between 6.0 and 7.0, which is slightly acidic to neutral. Soil pH is important because it can affect:

- The availability of several plant nutrients
- The activity of soil microorganisms
- The ability of the soil to hold plant nutrients

Most established grasses are tolerant to a wide pH range, so lime (which reduces acidity) is not usually recommended. (University of MN Extension, n.d.)

If phosphorus is needed, make sure you save the soil test report as proof you are following the MN phosphorus restriction law. It is valid for three years.

Example

University of Minnesota
Soil Testing Laboratory

SOIL TEST REPORT
Lawn and Garden

Client Copy
Department of Soil, Water, and Climate
Minnesota Extension Service
Agricultural Experiment Station

Page **2**
Report No. **41822**
Laboratory No. **88621**
Date Received **04/21/09**
Date Reported **04/29/09**

Sample/Field Number: KATE

SOIL TEST RESULTS

Estimated Soil Texture	Organic Matter %	Soluble Salts mmhos/cm	pH	Buffer Index	Nitrate NO3-N ppm	Olsen Phosphorus ppm P	Bray 1 Phosphorus ppm P	Potassium ppm K	Sulfur SO4 -S ppm	Zinc ppm	Iron ppm	Manganese ppm	Copper ppm	Boron ppm	Calcium ppm	Magnesium ppm	Lead ppm
Medium	**6.0**		**6.8**				**62**	**97**									

INTERPRETATION OF SOIL TEST RESULTS

Phosphorus (P): PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
5 Low | 10 Medium | 15 | 20 High | 25 V. High

Potassium (K): KKKKKKKKKKKK
25 Low | 75 Medium | 125 | 175 High | 225 V. High

pH: ************************************
3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0
Acid — Optimum — Alkaline

Soluble Salts:
0 | 1.0 | 2.0 | 3.0 | 4.0 | 5.0 | 6.0 | 7.0 | 8.0 | 9.0 | 10.0
Satisfactory — Possible Problem — Excessive Salts

RECOMMENDATIONS FOR: Home Lawn

LIME RECOMMENDATION: 0 LBS/1,000 SQ.FT.

Grass not watered Clippings not removed

TOTAL AMOUNT OF EACH NUTRIENT TO APPLY PER YEAR:*

NITROGEN	PHOSPHATE	POTASH
0.5 LBS/1,000 SQ.FT.	0 LBS/1,000 SQ.FT.	1 LBS/1,000 SQ.FT.

THE APPROXIMATE RATIO OR PROPORTION OF THESE NUTRIENTS IS: 15-0-30

Use a fertilizer with the percentage of nutrients closest to the above ratio. Apply according to the instructions on the fertilizer bag or container, or determine the amount required from the instructions given on the back side of this report. Since meeting the exact amount required for each nutrient will not be possible in most cases, it is more important to apply the amount of nitrogen required and compromise some for phosphate and potash.

-Apply the total amount recommended above at one time in early September.

*CAUTION! Do not apply more that 1 lb. nitrogen per 1000 sq. ft. in one application to avoid burning the grass, unless a slow release form or organic fertilizer is used. It is recommended that up to 50 percent of the nitrogen be of the slow release form.

Grass clippings left on the lawn is a sound practice. They recycle nutrients and conserve moisture. The above recommendations reflect this contribution.

County: HENNEPIN. For additional information, contact the YARD & GARDEN LINE: Phone: 612-624-4771 Website: www.extension.umn.edu/yardandgarden

Explanation of Soil Test Report

Soil pH: This is a measurement of acidity, which is important because it affects:
1) the availability of several plant nutrients, 2) the activity of soil microorganisms,
3) the ability of soil to hold plant nutrients.
The optimum pH for most plants and soil microorganisms is between 6.0 and 7.0. Some plants, however, such as blueberries, azaleas and others prefer more acidic conditions (i.e., lower pH). Since grasses are quite tolerant to a wide pH range, lime is generally not recommended on established grasses.

Buffer Index: This test is used only to determine the lime requirements and should not be confused with soil pH.

Organic Matter: The Regular Series test includes an estimate of the percent organic matter. The classifications used for organic matter are: Low 0-3%, Medium 3.1-4.5%, High 4.6-19%, and Organic Soil 19.1% or greater.
Organic Matter has many important functions in soils, some of which are:
1) to improve soil structure, water infiltration, drainage, and soil aeration on clayey type soils.
2) to act as a reservoir of available plant nutrients
3) to increase the water holding capacity of sandy soils. When organic matter is low, large amounts of peat, compost, crop residues, manure or other organic amendments are required to change the organic matter content of the soil.

Soluble Salts: This test is used primarily to check for high amounts of salts in "black" dirt that is used in new landscaping or for top-dressing purposes and for possible salt damage to grass from salted streets and sidewalks. Excess salt must be leached by intense watering before the plants will grow normally.

Lead: Recommended for soils or sandbox sand to which young children may be repeatedly exposed.

Other Special Tests: Recommendations are not provided for these tests since the interpretations are limited to special situations. The tests are provided for professionals only.

Interpretation of Soil Tests: The relative levels of various nutrients are indicated by a series of symbols. A line of P or K letters ending in the lower areas of the block, represents a low level of the nutrient.

Recommendations and Calculation of Fertilizer Required: Lime and plant nutrient recommendations are given in pounds per area (1000 square feet for turf, or 100 square feet for gardens, trees or shrubs). Plant nutrients are expressed as nitrogen (N), phosphate (P205) and potash (K20). The recommended plant nutrient requirements can be met by applying a given amount of fertilizer(s).

Commercial fertilizers are identified with a 3-numeral code that indicates the percentage of nitrogen, phosphate, and potash. A common garden fertilizer labeled 10-10-10 contains 10% of each of the three plant nutrients. Most garden centers sell fertilizer blends (10-10-10) rather than single nutrient fertilizers like 20-0-0 or 0-0-60 which are available from fertilizer dealers. Because there are a limited number of fertilizer blends on the market you may not find one that exactly meets the ratio recommended (reported on the front side). In this case, you should select a fertilizer blend with the closest ratio of N-P2O5-K2O to that recommended.

Since meeting the exact amount required for each nutrient will not be possible in all cases, it's most important to match the Nitrogen (N) required. The amount of fertilizer to apply that will give the recommended amount of nitrogen can be obtained from the following table:

Table to Determine Total Amount of Fertilizer to Apply Based on Actual Nitrogen Recommended:

	Nitrogen Recommended			
Fertilizer Nitrogen % (First number of fertilizer grade on bag)	0.1 lb. N/100 sq. ft	0.15 lb. N/100 sq ft	0.2 lb. N/100 sq. ft	1.0 lb. N/1000 sq. ft Total lbs. fertilizer to apply/1000 sq. ft
	Total lbs. fertilizer to apply / 100 sq. ft			
45	0.22	0.33	0.44	2.2
37	0.27	0.40	0.54	2.7
36	0.28	0.42	0.56	2.8
33	0.30	0.45	0.60	3.0
32	0.31	0.46	0.62	3.1
30	0.33	0.50	0.66	3.3
28	0.36	0.54	0.72	3.6
27	0.37	0.56	0.74	3.7
25	0.40	0.60	0.80	4.0
24	0.42	0.63	0.84	4.2
22	0.45	0.68	0.90	4.5
21	0.48	0.72	0.96	4.8
20	0.50	0.75	1.00	5.0
19	0.53	0.80	1.06	5.3
18	0.56	0.84	1.12	5.6
16	0.63	0.95	1.26	6.3
15	0.67	1.00	1.34	6.7
13	0.77	1.15	1.54	7.7
12	0.83	1.25	1.66	8.3
10	1.00	1.50	2.00	10.0
8	1.25	1.88	2.50	12.5
6	1.67	2.50	3.34	16.7
5	2.00	3.00	4.00	20.0

Example: If the N (nitrogen) recommendation is for 0.1 lb. N/100 ft. sq. and the fertilizer grade you selected has a ratio of 18-6-12 (column 1), you will have to apply 0.56 lbs of this fertilizer (from column 2) for each 0.1 lb. N recommended per 100 square feet.

Note: 2 cups (1 pint) of dry fertilizer weighs about 1 pound.

General Information

For Home Lawns: follow these rules when applying fertilizer:
1) use a formula designed for lawns (not trees, flower beds or farms).
2) apply fertilizer during the spring and late summer (do not fertilize frozen ground).
3) apply fertilizer uniformly in two directions with a mechanical spreader.
4) sweep up any fertilizer accidentally applied on sidewalks and driveways to prevent its movement to storm sewers, lakes and streams.
5) water the lawn thoroughly after fertilizing to dissolve the nutrients and force them down to the soil surface to combine with the soil.

For Vegetable and Flower Gardens:
Manure, compost, or other forms of organic matter may be added. These amendments provide a good source of trace nutrients as well as improve soil granulation. Three to five bushels of manure or compost per 100 square feet are recommended.

Fertilizers

How to choose the correct fertilizer

Use soil test results to choose the proper fertilizer.

1. Look at recommended ratio on soil test results: *Example: 15-0-30*
2. Select a fertilizer that most closely matches the nutrient ratio from your soil test. In this example, a 15-0-30 is a 1-0-2 ratio.
3. The Best Practices Matrix for your site will guide you on percentage of slow-release N.

What if that fertilizer ratio isn't available?

Use the closest ratio that you can find without exceeding N or P.

Example: Test recommendation is 15-0-30. If not available, settle for 10-0-30 or 12-0-25. The latter is still very close to a 1-0-2 ratio.

How to read the fertilizer bag:

Nitrogen-Phosphorus-Potassium/Potash (N-P-K)

Fertilizer bags list three important numbers. They are the percentage of the major nutrients (N-P-K) that make-up the fertilizer mixture. The example fertilizer bag reads 20-0-10. This means at least 20 percent of the contents of this bag is N, zero percent P as phosphate (P_2O_5), and at least 10 percent of the bag is K as (K_2O). The rest of the contents of this bag are inert materials that are used to help deliver the nutrients through your spreader.

Notice that there is no phosphorus in this fertilizer mix.

Slow-release Nitrogen

Read the ingredients listed on the bag to find out if the nitrogen is slow-release or quick-release. This can be tricky. On page 22 of the manual there is a list of common names for slow-release nitrogen you can compare with the ingredients list on your bag. Check the Best Practices Matrix to review slow-release N recommendations for your site. To calculate the percent of the nitrogen in the fertilizer that is slow-release, use this equation:

$$\%\ \text{slow-release N} = \frac{\text{slow-release nitrogen} \times 100}{\text{nitrogen number on fertilizer bag}}$$

Other Ingredients

The fertilizer bag will also list other ingredients that have been added to the mixture. However, it is filled primarily with inert ingredients that aid in the uniform dispersal of the material through a spreader.

Application Rate

The fertilizer bag will usually suggest various application rates and spreader settings for the fertilizer mix. Follow the soil test guidelines, not the fertilizer bag.

For the best growing results, follow the soil test guidelines, not the fertilizer bag guidelines.

Who can apply fertilizer?

Anyone (i.e. business, individual, etc) who applies fertilizer for hire is required to have a fertilizer license administered by the Minnesota Department of Agriculture (MDA). Those that work for a city and apply to city property do not need a license. For more information, refer to the MDA contact information and fact sheets in the Resources section of the manual.

When to apply fertilizer?

Late summer through early fall, around Labor Day, is the best time of year to fertilize. See the Best Practices Matrix in this manual for more information on application timing. Late fall applications (late October - November), after soil temperatures fall below 50° F, are not recommended.

Never fertilize on frozen ground. It will green up our lakes, not our turfgrass.

How much fertilizer to apply based on a soil test

Follow these steps to find out how much fertilizer you need. Remember to calibrate your spreader or you will not be able to apply the proper amount.

1. Follow soil test. Buy the recommended formulation. *Example: 15-0-30*

2. Follow soil test. How many pounds of nitrogen per 1,000 sq ft per year are recommended? *Example: 0.5 lb/1,000 square feet/year*

3. No matter the total recommendation for the year, never apply more than 1 pound of N per 1,000 square feet per application.

4. Calculate the pounds of fertilizer to use per 1,000 square feet:

$$\frac{\text{pounds of N recommended on soil test}}{\text{N number on fertilizer bag}} \times 100$$

Example: $\frac{0.5}{15} \times 100 = 3.3$

5. 3.3 pounds of the purchased fertilizer per 1,000 square feet should be applied to the turfgrass.

6. If your site is 20,000 square feet, you would apply 66 pounds of fertilizer to the entire site (3.3 x 20,000/1000 = 66).

How much fertilizer to apply based on the Best Practices Matrix

Following the Best Practices Matrix is not as good as using soil test recommendations. However, the matrix is better than no recommendations when it comes to fertilizer selection. Follow these steps to get the right amount of fertilizer applied. Remember to calibrate your spreader, or you will not be able to apply the proper amount.

1. Follow the Best Practices Matrix for your site. For example, an average quality turf, sunny site with compacted soils recommends a 4-0-2 ratio. Buy something in that ratio such as 20-0-10 (Nitrogen twice as much as potassium, no phosphorus).

2. Follow the Best Practices Matrix to see how many pounds of nitrogen per 1,000 square feet per year are recommended. In this case 1 lb/1,000 square feet/year is recommended.

3. Follow steps 3-6 on previous page.

Use the chart below for some common Minnesota Fertilizer formulations. If your fertilizer analysis is not listed, use the calculation on the previous page. The rates are based on the first number (Nitrogen) in the analysis.

Pounds of fertilizer needed per 1,000 square feet

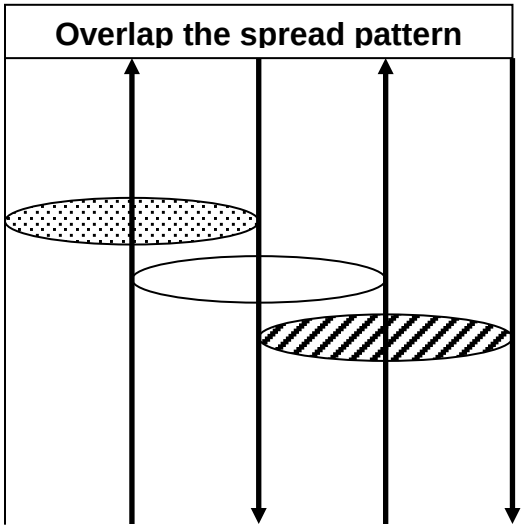
Fertilizer Analysis	Recommended Rate from Soil Test	
On the bag (N-P-K)	0.5 lbs N	1.0 lbs N
10-10-0*	5 lbs fertilizer	10 lbs
10-10-10*	5	10
10-20-0*	5	10
15-0-30	3.3	6.7
20-0-10	2.5	5
20-0-15	2.5	5
33-0-0	1.5	3

*Phosphorus fertilizer can only be used for new lawns, when a soil test indicates a need, or when applied by trained golf course staff.

Edge Guards
Use edge guards or shields to prevent application of fertilizers onto hard surfaces. Set to a lower application rate or close some of the holes in the spreader when using a guard.

How to apply fertilizer

Since fertilizer is applied in an overlapping pattern, the application rate should be calculated and cut in half to end up with the desired rate. In other words use a setting on your spreader that will deliver ½ of desired rate (your equipment must be calibrated to know spread rates for each setting (see calibration information on page 43)). With the 50% overlap of the spreader, you will end up with the correct application rate. Remember that settings are not linear, for example setting 7 would not deliver ½ of setting 14. If your equipment can't be adjusted to the lower rates, adjust by driving or walking faster.



Nutrient Tips

- Leave grass clippings. This equals one application of fertilizer per year.
- Mulch leaves with the mower. As leaves decompose they will release small amounts of nutrients available for the grass plants as well as provide some organic matter to the soil - a benefit for both plant roots and soil microbes.
- Fertilize following soil test recommendations, using the Best Practices Matrix timing recommendations to provide optimal results.
- Fill granular spreaders over hard surfaces so that spills can be swept up.
- Fill liquid spreaders over vegetation so that spills can be watered down.
- Calibrate all spreaders to ensure accurate application rates.
- Use a cover to prevent spillage.
- Close the gate when making turns to prevent over-application and burning.
- Don't over-water. Excess water depletes nutrients and wastes water.
- Turfgrass can use a limited amount of nutrients. Excess nutrients that are applied but not absorbed create environmental problems.

Managing properties

- Document the turfgrass quality expectations for each property.
- Follow soil test results for proper fertilizer selection.
- Follow Best Practices Matrix recommendations for application timing.
- Create a visual map of your properties. Note soil test results so that you can easily identify which formulation of fertilizer each property needs. Mapping doesn't work for you? Develop your own system to share information with your crew.
- If you can't have a custom blend fertilizer for each property, look at your soil test results and group them. Buy fertilizers that meet the needs of most. If you follow the rule to not over-apply N or P, you can compromise a bit to reduce your total number of formulations. You might be surprised to see that you only need a few varieties to service your sites accurately.

Cleaning fertilizer equipment

It is important to regularly clean your equipment. When you wash equipment, make sure wash water and debris do not drain to the stormsewers or to lakes and streams. Please refer to "The Law" in the Resources section for regulations governing proper fertilizer equipment cleaning.

If applying by the bag instructions instead of the Best Practices Matrix or soil test suggestions, you may be applying too much fertilizer.

Apply only what is recommended. Excess nutrients contaminate lakes, rivers, and groundwater.

Irrigation

Sufficient water to support healthy turfgrass or to at least ensure survival during summer stress periods is considered a good practice. Watering beyond the plant's need is both wasteful and expensive. Too often we tend to over-water our turfgrass instead of understanding the turfgrass needs and incorporating irrigation systems that are flexible enough to account for rainwater inputs and existing soil moisture. The problem may not seem that big when you look at the grounds you maintain, but consider this:

- Turfgrass covers about 49,000 square miles of land in the U.S.
- Turfgrass is the single largest irrigated crop in the U.S. by surface area (Lindsey, 2005).

To protect our drinking water, we must reduce the amount of freshwater used for irrigation. It is very likely you can reduce your irrigation water and still get the same, or even better, results.

Too much water:

- Leaches nutrients away from plant roots.
- Carries nutrients and sediment into waters.
- Wastes good, clean water.
- Lowers the groundwater table.
- Affects stream flow.
- Requires costly infrastructure (wells).

Watering needs

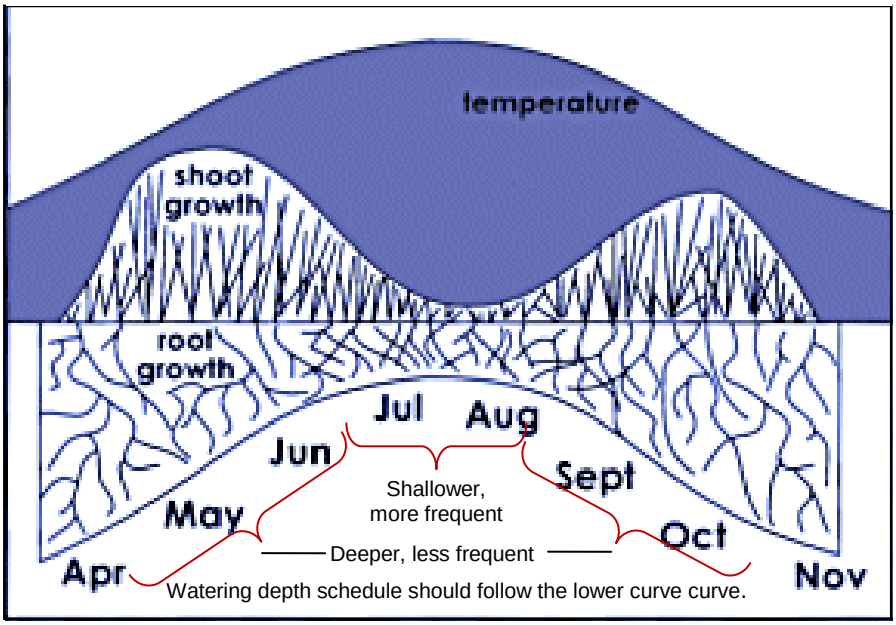
In the Twin Cities area of Minnesota the average amount of rainfall is very close to one inch per week during the growing season. Turfgrass requires roughly one inch of water per week to remain green during the growing season (see the Best Practices Matrix for site specific recommendations). Supplemental irrigation is often not needed except during June, July, or August. During the rest of the year more frequent rainfall (usually), shorter day lengths, and cooler temperatures result in less water loss by the plant and hence, little need for additional irrigation. This means that irrigation water should only be used to occasionally supplement the rainfall shortages and maintain active growth. It should not be done on a routine basis such as once or twice per week without considering whether or not any additional water is even needed.

The chart on the next page shows that the root systems of our cool-season grasses are naturally shallower during midsummer. This is primarily due to higher temperatures and drier conditions frequently encountered in a Minnesota summer. During that period, we should be watering to wet the active root zone (typically 3 to 4” deep) of our grass plants. Deep and infrequent watering during that time will often result in water draining through the soil and beyond the active root zone and therefore wasting water. In the middle of the summer, shorter more frequent watering intervals are better so long as the lawn surface is not kept continually wet. For example, instead of applying the entire amount of water at one time, consider dividing up the weekly allotment into two or three applications, allowing some drying time between watering. This avoids keeping the soil surface constantly wet and helps ensure as deep of

rooting as possible. During cooler periods of the year (i.e. spring and fall) watering can return to deeper, less frequent applications to coincide with more active and deeper rooting.

For optimum turfgrass health and reduced water use, implement an infrequent, deep watering regime, but bear in mind that "deep" will be changing during different times of the growing season.

Irrigation for cool season grasses



Adapted from Graphic Source: University of Minnesota, 2006

Dormant Grass

Many turfgrass areas do not have irrigation systems. Cool season turfgrasses, such as Kentucky bluegrass, will become dormant or significantly slow their growth rates during the hot, dry periods of the summer. This is okay; however, the turf cannot withstand high use during these times. On rare occasions, persistent hot, dry conditions will kill the turfgrass.. While this is a rare occurrence, it can happen where the crown or growing point of the grass plant dies as a result of the severe stress. Cool-season turfgrasses can withstand the loss of roots and leaf tissue during severe stress periods. However, if the grass crown also dies, the plant is lost, as it has no way to generate new shoot or root tissue.

There really is not a good way to visually know when turfgrass is approaching or has exceeded its threshold of survival. However, it is important to remember that a dry, brown turfgrass area is considerably warmer than an actively growing and green turfgrass. The main reason for this is that in the brown, dry turfgrass there is no transpiration, and therefore, no evaporative cooling occurs to reduce temperatures in and around the plant. The consequent heat build-up in and around the plant can reach levels fatal to all plant tissue, including the crown tissue. The best strategy is to condition your turfgrass. Conditioning turfgrass to warmer, drier conditions is very important to its survival. Conditioning means that water and nitrogen supplies are gradually reduced ahead of the summer stress periods to “condition” the turfgrass to slower, more stressful growing conditions.

Do not apply excessive amounts of water just before an impending watering restriction as a means to “build-up” plant and soil water reserves. In reality, this practice not only increases plant succulence (i.e., the plant now requires high levels of moisture to sustain this condition) but excess water can lower soil oxygen, which can severely damage the root system. Both of

Unirrigated sites cannot tolerate high traffic during hot, dry conditions. Reduce traffic to the area during hot, dry conditions.

those attributes severely decrease the plant's ability to tolerate summer stress and in general are very wasteful of water. In other words, this has a "deconditioning" effect on the plant, making it more vulnerable to injury or even death during hot, dry summer conditions.

If you allow turfgrass to go dormant during summer stress periods, then supplying some water-¼ to ½ inch every 10 days to two weeks-will usually keep the crown tissue alive to regrow under more favorable conditions. However, when temperatures are consistently in the nineties or even low one-hundreds with no rain forthcoming, that interval should be shortened. Likewise sandier soils will require somewhat more frequent watering than heavier clay soils due to differences in soil water-holding capacity. In addition, severely compacted soils will need shorter intervals than non-compacted soils, where root systems can be significantly deeper and mine a greater soil volume for moisture reserves.

Even when appropriate steps are taken to preserve turfgrass from dying during periods of summer stress, some permanent injury can still occur. This can be an opportunity to do over-seeding to introduce more drought-tolerant species. That can help reduce future moisture needs as well as other inputs.

Do you need more water?

Use a rain gauge to measure rainwater, take this amount and subtract it from the weekly watering recommendation from the Best Practices Matrix. Add only the amount of additional water that is needed. Often that will be zero.

Save our water by continually adjusting your irrigation system, depending on rain and soil moisture. Stay within Best Practices Matrix watering guidelines.

How can you control how much water is delivered?

- Calibrate irrigation system and adjust settings accordingly.
- Read and understand settings of irrigation system for delivery capacity.
- Install rain sensors to avoid watering during the rain.
- Install moisture sensors to avoid watering when soils are moist.
- Frequently adjust irrigation systems to account for recent rain, prevailing weather conditions, and season of the year.

More efficient watering

To get the most water to the plant and reduce water lost to evaporation or waste:

- Water in early morning. Grass blades need to dry out to minimize disease pressure.
- Water close to ground and with larger drops.
- Water slowly, deeply, and less frequently. Root growth is influenced by water depth and time of the year. Frequent shallow watering that keeps surface soils wet encourages shallow root growth, greater proneness to certain diseases, and reduced stress tolerance.
- Monitor irrigation systems. Make sure water is not lost by landing on or running off the turfgrass onto hard surfaces and the nozzles are the correct type for the turfgrass space.

- Leave clippings and mow at higher heights to reduce moisture loss and irrigation needs.
- Aerate turfgrass to improve water infiltration into the soil and increase soil oxygen levels deeper into the soil; both have positive impacts on root growth and soil microbial action. Deeper, more robust root systems combined with increased soil water-holding capacity will decrease the need for frequent supplemental watering.

Maintenance

Irrigation systems should be set up properly and checked frequently. Weekly inspection along with performing necessary maintenance is ideal, especially on systems that are not computer controlled and cannot account for the amount of rainwater received. Items to check include:

- Heads are working properly.
- Water is not directed to hard surfaces. One cycle does not create surface runoff from turfgrass areas.
- Programmed for early morning.
- Upgrade if your system cannot be controlled to deliver the right amount of water (rainfall considered), to obtain Best Practices Matrix recommendations.
- Verify that your schedule complies with city watering restrictions.

Upgrading your systems

Consider updating your irrigation system to include features such as rain sensors, soil moisture sensors, and smart scheduling that deliver only the required amount of moisture per week.

Minnesota Law

Minnesota Statute 103G.291 subd. 1 states. If the governor determines and declares that there is a critical water deficiency, public water supply authorities must adopt and enforce water conservation restrictions within their jurisdiction.
Minnesota Statutes, section 103G.291 subd. 4 requires public water suppliers to adopt conservation rate structures to encourage conservation of water. See the “The Law” in the Resources section of this manual for more information on Mn laws and city ordinances.

Signs of overwatering

It is far more common to overwater than underwater irrigated turfgrass.

- Yellow nutsedge appears more frequently in turfgrass (triangle shaped stem).
- Water-loving weedy grasses (annual bluegrass, rough bluegrass, creeping bentgrass) may start to appear and increase in area that they occupy.
- Soil is consistently moist to the touch.
- Problems with clumping clippings when mowing.
- Water running over the curb and/or down the street.
- Standing water in low areas.
- Pale-looking grass due to lack of nutrient uptake under persistently wet soils.
- Soil leaving (eroding from) the site.
- Mower tracks persist due to weak shoot and stem tissue that is slow to pop back to an upright position. Also occurs in dry conditions: see below.

- In wet conditions, plants are typically green but very succulent due to high moisture levels.

Signs of under-watering

- Turfgrass does not need much additional water to survive in Minnesota. Non-irrigated turfgrass areas are common and are explained in the Best Practices Matrix.
- For irrigated areas, a common sign of under-watering is a change of color from a healthy green to grayish-green or grayish-blue. This may be visible over the entire lawn or between irrigation zones where there is insufficient overlap to meet the water needs.
- Mower tracks and foot printing.

Add a rain or soil moisture sensor to your irrigation system-you'll use less water (the right amount) and save money.

This page is intentionally blank

Cultural Practices

Preparing for the Season

The best time of the year to prepare for upcoming turfgrass maintenance is before the growing season starts. It's time to tune up equipment, sharpen mower blades, calibrate herbicide and fertilizer spreaders, and train your crew. Take advantage of slow times of the year to prepare site assessment forms, maps, maintenance checklists, and to research updated turfgrass maintenance methods, tools, and equipment.

Calibration

Calibration tells you how much material will be applied at each setting.

Minnesota law (see the Law section under "fertilizers" and/or "pesticides") requires you to follow label instructions when applying pesticides. For healthy turfgrass, it is important to apply the correct amount of fertilizer. The Best Practices Matrix and your soil test will help guide you in understanding the target amounts. Calibration of equipment is essential for measuring the amount of material of (e.g. fertilizer or herbicide being delivered at any given setting. This should be the backbone of your maintenance program. By calibrating equipment, waste and costs of material will be reduced, performance will be enhanced, and environmental impacts will be reduced.

You can calibrate any type of equipment (e.g. backpack sprayers, handheld sprayers, rotary spreaders, drop spreaders, etc). Calibration is what separates the top-performing organizations from the average performing organizations!

Good programs include calibration of equipment.

Calibration guidelines

- Calibrate each piece of equipment yearly.
- Calibrate new equipment.
- Calibrate for each granular product; different materials flow differently.
- Calibrate for every setting within your range of application rates.
- Place calibration card in or near equipment for easy access.
- For specific calibration directions, contact the manufacturer of the spreader or sprayer.

Adjust application rates

- For most equipment, application rates are adjusted by walking or driving faster or slower.
- Application rates are also adjustable by changing the setting.

Equipment

- When buying new equipment, look for equipment that can deliver low application rates.
- Calibration tools that measure slot size of a spreader do not replace calibrating the equipment, nor do they guarantee the correct application rate.

Calibration is a great way to improve your operations, save money, and protect the water.

Calibration Example: Dry Material

1. Locate test area: Clean/sweep a flat, hard surface or lay out a tarp (or remove spinner from spreader and use a calibration tray).

2. Write down the type of material you are using.
   Example: Tessman fertilizer 20-0-10

3. Write down what piece of equipment you are calibrating.
   Example: Scotts Standard Broadcast Spreader- Wayzata # 12

4. Select a setting. *Example: Setting #1*

5. Apply material at a constant rate across cleaned surface.
   Hint: Start walking (but not applying) before the start line for steady speed throughout

6. Record speed or rate. *Example: 3 mph or Jim walking normal pace*

7. Measure the coverage area (length x width).
   Example: 22 ft x 12 ft = 264 square feet where fertilizer landed

8. Collect what was applied (sweep it up), or weight calibration tray.

9. Weigh what was applied.
   Example: 0.17 lbs (material used on setting #1 for 264 square feet)

10. Translate this to the units we use: 1,000 square feet.
    Example: Divide 1,000 by the coverage area
    1,000 square feet/ 264 square feet = 3.78
    3.78 x 0.17 lbs = 0.64 lbs
    Setting #1 applies 0.64 lbs of material/1,000 square feet
11. Repeat for all settings.
12. Repeat for all materials you intend to spread with this equipment.
13. Make a chart. Place it in or near equipment for easy use by operator.

Scotts Standard Broadcast Spreader – Wayzata #12		
Application Rate (lbs/1,000 sq ft)		
Speed: 3 mph or Jim walking at a normal pace		
Setting	**Tessman fertilizer 20-0-10**	**Grass seed**
#1	**0.64**	**3**
#2	**1.30**	**6**
#3	**2.70**	**9**
#4	**4.00**	**12**

Note: The application rates in this chart are not real.

Calibration Example: Liquids

A simple method for calibrating a backpack or handheld sprayer (from University of MN):

1. Mark out an area 18.5 feet x 18.5 feet
2. Spray the area uniformly with water, as you would do when applying a pesticide
    - Maintain constant pressure and speed.
    - Record the amount of time it takes to spray the designated area.
3. Spray into a measured container for the same amount of time.
    - Maintain constant pressure
4. Measure the number of ounces in the container.
    - This equals the amount of Gallons/Acre the sprayer delivers
5. Divide Gallons/Acre by 43.560 to determine Gallons/1000 ft^2
6. Sprayers should be calibrated for each individual using it since they will walk at different speeds.
7. Record the results and place the information where it is ready available to applicators.

Note: these calculations only work when using the specified test area (18.5 ft x 18.5 ft).

Sweeping

Sweeping hard surfaces such as roads, sidewalks, and parking lots is a simple way to reduce water contamination. Everything on hard surfaces drains to the street, through the stormdrain or ditch, into the nearest lake, pond, wetland, or river.

Sweep frequently

- Sweep as often as you can. A year-round program is optimal.
- Sweeping makes a good impression. If your hard surfaces look good, everything will appear better maintained
- Be proactive. Keep sand, salt, clippings, seeds, leaves, and debris from entering our stormdrains. Plant parts act as fertilizers in our waters. As they bio-degrade, they release nutrients that turn the lakes green. Dirt entering the stormdrains accelerates the aging of our lakes, and things like oil and salt act as toxins to our aquatic systems.

Dispose of sweepings properly

There are several options for sweepings disposal:

- Dispose of sweepings in a landfill.
- Take sandy sweepings to a facility that will re-use the material (i.e. asphalt companies).
- Screen sandy sweepings and reuse the screened sand as construction fill.
- Organic sweepings (grass, leaves, seeds) can be composted.
- Do not dispose of sweepings in low areas, lakes, streams wetlands or holding ponds, or where rain will wash them to the stormdrain or ditch.
- Do not dispose of sweepings where children play.

Power Raking

Power raking can be useful as a spring clean-up tool to remove sand and debris from turfgrass and fluff up the grass blades. This process does damage turfgrass plants, but recovery is usually quite rapid during this period of the year. To reduce damage to turfgrass, make sure the raking is done lightly (shallowly) and not deeply.

Power raking

- Does NOT reduce thatch.
- Stands grass up, thereby opening up the turfgrass canopy, allowing sunlight to reach the soil surface where soil is warmed and early spring grass growth is encouraged.
- Is stressful to turfgrass plants.
- Clears out debris and dead vegetation.
- Is performed only in the spring.
- Should not be done routinely but rather only if conditions warrant.

Thatch

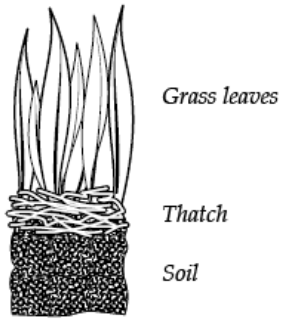
Thatch is the dark brown, felt-like, fibrous layer between the soil surface and where the grass shoots become visible. It is a normal and necessary part of a turfgrass system. It helps insulate turfgrass from rapid changes in soil temperature and moisture; however, if it is too thick, it can impede water, nutrient, and air penetration into the soil, which causes reduced root growth and/or rooting up into the thatch layer and increased potential for drought stress

How much thatch do you need?

- A thin layer of thatch is good – less than ½ inch. This is very common.
- A thick layer of thatch is bad – more than ½ inch. This is very uncommon.

Preventing thatch build-up

- Avoid excessive amounts of nitrogen.
- Avoid frequent, shallow watering that keeps the surface soil layers consistently too wet.
- Avoid overuse of pesticides, especially fungicides and some insecticides.
- Core aerate frequently (at least once/year).
- Leave grass clippings.



Fagerness, 2001

Managing thatch build-up

- Verify that you really have a thatch problem.
- Core aerate frequently as needed.
- Use a vertical mower. It will vertically slice through the thatch layer, pulling it to the lawn surface. It can then be raked off.
- Do not use a power rake, such as those used for clean-up in the spring, to remove thatch. This is not effective at true thatch removal and can cause significant turfgrass injury. (Note:

some vertical mowers are known or even labeled as power rakes. If renting or purchasing a unit, make sure it really is a vertical mower.

Aeration

Aerating your turfgrass is excellent for maintaining healthy turfgrass. Aeration fights soil compaction, improves water infiltration, promotes healthy root systems and healthy soil microbial communities, and prevents thatch build-up.

 ***If you have money for only one practice, choose aeration!***

Best Aeration Practices:

- Core aeration is the best method.
- Autumn is the best time to aerate.
- Spring is the second best time to aerate; however, aerating in the spring can make turfgrass susceptible to weed invasion.
- Penetrate 2-3 inches into the soil.
- Aim for 20-40 holes per square foot (this requires more than one pass, 40 holes/ft = 20% of area).
- Leave cores on the surface. Mow the cores if needed, but do not bag or collect them. Note: this may dull blades a little more quickly. However, if blades are sharpened regularly, it should not be a significant problem.
- Make sure all tines are unclogged and available for aerating.
- Aerate close to sidewalks and paths where compaction is likely, but be careful not to aerate over concrete, asphalt, tree roots, irrigation systems, cable lines, etc. Mark these areas.

When not to aerate:

- Avoid aerating dry or stressed turfgrass.
- Avoid aerating non-irrigated sites if hot, dry, windy weather is predicted.

Seeding

Selecting the right seed to match your growing conditions is the key to success. Use a good quality seed. It may cost more, but it will be more successful and save money in the long run.

What to look for on seed label?

- % germination. You want greater than 80% germination. Multiplying the percent germination by the seed purity will give you the expected amount of seed that will actually grow. This figure is termed the "pure live seed" of that variety in the seed mix. Collectively, it can be used to determine the amount of pure live seed in the entire mixture. One can determine the amount of seed to purchase based on the amount of pure live seed contained in the seed blend or mix. See a more detailed description of this calculation at the end of this section.

- % weed seeds. Look for 0.5% or less (ideally 0%) weed seeds. (Look carefully. You want 0.5% or less, not 5.0% or less).
- % inert material. Look for less than 4% inert material. Inert materials are fillers or non-seed items, such as chaff and hulls. They will not grow under any circumstance.
- Noxious Weeds. Make sure the mix does not include noxious weeds.
- Date tested. The seed should have been tested within the last 9 to 12 months.

What type of seed to buy?

- Annual – will only grow this year. Often annual grasses will green up faster and hold soils until perennial grasses come in. The annual grass most often included in a grass seed mixture is "annual" or "Italian" ryegrass.
- Perennial – will grow this year and beyond; the mainstay of your turfgrass system.
- Check the Best Practices Matrix for seed mix recommendations based on turfgrass expectations and site conditions. Also refer to the Resources section under “Seeding”.

Sunny or shady?

The most common difference between sunny and shady seed mix is the ratio of fine fescue to Kentucky bluegrass. For sunny sites the amount of Kentucky bluegrass should be higher, for shady sites the amount of fine fescues should be higher. Limit the amount of perennial ryegrass in your mix-even though it may reduce your cost-as ryegrass is not as hardy in the long run for Minnesota. Be aware that annual ryegrass in your mixture can help as a cover crop but can also shade and outcompete the perennial grasses that you are trying to establish. Thus, begin mowing early, even if the other grasses are just getting started, to avoid the possibility of too much shading and competition from perennial (or annual) ryegrass.

What is a fine fescue?

A fine fescue is a narrower, finer-leaved turfgrass plant. Fine fescues are some of our best low maintenance, tolerant lawn grasses. They are characterized by their good adaptability to dry conditions, low nitrogen levels, and reduced mowing. They are also somewhat shade tolerant. Some common species of fine fescues are creeping red fescue, chewing’s fescue, hard fescue, and sheep fescue. When you look at a seed mix it won’t say fine fescue, it will list the actual type of fine fescue.

Some fine fescue mixes, often called "low-mow" or "no-mow," are excellent for low-use areas. They do not require weekly mowing.

When to seed?

The best time of year to seed is between mid-August to mid-September when weed competition is lower and environmental conditions are more favorable. See the Best Practices Matrix for seeding time recommendations.

How much seed do you need?

Three to five pounds of seed per 1,000 square feet is typical for Kentucky bluegrass, fine fescue, and perennial ryegrass mixtures. In general, the more Kentucky bluegrass in a seed mix, the lower the seeding rate can be. More is not better. Too much seed can result in excessive competition between the plants and slower establishment. Read seed label for seeding rate recommendations.

Over-seeding

The process of sowing more grass seed over the top of existing turfgrass is called over-seeding. The following steps will increase your success in over-seeding. See "Seeding" in the Resources section of the manual for a comprehensive description of lawn rejuvenation. Here are the basic steps:

1. Mow existing turfgrass shorter than usual
2. Remove clippings
3. Core aerate to relieve soil compaction and/or bring soil to the surface. A brisk raking or vertical mowing to loosen the surface soil will also help provide a more favorable seedbed. Anything to ensure good seed to soil contact will help in getting the turfgrass established.
4. Sow seed. Select mix appropriate to your sun/shade conditions. No need for annual grass seed in this mix.
5. Water lightly but consistently once or twice a day for at least 2 weeks to wet soil, but do not allow soil to become soggy. If seeds or new grass plants dry out during this seedling phase, you will not be very successful.
6. Keep existing turfgrass mowed short (about 2½") during this time and gradually raise mower height as new seedlings catch up to the existing turfgrass height.

Over-seeding is one of the best and most environmentally safe herbicides. Grass and weeds can't occupy the same spot.

Can you use phosphorus fertilizer when seeding?

Yes. Phosphorus is allowed at the time of establishment using a starter type of fertilizer and throughout the first growing season, if necessary. See the "The Law" in the Resources Section for more information on Minnesota's Phosphorus Lawn Fertilizer Law.

A Home Lawn Care Primer

(Topic: Selecting Grass Seed Through Getting it Planted)

Successful turfgrass establishment can be significantly improved by doing the little things (i.e. the details) right. This handout will cover a few of the details associated with choosing the right cultivars and species for the right place and some notes on planting grass seed to help ensure uniform, rapid establishment.

First Things First: Right Seed – Right Place – Right Function

- Like most aspects of landscape plant selection, choosing the right plant for the desired location is of utmost importance for long-term plant health. In addition, when choosing turfgrass varieties, blends or mixes, it is very important to match the intended use of the lawn area with the proper types of grasses. Following are some examples to help you match appropriate turfgrasses with intended *function*:
  - Full-to-partly sunny conditions with minimal traffic or wear, low-to-moderate inputs intended: 60% to 70% Kentucky bluegrasses, 20% to 30% fine fescues, ~10% perennial ryegrass.
  - Full-to-partly sunny conditions with moderate-to-high levels of traffic and/or wear, moderate-to-high inputs required for rapid recovery: 75% to 85% Kentucky bluegrass, ~15% to 20% perennial ryegrass.
  - Shaded for a portion of the day or receives partial shade all day with minimal traffic or wear, primarily a dry shade: 65% to 75% fine fescue; 25% to 35% Kentucky bluegrass (shade tolerant cultivars); ~10% perennial ryegrass.
  - Shaded for a portion of the day or receives partial shade all day with minimal traffic or wear, typically a moist shaded area: 30% to 40% fine fescue; 25% to 35% *Poa trivialis*, 20% - 30% Kentucky bluegrass (shade tolerant cultivars) ~10% – 15% perennial ryegrass.
  - Full sun-to-very light shade, little to no inputs intended: 70% to 85% fine fescues; 10 – 20 % common Kentucky bluegrass; 5 to 10% perennial ryegrass.

- Be a little cautious when adding perennial ryegrass to a mix. Research has shown that a 50/50 mix of Kentucky bluegrass to perennial ryegrass results in a stand that may be dominated by perennial ryegrass even though there are many more seeds of bluegrass than perennial ryegrass in the mix.

- Because of the seedling vigor of annual ryegrass, it is sometimes used in general-purpose seed mixes; but almost never in mixes for "elite" or "premium" turf.

Seeding Rates – If a little is good more is *not* better!

- Avoid the temptation of seeding at higher than recommended rates for a particular mix. Too high of a seedling plant population results in a condition known as "stall". Lawn establishment can be significantly delayed if too many plants initially germinate and have to fight to see which ones survive. Our lawn grasses, especially those of stoloniferous or rhizomatous nature will fill in the gaps quickly and cover the ground more rapidly when seeded at the recommend rate. Home lawn seeding rates of 3-to-5 pounds of seed per 1000 square feet are typical for Kentucky bluegrass, fine fescue and perennial ryegrass mixtures.

Prepared by: Bob Mugaas, Extension Educator – Horticulture
University of Minnesota Extension
February 2005 SelectPlantSeedGeneric_factsheet

Timing is everything

- In the upper Midwest, the best time for seeding cool season lawn grasses is from about the middle of August to the middle of September. The second best time would be early spring as soon as you can get out and work the soil without having it be too muddy and sticky. A third, but more variable in terms of results, is dormant seeding in late fall when soils are too cold for germination to occur but still workable such that the seed can be incorporated into the soil. Germination takes place the following spring as the soil begins to warm.

Seeding Depth – One of the more often overlooked variables in seeding success

- As a general rule of thumb, the smallest seed in the mixture should determine seeding depth.

- The size of the seed typically gives us a clue as to how much food reserves have been stored away to be used during the germination process. Thus, a very small seed such as Kentucky bluegrass can have difficulty reaching the soil surface before exhausting its food reserves. In all likelihood, that plant will die.

- On the other hand, a large seed such as perennial ryegrass can be planted fairly deep and still reach the surface and begin to manufacture additional food through photosynthesis to keep growing.

- So how deep is too deep? As a general rule of thumb the seed should be sown no deeper than about twice the length of the seed. For example, if the seed is about 1/8 inch in length, then the planting depth should be no more than about ¼ inch. For Kentucky bluegrass, the seeding depth should be no deeper than about ¼ inch. For fine fescues it should be no more than ¼-to-½ inch and for perennial ryegrasses the seeding depth should be no more than ½-to-¾ of an inch.

- When setting slit seeders, adjust the seeding depth to the smallest seed in the mixture that you will be using. For example, if you are sowing a general-purpose mixture of Kentucky bluegrass, fine fescue and a small amount of perennial ryegrass adjust the seeding depth to that of Kentucky bluegrass. The other grasses will germinate just fine at shallower depths. However, if Kentucky bluegrass is sown too deeply, its ability to reach the soil surface following germination will be seriously impaired thus leading to a stand dominated, or completely composed of, perennial ryegrass and fine fescue. Not only will that situation not provide the intended result, but also you will have wasted the much more costly bluegrass seed compared to perennial ryegrass seed.

- Where seeding has been done by a drop spreader or by hand, good seed to soil contact can be achieved by turning a leaf rake on its back (i.e. rake teeth facing up) and dragging it across the seeded area. This will lightly incorporate the seed into the soil and improve germination and establishment.

Achieving a rapid, uniform "grow-in"

- A good practice when slit seeding or simply using a drop spreader is to split the seed needed in half and sow each half in a perpendicular direction to each other. In other words, if you sowed the first half in a north-to-south direction, then sow the second half in an east-to-west direction. In the case of slit seeding, the grass will fill in much more quickly when it grows together from four directions instead of two. Likewise, a drop spreader used as mentioned above will likely not leave any gaps and hence grow-in will be much quicker.

Prepared by: Bob Mugaas, Extension Educator – Horticulture
University of Minnesota Extension
February 2005

PURCHASING SEED AND UNDERSTANDING SEED LABELS

Purchasing the highest quality seed possible is always a good investment. Improper cultural practices will waste the money invested in purchasing high quality seed. However, poor quality seed will almost never result in a well-established lawn no matter how good the cultural practices. Determining what is high quality seed can be difficult for most people. Purchasing high quality seed can be easier if you understand a few basic terms on the grass seed label. All labels must provide information about the grass seed purity, its germination potential, crop seeds present, weed seeds present, noxious weeds present, and inert components in the package.

Example seed label
(Company and variety names are fictitious)

TURF-GROW SEED COMPANY, TURFTOWN, OREGON
Lot No: 7890-8

Test Date: (month/year)

Pure Seed	Variety	Germination
44%	Arctic Creeping Red Fescue	85%
31%	Blue Ribbon Kentucky Bluegrass	80%
9%	Wilson Chewings Fescue	85%
12%	Gopher Perennial Ryegrass	90%
1.56%	Crop	
2.11%	Inert Matter	
0.33%	Weeds	

Noxious Weed Seed: 25 Canadian Thistle Seeds Per Pound

Purity is the percent by weight of pure seed, crop, weed, and inert ingredients in the package. These percentages added together should total 100 percent. Purity is concerned only with quantity, not quality. That is, not all seeds present in the package are capable of growing. To determine the seed that will actually grow or what is known as *pure live seed*, the percentage purity should be multiplied by the germination percentage. For example, 90 percent Kentucky bluegrass (purity) multiplied by 85 percent germination conditions. It should be apparent that you should always seek to purchase the grass seed with the highest purity and germination percentage possible.

Germination is the percent of pure seed that will germinate and grow in an ideal laboratory environment during a prescribed length of time. Since field conditions rarely duplicate these laboratory conditions, it is especially important to purchase seed with the highest germination percentage possible. As noted above, this is the percentage used to determine pure live seed.

Crop is the percent by weight of seeds normally considered to be grown as an agricultural crop such as grain. This can include other types of grasses that may be undesirable in a lawn. This percentage should be as close to zero as possible.

University of Minnesota Extension Service Master Gardener Core Course textbook – Lawn Care section. Bob Mugaas, Extension Educator, University of Minnesota Extension. 2002

Weeds refer to the percent by weight of all seeds in the package that are not otherwise listed in pure seed or crop. It is not required to identify these weeds or how many there are since this is on a percent by weight basis. For example, one or two large seeds of a weed species would pose no particular threat. This percentage should always be as low as possible.

Noxious weeds are listed as the number per pound, not the percentage per pound. Noxious weeds are weedy plants considered by individual states to be very difficult to control and that could pose hazards to both human and livestock. While this is often more of a problem in farm crop seed, one should always buy grass seed without the contamination of any noxious weeds.

Inert is the percent of material contained in the package that will not grow under any condition. Broken and damaged seeds, chaff, and empty seed hulls are some of the more common inert material included. Obviously, this percentage should be as low as possible.

Considering seed count vs. seed weight

The Federal Seed Act requires that grass seed be listed on the label by weight and that it be separated into two broad categories: fine-textured grasses and coarse-textured grasses. However many of the grasses vary significantly in their respective seed sizes and consequently vary significantly in the number of seeds per pound. A more accurate description of the grass seed contents contained in a package would be to list their percentage by seed count rather than percentage by weight. For example, large seeds (such as those of perennial ryegrass) are quite heavy and take only about 225,000 seed to make one pound. On the other hand, Kentucky bluegrass requires from 1 to 2 million seeds, depending on variety, to make a pound.

Given the above example, a 50 percent perennial ryegrass: 50 percent Kentucky bluegrass mix by weight actually contains only about 112,500 seeds of perennial ryegrass per pound of mix. The number of Kentucky bluegrass seeds present in this mix would be about 500,000 to 1 million. Therefore this sample mixture contains about 11 to 23 percent perennial ryegrass and 77 to 89 percent Kentucky bluegrass. Using this example, one may need to add a certain amount of one type of grass or another based on seed count to create the best mix for a particular site condition. For example, adding some additional pure creeping red fescue seed to an off-the-shelf seed mixture for shady areas will increase the number of seeds of the more shade tolerant creeping red fescue. This should provide greater potential for establishing a lawn in the more shady parts of the landscape.

University of Minnesota Extension Service Master Gardener Core Course textbook – Lawn Care section. Bob Mugaas, Extension Educator, University of Minnesota Extension. 2002

Mowing

Mowing strategies are influenced by many factors: the rate of turfgrass growth, the availability of the mowing crew, and the weather, to name a few. But our mowing decisions should also consider the plant's life cycle, health, and growth factors. Integrating science and maintenance will give the best results for the lowest cost.

Turfgrass grows approximately 1/10 of an inch per day.

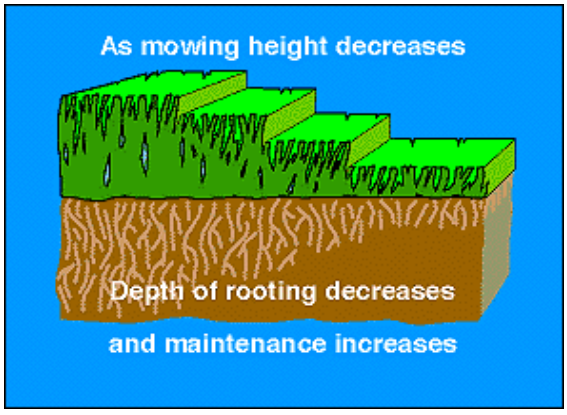
Avoiding plant damage

To keep the turfgrass healthy, adopt strategies to reduce plant injury. Mowing improperly can cause rips, tears, or cuts in the plant and increase its susceptibility to disease. Damage to plant tissue reduces the plant's ability to photosynthesize. Here are tips for reducing damage:

- Keep blades sharp. Sharp mower blades reduce shredding of the turfgrass plant. Sharp mower blades are especially important during the flowering stage of the plant. At this time the seed stalk is sent up. The stalk is tougher and harder to cut through. With dull blades, damage to the plant is more pronounced.
- Avoid mowing during extremely dry periods. The soils sandblast the turfgrass, which is already under stress from drought conditions.
- Avoid mowing in extremely wet conditions. As the mower turns (e.g. around trees), the tires can tear out the grass plants. The soils are also more prone to compaction.
- Change mowing patterns. Turfgrass is stressed by constant repeated mowing patterns.
- Keep mowers away from base of trees and off of the tree's root zone to prevent tree damage. Mulching around the base of trees can help. Use a 2 to 4 inch depth of mulch, extending 3 to 6 feet out from the trunk, hollowed out around the base of the tree for air and water exchange. Do not mound mulch up against the tree trunk.
- Be aware that it is possible to permanently damage the grass crown and therefore kill the plant if the turfgrass is driven on when in severe drought stress or frozen. Walking or driving over the turfgrass when there is frost on it can also cause significant injury to the foliage and even the crown. Damage is evidenced by the distinct brown/tan footprints or tire tracks left through the turfgrass area.

Taller turfgrass:

- Produces deeper roots, which is the key for survival in low water periods. Deeper roots can absorb more nutrients. Deep roots produce strong plants.
- Has greater surface area for photosynthesis, the energy-making system in plants.
- Requires less frequent watering. Deeper roots and longer grass blades store more moisture, create more shade and reduce transpiration.



University of Minnesota, 2006

Taller turfgrass will be healthier and requires less water and fertilizer.

Setting deck height

With frequent blade sharpening comes the opportunity to reset the deck height on mowers. Every time the blade is changed, think about what is the best deck height for the conditions rather than keeping the deck height stationary all year long.

- To reduce plant stress, the tallest heights should be in the hot stressful time of summer, giving the plant the full advantages of shade, moisture retention, and photosynthesis.
- On average, set deck to 3 inches. See recommendations in the Best Practices Matrix based on time of year, soil type, exposure, and turfgrass quality expectations.
- Double check your work. After adjusting blade height, mow a strip and measure the blade of grass to make sure that it is cutting at 3 inches.
- Incrementally change mower height. Large changes are stressful on the plant.

Photo courtesy of Jim Weber

Trim less than ⅓ of the turfgrass blade

Mowing shocks turfgrass, especially if it is a major cut. The grass blade will use all of its energy to repair itself. In addition, the turfgrass will produce less energy through photosynthesis because much of the grass blade has been removed.

- If you are mowing overgrown turfgrass, mow it a couple of times a few days apart to reduce the shock and stress on the plants.
- Double mow:
    - To reduce thick clipping layer.
    - Change mowing pattern on second pass.
    - Lift up the deck for the second pass, especially when double mowing on the same day. Cutting twice at the same height and different angles could cut or tear each blade of grass again, or just brush the top, which will damage the plant as well.

Mower blades

- Blade must be sharpened straight, never curved.
- Only sharpen one side of the blade.
- Make sure blade stays balanced, equal weight on both sides.
- Dull blades use 22% more fuel.
- Dull blades or grass-coated blades tear the turfgrass and give it a whitish cast.
- Blade “wings” or foils point up, or blade is on upside down.

Maxpower Lawn Mower Blade Balancer

Leave clippings and leaves on turfgrass

- Grass clippings equal one application of nitrogen per year and reduce fertilizer needs.

- Grass clippings and mulched leaves will help retain moisture.
- Discharge clippings onto turfgrass, not sidewalks or hard surfaces that drain to the nearest pond, lake or river.
- Sweep or blow clippings from hard surfaces back into turf areas.

Cleaning equipment

See “Cleaning Equipment” in "The Law" for more information on the discharge of any waste (grass clippings) into waters of the state. Here are a few tips:

- Use compressed air or rinse mowers on the grass to avoid water runoff.
- Don’t allow wash water and debris to enter stormdrains (they drain to a lake or stream). Collect water and dispose in sanitary sewer or use inlet protection devices to filter water and capture debris.
- Cover air filters before cleaning with water.
- Make sure hard surfaces are swept up after cleaning mowers.

Leaves

Mulched leaves can provide benefits for the soil and turfgrass plants, but they must be managed in a way that the turfgrass is still visible and able to photosynthesize.

When to mow or mulch leaves?

- Always.
- Remove some shredded leaves if covering more than 50% of the turfgrass plants.
- Be careful that mulched leaves remain on turfgrass and are not blown onto the road, sidewalk, or other hard surfaces where they can enter stormdrains.

A study conducted over several years at Purdue University shows that using a rotary mower to mulch leaves into the lawn has no detrimental effect on turf health. The mulched leaves may, in fact, improve soil conditions (Reicher & Hardebeck, 2000).

Benefits of mulching leaves

- Saves time collecting leaves.
- Saves the cost of hauling leaf litter away.
- Biodegradable on site, no need to have extra burden on compost sites.

Disposing of leaves and seeds

- Mulch on turfgrass, spread to cover less than 50% of turfgrass in any one spot.
- Bring extras to a compost site.
- Haul leaves securely covered.
- Do not leave plastic bags at compost site
- Do not put in low areas, wetlands, or holding ponds.
- Do not put in woods unless you can spread them in a thin layer.
- Tree seeds are a large source of phosphorus. Sweep them out of the street and compost them. Do not dispose of in natural areas.

Weeds and Weed Control

Weeds

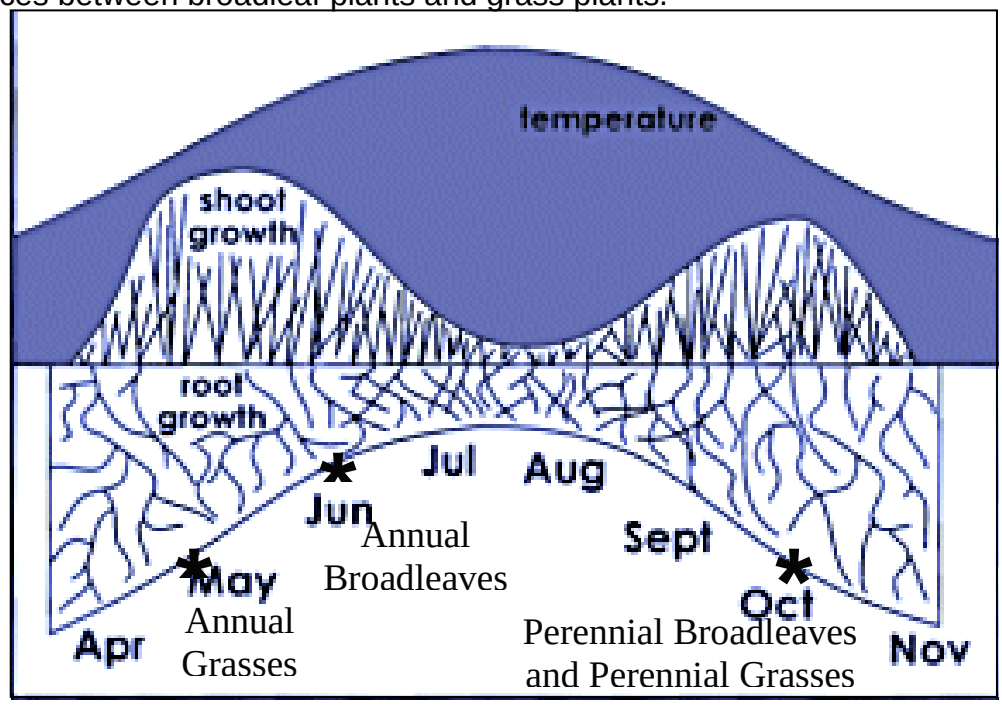
Weeds can be controlled more efficiently if we understand their life cycle and attack them at their weakest stage. By applying science to turfgrass management we can get the same results with less work, less money, and more environmental protection. “Integrated pest management (IPM) is an approach which first assesses the pest situation, evaluates the merits of pest management options and then implements a system of complementary management actions within a defined area. The goal of IPM is to mitigate pest damage while protecting human health, the environment and economic viability” (MDA, 2010). Integrated weed management is a subset of IPM. Management techniques include cultural, mechanical and chemical methods.

Most weeds can be divided into four categories. By understanding each plant's life cycle we will have the insight to control them at the optimal time.

- Annual grass weed
- Perennial grass weed
- Annual broadleaf weed
- Perennial broadleaf weed

Weed management diagram

For best management you will need to know if your weed is an annual or perennial plant and if it is a grass or broadleaf plant. A plant is perennial (lives more than 1 year) or annual (lives only 1 year). Control options are recommended based on the plant's lifecycle. Herbicides have been developed to take advantage of the biological differences between broadleaf plants and grass plants.



Adapted from Graphic source: University of Minnesota, 2006

General weed control information

- Weeds often grow where turfgrass is thin and weak. The best control of these plants is to figure out why the area is stressed or disturbed and fix the underlying cause.
- Allowing a mix of broadleaf plants and perennial grasses is often recommended, especially in areas of heavy shade or in other stressful growing conditions such as the boulevard between the road and sidewalk. A mix of plant types will help hold your soils and prevent erosion. If this look is acceptable, use mowing as your control. It will go a long way in blending the different plants into an acceptable look. For example, violets are considered by some to be weeds and others to be treasures; however, they can be used successfully to compliment turfgrass in shady areas by increasing plant density.
- Treat only problem areas with herbicides, not the entire turfgrass surface.

Weeds may be acceptable in difficult sites, such as boulevards. Use mowing to indicate the site is well maintained

- Avoid using weed-and-feed mixes. The optimal timing for fertilizing usually differs from the best time for weed control. Refer to the Best Practices Matrix for timing guidelines.

For photos of common weeds and other plants, see the "Common Weeds" photos later in this section and visit the University of Minnesota Extension websites listed in the Resources section of this manual.

Manage annual weedy grasses in the spring

Grasses are monocots (plants with long slender leaves). Because they are monocots, they biologically function differently than dicots (broadleaf plants). The type of herbicide used to selectively kill dicots will not harm grasses.

An annual grass differs from a perennial grass in that it only lives one year. It germinates from seed in the spring, grows, puts on a seed head, and dies. Some annual grasses are desirable, and in seed mixes, some are not so desirable. The undesirable varieties often appear in disturbed or stressed areas of turfgrass.

Control Measures:

- If you believe you must use an herbicide, the best approach is to use a pre-emergent herbicide before soil temperatures reach 55 degrees. Timing is critical. The herbicide must be present before the seedling pops through the soil. If the herbicide is applied too early it will not be present during emergence, and if applied after the plant has emerged it will have no effect.
- Monitor soil temperatures
    - Invest in a soil thermometer. Insert soil thermometer one inch into the ground to monitor temperatures near the seed bank. Do not insert soil thermometer to the full depth of the shaft. Take readings in the morning before the sun warms the soil to get a better reading.

- o Soil temperatures across Minnesota are available from the University of Minnesota weather station; these are updated weekly so you can see the trend. These soil temperatures are taken at a 4 inch depth so they will not be the same temperature as the 1 inch depth. They will, however, show the soil-warming trends. See the Resources section for the soil temperature website.
- o Soils warm up faster near hard surfaces. This is also where there is often an annual grass weed problem. Make sure you monitor soil temperatures in the area where the weed problems exist. Soil temperatures will likely drop as you move away from heat sinks such as sidewalks and buildings.

Common annual grassy weeds

- Examples: barnyard grass, fall panicum, giant foxtail, large crabgrass

Manage unwanted perennial grasses in the fall

Grasses are monocots, and there are no herbicides that will select one grass plant over another. That is bad news for controlling perennial grassy weeds. A perennial grass differs from an annual grass in that it comes back year after year. Because their lifecycle is the same as most of our desired turfgrass species, there are no selective control methods.

- The last and most drastic approach is a non-selective herbicide. This will kill all vegetation, and you will have to start over. Fall is the best time for this activity since the plant's energy is being directed downward to the root system and will more efficiently carry the herbicide to those same areas, resulting in better kill of the below-ground reproductive structures..

Common unwanted perennial grasses:

- Examples: reed canary grass, quackgrass, timothy

The Minnesota DNR website describes the most invasive perennial grasses. See the Resources section under "Weeds and Plant Identification".

Manage annual broadleaf weeds in early summer

Broadleaf plants are dicots. They are called a broadleaf because they have a wide leaf, unlike a grass blade. They are susceptible to herbicides that do not affect monocots. The challenge with broadleaf control is to determine if you have annual broadleaf weeds or perennial broadleaf weeds. To minimize herbicide use and maximize weed control you must first properly identify which type of broadleaf weeds you are intending to control.

Spot-treatment uses less chemical. That's better for the environment and may save money.

Since broadleaves are a completely different type of plant, it makes it easier for us to control them without disturbing turfgrass. Annual broadleaf plants live only one year. They germinate from seed each year. The seed grows into a plant; it flowers, seeds, and dies. Broadleaf herbicides are specifically formulated to kill broadleaf weeds (both annual and perennial) without harming turfgrass.

- If you feel you must use an herbicide, the best approach is to use a post-emergent herbicide when the plant is very young and weak. The proper time to apply early post-emergent herbicides to control annual broadleaf plants is in June.

- If the plant has gone to seed, do not use herbicide. The damage has already been done; the seed is set for next year's growth. The adult plant you intend to kill will die without herbicide at the end of the growing season.

Common Annual Broadleaf weeds:

- Examples: cocklebur, lambs quarters, ragweed, velvet leaf, prostrate spurge, knotweed

Manage perennial broadleaf weeds in the fall

Perennial broadleaf weeds and broadleaf plants return year after year from their roots. Since these dicots are living amongst our turfgrass (monocot) plants, we have the ability, if needed, to use herbicides to selectively remove them without harming the turfgrass. Reduction of herbicide use is needed across the board to protect our lakes and rivers. Here are some strategies for controlling perennial broadleaf weeds:

- If you feel you must use herbicide, it is most effective to treat perennial broadleaf plants in the fall. It is most tempting to treat broadleaf perennials during their showy bloom stage. However, this is not the most effective time. Save your herbicide until it will do more good. During the fall, the plant's energy is directed toward its roots. It is the most effective time for herbicides, and you will be most successful at weed control.

- Treat only the problem areas with herbicides, not the entire turfgrass surface.

Common Perennial Broadleaf weeds:

- Examples: dandelion, broadleaf plantain, Canada thistle, clover, birdsfoot trefoil, creeping Charlie

If you know the name and type of weed you have, you can control it with the least amount of chemical and effort. Take time to identify your most troublesome weeds and determine which of the four main categories they belong.

Note: *This manual does not cover pests such as insects and diseases. To find information on these topics, see the Minnesota Department of Agriculture website listed in the Resources section of the manual.*

Common Terms Associated with Weed Biology and Growth

Growth cycles

- Annuals
  - Summer annuals – germinate in the spring, grow, flower produce seed, die
    Examples – prostrate knotweed, prostrate spurge, yellow woodsorrel, black medic, redroot, pigweed, lambsquarters

  - Winter annuals – germinate in late summer to early fall, overwinter in vegetative stage and flower the next spring, produce seed, die
    Examples – common chickweed, henbit, shepherds purse, pepper weed, pennycress

- Biennials – grow from seed the first year and form a rosette, overwinter in that state followed by flowering the next spring or early summer, produce seed, die
  Examples – yellow rocket, common mullein, burdock, bull thistle, musk thistle

- Perennials – live from year-to-year surviving primarily by root systems that grow and produce both flower stalks and new vegetative structures each year
  Examples – dandelion, broadleaf plantain, clover, ground ivy, yarrow, Canada thistle, mousear chickweed, birdsfoot trefoil

Growth Habits

- Upright – vegetative and/or flowering stems extend vertically, not forming rosettes
  Examples – redroot pigweed, lambsquarters, pineapple weed, henbit, yellow woodsorrel

- Spreading – stems spread laterally over the ground surface; stolons (above ground) and rhizomes (below ground) are specialized stem structures that root at the nodes and give rise to new plants
  Examples – white clover(s), ground ivy(s), Canada thistle(r), common yarrow (r), mousear chickweed, prostrate spurge, wild blue violets (r)

- Basal leaf clusters (rosettes) – circular cluster of leaves formed around the stem at ground level
  Examples – dandelion, plantain, many of the mustard family plants

Rooting characteristics

- Taprooted – usually a large, fleshy vertically oriented root; occasionally taproot is thin and not as fleshy as in prostrate knotweed or birdsfoot trefoil
  Examples: dandelion, common mullein, lambsquarters, redroot pigweed, many of the mustard family plants

- Fibrous rooted – thin roots arising from nodes along a spreading stem or from root tissue
  Examples – mousear chickweed, plantain, ground ivy, clover, common chickweed, wild violets, many others

Prepared by: Bob Mugaas, Extension Educator, Horticulture
University of Minnesota Extension

UNIVERSITY OF MINNESOTA EXTENSION

★ ★ ★ COMMON WEEDS IN MINNESOTA LAWNS ★ ★ ★

BLACK MEDIC

WHITE CLOVER

LARGE CRABGRASS

QUACKGRASS

GROUND IVY

COMMON CHICKWEED

Prepared by: Bob Mugaas, Extension Educator, Horticulture
University of Minnesota Extension

UNIVERSITY OF MINNESOTA
EXTENSION

* * * COMMON WEEDS IN MINNESOTA LAWNS * * *

PROSTRATE KNOTWEED

PROSTRATE SPURGE

YELLOW WOOD SORREL

YELLOW NUTSEDGE

DANDELION

BROADLEAF PLANTAIN

UNIVERSITY OF MINNESOTA EXTENSION

Prepared by: Bob Mugaas, Extension Educator, Horticulture
University of Minnesota Extension

Weed Control

Any plant may be a weed to one person and a desirable plant to another. When we look at weed control we should look at our level of weed acceptance. It is not affordable or sustainable to remove every plant that is not turfgrass. As we are more accepting of plant diversity and smarter about weed control, the less herbicide we will need.

There are many methods of weed control. Weeds can be managed manually, mechanically, and chemically. Weed control can be frustrating, time consuming, and expensive. By understanding the life cycle of the weeds and the turfgrass you can be more strategic in their control. As a professional turfgrass maintenance expert you have the ability to influence the expectations of your customers. By helping them set sustainable expectations, weed control can be much more ecologically sound. By applying plant science to weed control, you and your crew can manage weeds responsibly, efficiently, and effectively.

Accepting some weeds

What is your or your client's tolerance toward weeds? Can you live with "other" plants mixed into turfgrass? Some plants can be helpful to turfgrass. Clover, for instance, puts nitrogen back into the soil; and nitrogen is an essential nutrient for turfgrass. The two species grow well together and reduce the need for external fertilizers.

We are so accustomed to turfgrass that we force it to grow in sites that do not favor its growth, like shady sites, hot dry sites, sites with poor soils, and so on. Given harsh site conditions, weeds are more common. The effort to grow pure turfgrass in harsh sites may be time, cost, and environmentally prohibitive. In these sites other plants should be welcomed. You can control the plant community. For example, violets growing within turfgrass are more acceptable than thistle. Sites can be managed for a mix of plants.

Consider grasses and wildflowers for sites where turfgrass does not grow well. Native plants do not require fertilizer or watering.

The density of weeds should be considered. A chemical attack for a single weed here or there is not ecologically responsible. Fortunately, the cost for this type of management discourages this practice. If cost is not a limiting factor for your clients, educate them on the environmental costs and see if you can change their expectations.

Maintain healthy turfgrass

Healthy, dense turfgrass is the best defense against weed invasion. Weeds thrive in degraded or weakened turfgrasses. Remember that overseeding or sodding can be an excellent practice in helping reduce weed invasion. By incorporating many of the practices discussed in this manual, you can increase the health of your turfgrass and lower your use of herbicides.

Healthy, dense turfgrass is better for the environment than neglected turfgrass.

Mowing

Not all weeds need to be removed. Some serve a good purpose in increasing vegetative coverage and reducing erosion. Areas that likely have a variety of plants mixed into turfgrass are shady areas and areas of harsh growing conditions such as boulevards and road edges. In these examples, mowing gives a more uniform look between weeds and turfgrass, reduces herbicide use, and helps stabilize soils.

Manual control

Although manual control of weeds is slow and tedious, it does have its place in overall weed management. The key in manual removal is to understand the plant life cycle. Annual weeds need to be stopped before they go to seed. Mowing or clipping seed heads before seed dispersal may be an option for managing annual weeds. Perennial weeds need to be removed by the roots. Digging or pulling would be required for this type of management.

Biological control

For some weeds, there are biological controls. The Minnesota Department of Agriculture has recommendations on insects that can be released that feed on the target weed. Biological controls are often very effective at managing large weed infestations. These weeds typically wouldn't be in your turfgrass area, but they are frequently found next to our turfgrass areas. The most commonly used biological controls are for purple loosestrife and leafy spurge. See the Resources section under "Weeds and Weed Control" for more information on biological control.

Chemical control

Herbicides are the most common tool used for weed control. They have an important place in weed control, but sometimes they are used in a "sloppy" fashion (applied at wrong time of the year, applied over entire site, applied with un-calibrated equipment). To protect the environment, weed control focus must be on less and smarter use of herbicides. This will allow us to protect our water but still meet turfgrass quality expectations. Smart use of herbicides includes:

- Identifying the type of weed and selecting the appropriate herbicide.
- Applying herbicide at the optimum time in the weed's lifecycle. See Weed Management. diagram at the beginning of this section and the chart below.
- Applying herbicide in the proper quantities using calibrated equipment.
- Using spot treatments.
  - o apply herbicide to only the area of infestation.
  - o reduce or eliminate blanket treatments.
- Follow the label instructions for the proper use, handling, and storage of herbicides. See next section.
- Avoiding spraying herbicide in the root zone area around the bases of trees. Studies show long-term damage to tree health from this practice (Fraedrich, n.d.).
- Looking for opportunities to use less herbicide.

Lawn Weed Management Summary:
Selecting and Using Herbicides Based on Plant Life Cycles

Life Cycle: Annual
Weed Type: Broadleaf
Herbicide Category: selective, post emergence
Optimal application timing: late spring through early summer when weed seedlings are still small but actively growing

Common Examples: prostrate knotweed, prostrate spurge, yellow woodsorrel, black medic, common lambsquarters, redroot pigweed, pineapple weed, common ragweed, common mallow

---

Life Cycle: Perennial
Weed Type: Broadleaf
Herbicide Category: selective, post emergence
Optimal application timing: late summer to early fall when temperatures are cooler and usually more rainfall is occurring thereby causing plants to resume active growth; second best time would be early spring as active growth resumes during cooler temperatures

Common Examples: common dandelion, white clover, plantain, creeping Charlie, musk and bull thistle rosettes, Canada thistle, mouseear chickweed, birdsfoot trefoil, *black medic*, *yellow woodsorrel*

Life Cycle: Annual
Weed Type: Grass
Herbicide Category: selective, preemergence
Optimal application timing: mid-spring as soil temperatures reach the mid fifties but before germination of weedy grass seeds has begun; usually early to mid-May in the Twin Cities area

Common Examples: smooth and large crabgrass, yellow, green and giant foxtail, barnyard grass, long-spined sandbur, goosegrass

---

Life Cycle: Perennial
Weed Type: Cool-season grasses
Herbicide Category: non-selective, post emergence
Optimal application timing: best at cooler times of the year when weeds are actively growing; control can also be effective at other times when active growth is occurring. ***Use of non-selective products in a lawn will require overseeding or resodding in order to repair those areas killed by these products.***

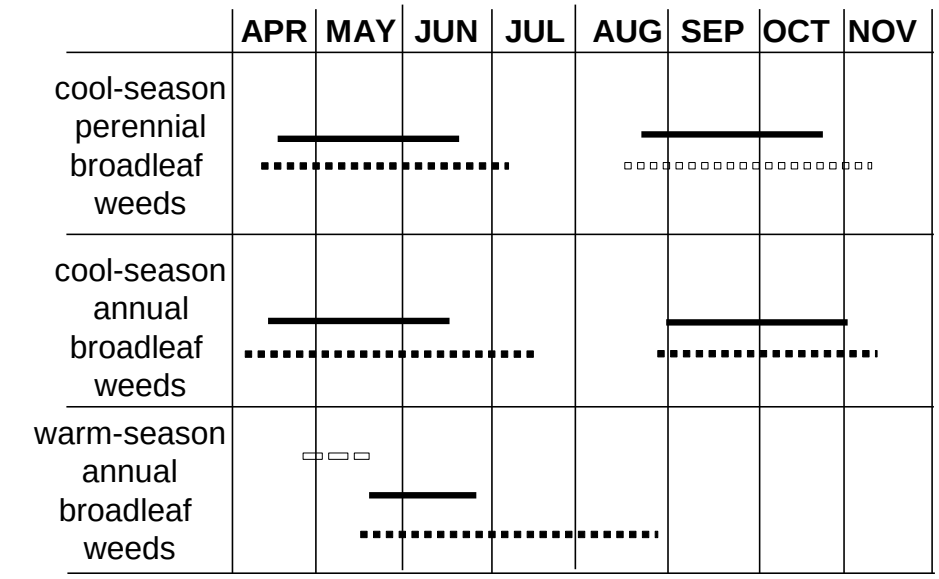
Common Examples: creeping bentgrass, quackgrass, tall fescue, smooth brome, orchardgrass, reed canary grass

---

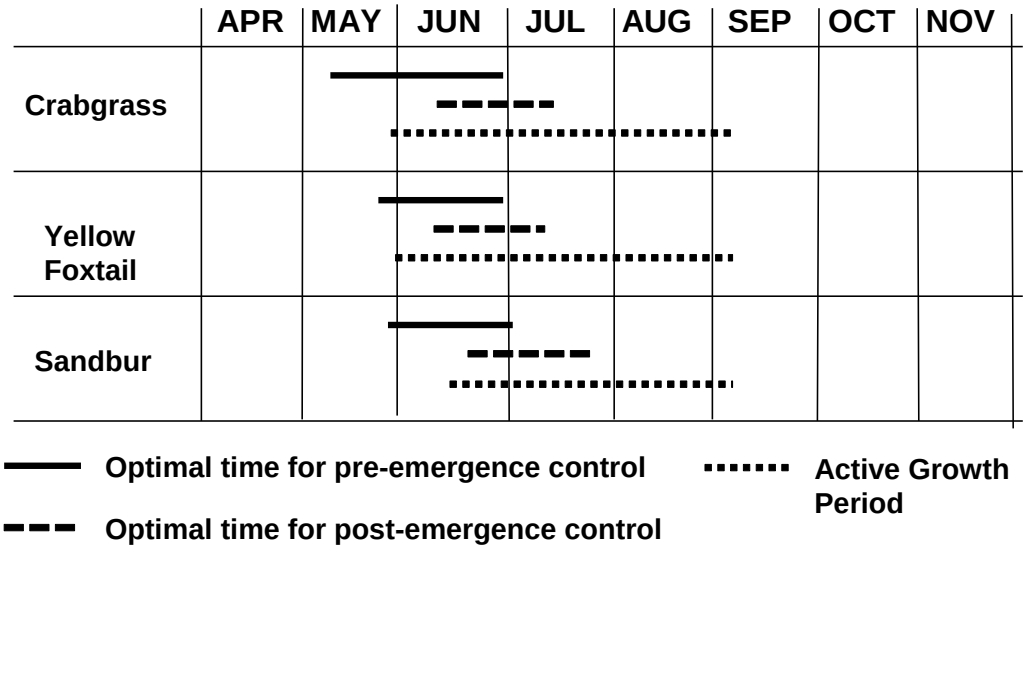
For more information on specific weeds and possible control strategies, go to 'Is This Plant a Weed' at the University of Minnesota Extension, Gardening Information website:
http://www.extension.umn.edu/gardeninfo/weedid/index.html

UNIVERSITY OF MINNESOTA
EXTENSION

Post-emergence Herbicide Timing for Broadleaf Weeds



Pre-emergence Herbicide Application Timing



Prepared by: Bob Mugaas, Extension Educator,Horticulture
University of Minnesota Extension

UNIVERSITY OF MINNESOTA EXTENSION

Minnesota Department of Agriculture Requirements

The Minnesota Department of Agriculture (MDA) is the lead state agency for all aspects of pesticide and fertilizer environmental and regulatory functions. These authorities are described in Minnesota Statutes §§ 18B, 18C, 18D and 103H.

This manual does not replace the MDA's rules, regulations, or training and certification.

There are risks to using pesticides. The MDA has programs in place to help reduce these risks. Without proper safeguards, pesticides may contaminate surface water and/or groundwater. The MDA certifies applicators as competent and qualified to obtain a license by initial testing. Applicators whom the MDA deem as qualified may obtain a pesticide applicator's license. The MDA issues different license types with specific categories, depending on the intended application site.

To learn more, visit the MDA website listed in the Resources section of this manual.

Here are some tips from the MDA to help you make better decisions:

What is a Pesticide Applicator's License?

The MDA issues licenses to Commercial and Noncommercial Pesticide Applicators and Structural Pest Control Applicators. The MDA administers closed-book and monitored exams as part of the certification and license process. The initial certification exam measures competency in specific use categories and determines if the person is eligible for a pesticide applicator's license.

A pesticide license may be required to apply pesticide products that include herbicides, insecticides, fungicides, rodenticides and other products intended to kill, repel, or control pests. Weed-and-feed products are both a pesticide and a fertilizer.

Who needs a Pesticide Applicator's License?

Commercial Pesticide Applicator

Commercial pesticide applicator licenses are for pesticide applicators who apply any pesticide (including herbicides) for hire. "For hire" means you charge or invoice for the service.

Noncommercial Pesticide Applicator

Noncommercial licenses are for all pesticide applicators that apply restricted-use pesticides (RUP) as part of their job on property owned or contracted by their employer.

See the MDA fact sheet website in the Resources section of this manual.

Which Pesticide Applicator's License do I need?

See the MDA fact sheet website in the Resources section of this manual.

How do I get a Pesticide Applicator's License?

1. Complete a NEW Pesticide Applicator License application form.
2. Submit license fee and Agricultural Chemical Response and Reimbursement Account (ACRRA) surcharge, if applicable, with application form.
3. Obtain study materials from the University of Minnesota Extension, and schedule a test time with MDA.
4. Take and pass required certification exam(s). The exams are closed-book and 70% or better is passing. At least two use category exams are required to become licensed (i.e. A&E categories).
5. Meet financial responsibility requirements for the license.

See the MDA fact sheet website in the Resources section of this manual.

Pesticide storage and safety

When handling or storing pesticide products, read and follow the label language. Label instructions will provide the appropriate information for use, safe handling, and storage for the particular product. Following label instructions will help you avoid misuse, human health risks, and possible environmental contamination. Store pesticides only in the original labeled container, separated from other products (such as food, feed and seed), and in a locked building with appropriate warning signs.

What should I do if I spill pesticide?

State law requires that agricultural chemical incidents must be reported immediately to the Minnesota Duty Officer. An "incident" means a flood, fire, tornado, transportation accident, storage container rupture, portable container rupture, leak, spill, emission, discharge, escape, disposal, or other event that releases or immediately threatens to release an agricultural chemical, accidentally or otherwise, into the environment and may cause unreasonable adverse effects on the environment. An incident does not include a release resulting from the normal use of a product or practice in accordance with the law. A reportable spill is an amount greater than the rate recommended per acre or 1,000 square foot.

MDA staff is available to receive reports 24 hours a day, 7 days a week. MDA uses the Department of Public Safety's duty officer system, 1-800-422-0798 or 651-649-5451. The duty officer will relay your message to an MDA staff person on duty who will call you back promptly with instructions. See "Minnesota Department of Agriculture" in the Resources section.

How do I dispose of unused pesticide and pesticide containers?

1. **Follow label use, storage and disposal instructions.**
2. **Pressure-rinse or triple-rinse containers** immediately after emptying. Delay in rinsing pesticide containers may result in a residue that, upon drying, is highly resistant to rinsing. Use rinsate as dilution make-up water and apply evenly over labeled sites.
3. **Dispose of empty paper bags, plastic bags and other types of containers at sanitary landfills.** Contact waste hauler or landfill operator for information.

4. **Do not burn any pesticide container** in an open fire, such as in the field, in trash barrels or on burn piles. This is illegal in Minnesota.
5. **Do not reuse pesticide containers** unless they are dedicated for reuse or unless they have been cleaned according to the pesticide manufacturer's protocol and are intended to be refilled with pesticides.

***Waste Pesticide Collection Program*:**
The MDA is stepping up efforts to help Minnesota farmers and households safely dispose of unwanted and unusable pesticides through the Waste Pesticide Collection Program. The program provides an environmentally sound option to dispose of unusable and unwanted pesticides. Through the Waste Pesticide Collection program, pesticide users in almost every county around the state will be able to dispose of unwanted agricultural pesticides once a year and household pesticide products more than once a year.

Find the MDA fact sheet website in the Resources section of this manual.

Empty Pesticide Container Recycling Program
Proper management of pesticide containers (full and empty) requires planning. Removal of the product from the container does not end the need for special management of that container. The appropriate handling, rinsing, storage, and disposal of empty pesticide containers can prevent future health, environmental, and regulatory problems.

Find the MDA fact sheet website in the Resources section of this manual.

Is it okay to spray on a windy day?

Read and follow label wind restrictions. High winds will increase potential for herbicide to drift onto non-target sites. Regardless of wind conditions, even when you make applications within the wind restrictions, you are liable for herbicide damages on non-target sites.

Should I keep records?

Yes, It is required by MDA depending upon your licensure, but is always encouraged. If problems arise, your records may protect you.

Other Herbicide Tips

Summer Herbicide Tips for Protecting Water Quality

1. Never apply herbicides (or other lawn pesticides) to impervious surfaces in either liquid or granular formulations; this also includes weed-and-feed products and any fertilizer product

2. Never apply lawn herbicides directly to any water body. Appropriately labeled aquatic products with any necessary permits are the only means where herbicides can be applied.

3. Spraying to wet the weed foliage is usually sufficient to kill the target plants. It is not necessary to drench an area; this only increases the chance for movement into the soil where it can affect other plant root systems and thereby damage other non-target plants, or leave the site via runoff and/or erosion.

4. Keep grass clippings recently treated with an herbicide on the lawn and not blown into the street where they can be carried into the street and through storm sewers to water resources

5. High temperatures will increase herbicide volatility (vaporization) thereby increasing the risk of off-site movement including into water areas and non-target plants. Follow label directions for temperatures during which the product can be applied.

6. High temperatures combined with moderate to high winds further increases the chance for off-site movement.

7. Irrigation of ¼ to ½ inch of water, or rain event, following a pre-emergence application will help incorporate it into the soil thereby increasing effectiveness and decreasing its chances for off-site movement during rain storms.

8. Avoid herbicide applications just prior to thunderstorms where intense rainfall is anticipated thereby eliminating the chances for the product to move offsite; follow label directions for how long following application the product will be rainfast (stuck) to the weed foliage.

UNIVERSITY OF MINNESOTA
EXTENSION

This page is intentionally blank.

Resources and References

Last updated 6/25/14

Problems with links? Please notify Fortin Consulting, Inc. www.fortinconsulting.com

Resources

Turf Grass Training Matrix Charts
www.pca.state.mn.us/programs/summermaintenance.html

Calibration:
How to Calibrate your Hand-Held Herbicide Sprayer
http://ohioline.osu.edu/for-fact/0020.html

Calibration Guidelines for Rotary and Drop Spreaders
https://www.extension.purdue.edu/extmedia/PPP/PPP-46.pdf

How to Calibrate your Sprinkler System
http://itc.tamu.edu/documents/extensionpubs/University%20of%20Florida/ENH61.pdf

Environmental Resources:
Minnesota Department of Natural Resources Lake Finder
http://www.dnr.state.mn.us/lakefind/index.html

Minnesota Pollution Control Agency http://www.pca.state.mn.us/index.php/water/water-types-and-programs/minnesotas-impaired-waters-and-tmdls/impaired-waters-list.html (Impaired Waters)

Mississippi Watershed Management Organization http://www.mwmo.org/

Equipment (Incomplete List of Suppliers):
Find a local vendor or contractor from the sites below.
Maintenance equipment
www.toro.com
www.exmark.com
www.deere.com

Irrigation Systems
www.hunterindustries.com
http://www.toro.com/watermgmt/index.html
http://store.rainbird.com/

Soil Probes, Soil Thermometers and Anemometers
Forestry Suppliers, Inc.
205 West Rankin Street
Jackson, MS 39201
www.forestry-suppliers.com

Ben Meadows
1-800-241-6401
www.benmeadows.com

Fertilizers and Fertilizing:
Fertilizer research – Best time to fertilize:
www.extension.umn.edu/distribution/horticulture/dg3338.html

How to Dispose of Lawn Fertilizer Containing Phosphorus
http://www.mda.state.mn.us/chemicals/fertilizers/options-for-leftover-lawn-fert.aspx

Irrigation
EPA Water Sense Program- professional certification for irrigation designers, contractors, and auditors. http://www.epa.gov/watersense/outdoor/cert_programs.html

Minnesota Department of Agriculture:
625 Robert Street North, St. Paul, Minnesota 55155-2538
651-201-6000 or 1-800-967-2474 http://www.mda.state.mn.us

Minnesota Department of Agriculture Fact Sheets:
To view the following factsheets, go to:
http://www.mda.state.mn.us/en/licensing/licensetypes/pesticideapplicator.aspx

- Pesticide Applicator Incident Response Plan Guide
- Pesticide Applicator Initial License and Renewal Requirements
- Pesticide Applicator License Categories
- Pesticide Applicator License Changes & Fees
- Pesticide Applicator License Types
- Pesticide Applicator Recertification Requirements
- Steps to Successfully Completing a Pesticide Certification Exam
- Pesticide Application Record – Category E
- Pesticide Containers: Management & Disposal
- Pesticide and Fertilizer Storage: Small Package Requirements
- Management & Disposal of Pesticide Containers

Minnesota Department of Agriculture staff is available to receive reports 24 hours a day, 7 days a week. MDA uses the Department of Public Safety's duty officer system. Call *651-649-5451* (metro) or *800-422-0798* (non-metro) day or night. The duty officer will relay your message to an MDA staff person on duty who will call you back promptly with instructions.

Managing Pesticides, Waste Pesticides & Empty Pesticide Containers
http://www.mda.state.mn.us/protecting/bmps/waste.aspx

Minnesota Pollution Control Agency (MPCA)
http://www.pca.state.mn.us/programs/summermaintenance.html

Minnesota State Statutes https://www.revisor.mn.gov/statutes/

Miscellaneous Resources:

Garden Arithmetic Calculators
http://www.extension.org/pages/10063/garden-math#.U6s4VfldWVI

Heavy Metals in Fertilizer http://www.mda.state.mn.us/chemicals/fertilizers/heavymetals.aspx
Paul McNelly, Minnesota Department of Agriculture, (651) 201-6560

Tree Owner's Manual for the Northeastern and Midwestern United States is available online in PDF format. http://www.ctpa.org/TreeOwnersManual.pdf

Aerial photo measurement tool (fee required)
www.goilawn.com

Organic Lawn Care: www.safelawns.org
The Organic Lawn Care Manual by Paul Tukey
The Chemical Free Lawn by Warren Schultz

Phosphorus-Free Lawn Care:
Use Phosphorus-Free Lawn Fertilizer to Protect Minnesota Lakes and Rivers Handout
http://156.98.19.245/download/phosphorus.pdf

Phosphorus in Lawns, Landscapes and Lakes
http://www.mda.state.mn.us/news/publications/chemfert/reports/phosphorusguide.pdf

Seeding:
Lawn Renovation (2010) by R.J. Mugaas and B.W. Pedersen
http://www.extension.umn.edu/garden/yard-garden/lawns/lawn-renovation/

Soil Temperatures:
http://climate.umn.edu/cawap/soilpan/soilpan.asp

Soil Testing Laboratories:
http://soiltest.cfans.umn.edu
http://www2.mda.state.mn.us/webapp/lis/soillabs.jsp

Soils and Soil Testing Resources:
Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens, and Landscape Plants
http://www.extension.umn.edu/distribution/horticulture/DG1731.html

Web Soil Survey
http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Training Resources – Turfgrass Maintenance with Reduced Environmental Impacts:
Fortin Consulting – Additional training
http://www.fortinconsulting.com/our-work/turfgrass/

Minnesota Pollution Control Agency (MPCA)- turfgrass manual, best practices matrix, certified individuals, schedule of classes.
http://www.pca.state.mn.us/programs/summermaintenance.html

Training Resources – Other training courses:
Minnesota Circuit Training and Assistance Program
http://www.mnltap.umn.edu/About/Programs/CTAP

Minnesota Erosion Control Association
http://www.mnerosion.org

Minnesota Pollution Control Agency (MPCA) - winter maintenance training
http://www.pca.state.mn.us/programs/roadsalt.html

Mississippi Watershed Management Organization
http://www.mwmo.org

University of Minnesota Extension
http://www.extension.umn.edu

Weed and plant identification:
Grasses and Broadleaves-photos and drawings
http://www.extension.umn.edu/agriculture/crops/weed-management/weed-seedling-identification/
http://www.pca.state.mn.us/index.php/view-document.html?gid=12940
http://www.extension.umn.edu/agriculture/crops/weed-management/#weedid
http://www.lawn-care-academy.com/weed-identification-perennial-2.html
http://www.uaex.edu/yard-garden/resource-library/weed-id/

Minnesota Invasive non-native terrestrial plants
http://www.comm.media.state.mn.us/bookstore/mnbookstore.asp?page=viewbook&BookID=68178&stocknum=311 (MNDNR Guidebook)
http://www.dnr.state.mn.us/invasives/terrestrialplants/index.html

Noxious Weeds
http://plants.usda.gov/java/noxious?rptType=State&statefips=27

University of Minnesota Gardening information- diagnostics for weeds, insects and turfgrass
http://www.extension.umn.edu/gardeninfo/

Weed Seedling Photos
http://www.extension.umn.edu/agriculture/crops/weed-management/minnesota-weed-seedling-photo-collection/

Weeds and Weed Control:
Biological control
Monika Chandler, Minnesota Department of Agriculture
Monika.Chandler@state.mn.us (651) 201-6537

National Pesticide Information Center http://www.npic.orst.edu/

Pesticide Application Safety Signs
Example sources:
www.gemplers.com
www.mysafetysign.com
www.grainger.com

Reporting Pesticide Misuse in Minnesota
http://www.mda.state.mn.us/chemicals/pesticides/complaints.aspx

Weed Control in Lawns and Other Turf – University of Minnesota
http://www.extension.umn.edu/distribution/horticulture/DG1137.html

The Law

Do you know the city ordinances and state laws that may apply to your work?
To find the actual language for the rules and statutes mentioned below, go to https://www.revisor.mn.gov/statutes.

Cleaning Equipment:

- Waste (including grass clippings, leaves, etc) may not be discharged into any waters of the state so as to cause nuisance conditions or pollution.
- In other words, don't clean mowers or other equipment where the wash water and debris will end up in a lake, stream, or wetland, either directly or through a storm sewer or ditch.
  Minnesota Rule 7050.0210 subp. 2 and 13
  https://www.revisor.mn.gov/rules/?id=7050.0210

Fertilizer:

- Use of Phosphorus Fertilizer on Lawns and Turf is Restricted unless:
  - a soil test or plant-tissue test shows a need for phosphorus;
  - a new lawn is being established by seed or laying sod;
  - Phosphorus fertilizer is being applied on a golf course by trained staff;
  - Phosphorus fertilizer is being applied on farms growing sod for sale.

  Minnesota Statute 18C.60
  https://www.revisor.mn.gov/statutes/?id=18C.60

  Phosphorus law information: Contact the Minnesota Department of Agriculture:
  (651) 201-6000 or 1-800-967-2474 or visit www.mda.state.mn.us/phoslaw.

- A person may not apply a fertilizer to an impervious surface. Fertilizer released on an impervious surface must be immediately contained or legally applied to turf.
  Minnesota Statute 18C.61
  https://www.revisor.mn.gov/statutes/?id=18C.61

- If you are hired to apply fertilizer, someone from your company must have a fertilizer license.
  Minnesota Statute 18C.415
  https://www.revisor.mn.gov/statutes/?id=18C.415

- You may not fill fertilizer application equipment directly from a public water supply, unless the outlet from the public water supply is equipped with a backflow prevention device.
  Minnesota Statute 18C.201
  https://www.revisor.mn.gov/statutes/?id=18C.201

- You may not fill fertilizer application equipment directly from a public or other waters of the state unless the equipment contains proper and functioning anti-back siphoning mechanisms.
  Minnesota Statute 18C.201
  https://www.revisor.mn.gov/statutes/?id=18C.201

- A person may not store, handle, distribute, or dispose of a fertilizer, rinsate, fertilizer container, or fertilizer application equipment in a manner that will endanger humans, agricultural products, food, livestock, fish, wildlife, the environment, or waters of the state.
  Minnesota Statute 18C.201
  https://www.revisor.mn.gov/statutes/?id=18C.201

- Fertilizer equipment may not be cleaned in surface water. Fertilizer equipment may not be cleaned adjacent to surface waters, ditches, or wells where they can contaminate surface and ground waters.
  Minnesota Statute 18C.201
  https://www.revisor.mn.gov/statutes/?id=18C.201

  Fertilizer regulation: Contact the Minnesota Department of Agriculture:
  (651) 201-6000 or 1-800-967-2474 or visit
  http://www.mda.state.mn.us/licensing/licensetypes/fertilizer.aspx

Gopher State One-Call 1-800-252-1166 or 651-454-0002

- Underground utilities must be marked at least 48 hours before digging.
  Minnesota Statute 216D.04
  https://www.revisor.mn.gov/statutes/?id=216D.04

Irrigation:

- Rain sensors are required on all newly installed sprinkler systems.
  Minnesota State Statute 103G.298 and Federal Water Conservation Standards Policy effective July 1, 2003. www.revisor.leg.state.mn.us/statutes/?id=103G.298

- If the governor determines and declares that there is a critical water deficiency, public water supply authorities must adopt and enforce water conservation restrictions within their jurisdiction.
  Minnesota Statute 103G.291
  https://www.revisor.mn.gov/statutes/?id=103G.291

- Many cities in Minnesota enforce watering ordinances and/or bans.
  For more information contact the city where you are working.

- *Minnesota Statute 103G.291Subd. 4* **Demand reduction measures.**

  (a) For the purposes of this section, "demand reduction measures" means measures that reduce water demand, water losses, peak water demands, and nonessential water uses. Demand reduction measures must include a conservation rate structure, or a uniform rate structure with a conservation program that achieves demand reduction. A "conservation rate structure" means a rate structure that encourages conservation and may include increasing block rates, seasonal rates, time of use rates, individualized goal rates, or excess use rates. If a conservation rate is applied to multifamily dwellings, the rate structure must consider each residential unit as an individual user.

(b) To encourage conservation, a public water supplier serving more than 1,000 people must implement demand reduction measures by January 1, 2015.
https://www.revisor.mn.gov/statutes/?id=103G.291

Noise:

- Many cities throughout Minnesota enforce a noise ordinance at certain hours of the day. Operation of power equipment (eg. lawn mower, chainsaw, mulcher, etc.) may be prohibited in the mornings and evenings.
  For more information contact the city where you are working.

Pesticides:

- If you are hired to apply pesticides, you must have a Commercial Applicator License.
  Minnesota Statute18B.33
  https://www.revisor.mn.gov/statutes/?id=18B.33

- Any person (hired or not) applying "Restricted-use Pesticides" must have a Commercial Applicator License, a Non-Commercial Applicator License, a Private Applicator Certification, or a Structural Pest Control Applicator License.
  Minnesota Statute 18B.34
  https://www.revisor.mn.gov/statutes/?id=18B.34

- Pesticides must be applied in accordance with the product label or labeling and in a manner that will not cause unreasonable, adverse effects on the environment.
  Minnesota Statute 18B.07
  https://www.revisor.mn.gov/statutes/?id=18B.07

- All Commercial or Non-Commercial Applicators who apply pesticides to turf areas must post a warning sign on the property where the pesticides are applied.
  Minnesota Statute 18B.09
  https://www.revisor.mn.gov/statutes/?id=18B.09

- Pesticide containers (rinsed and un-rinsed) must be stored in a secure place in their original containers.
  Minnesota Statute 18.B07
  https://www.revisor.mn.gov/statutes/?id=18B.07

- You may not fill pesticide application equipment directly from a public water supply, unless the outlet from the public water supply is equipped with a backflow prevention device.
  Minnesota Statute 18B.07
  https://www.revisor.mn.gov/statutes/?id=18B.07

- Pesticide equipment may not be cleaned in surface water. Pesticide equipment may not be cleaned adjacent to surface waters, ditches, or wells where they can easily contaminate surface and ground waters.
  Minnesota Statute 18B.07
  https://www.revisor.mn.gov/statutes/?id=18B.07

For more information about Pesticide Licenses and Regulations, contact the Minnesota Department of Agriculture.
(651) 201-6000 or 1-800-967-2474 or visit
http://www.mda.state.mn.us/en/licensing/licensetypes/pesticideapplicator.aspx

Signage:

- State statute 18B.09 allows cities to require the posting of signs where turf has been treated with pesticides (https://www.revisor.leg.state.mn.us/statutes/?id=18B.09).
- Check with the city where you are applying pesticides to determine if signage is required.

Yard Waste:

- Federal rules for Municipal Separate Storm Sewer Systems (MS4's) may affect your maintenance practices. In many cities, it is a violation to rake, sweep, or blow leaves, grass, and other yard debris into the streets.
  For more information, contact the City where you are working.

- Beginning January 1, 2010, residents of Anoka, Carver, Hennepin (excluding City of Minneapolis residents), Ramsey, Scott, and Washington Counties who bag their yard waste or other compostable waste will be required to put their waste out for pickup in bags certified as compostable by the American Society for Testing and Materials (ASTM). City of Minneapolis residents are not required to use compostable bags until January 1, 2013. Residents of Dakota County who bag their waste are already required to use compostable bags for yard waste pickup.
  For more information contact Public Information Services: 651-296-2146

Additional Tools

Please use the following sheets to help you with your everyday operations:

1. Common Conversions
2. Example Spot Herbicide Application Advertisement
3. Example Soil Testing Advertisement
4. Guidelines for Equipment Storage/Idle Equipment
5. Example Daily Maintenance Checklist for Equipment
6. Example Maintenance Visit Form

Common Conversions

1 acre = 43,560 square feet
1 cubic yard = 27 cubic feet
1 square yard = 9 square feet
1 cup = 8 liquid ounces
1 pint = 2 cups or 16 liquid ounces
1 quart = 2 pints or 32 liquid ounces
1 gallon = 4 quarts or 128 liquid ounces
1 liter = 1.056 liquid quarts

Length x width = area

Example Fliers

Company logo

[Company Name]

You can reduce pesticide run-off, save money, and maintain a healthy turf!!

SPOT-TREAT HERBICIDE APPLICATION

Keep our lakes healthy!

Don't over-apply herbicide that will be washed-off into the nearest water source.

Turf specialists agree! It may not be necessary to herbicide your entire yard!!

By understanding the needs of your lawn, we will be able to manage it more effectively.

Please call for a consultation:
(555) 555-5555

Don't pay more for one or more blanket treatments.

Price estimate for spot-spray application:

$___.__

[Company Name]

Company Logo

Professionals take <u>SOIL TESTS</u> to identify the needs of your turf.

We offer a thorough lawn consultation to better understand the needs of your turf. We are driven to give you the best looking yard while maintaining a healthy relationship with the environment.

All lawns are not the same. We can customize a fertilizer formula for your lawn's optimum health and growth.

Our goal is to keep your turf healthy and balanced without over applying fertilizers that could pollute our waters.

A lower application rate could even save you money!

Price estimate:

$___.__ per sample

Depending on the character of your yard (i.e. shaded and sunny, soggy patches and dry patches), more than one sample may be necessary.

Please call for a consultation:
(555) 555-5555

Guidelines for Equipment Storage/Idle Equipment

- Fuel should be emptied when possible and carbs drained, or run until it dies.
- If machine has a tank that can have the fuel shut off, cut fuel, drain carb and FILL the tank to the brim. This will prevent condensation from forming in the tank. Try to run empty or drain whenever it is feasible. Example: you have a 10 gallon tank with 8 gallons in it, fill it. If it has 1 gallon, drain it. Let common sense dictate your decision.
- Oil changed and all fittings greased. Check and fill all fluids.
- All air filters or dust screens cleaned.
- If tool requires sharpening, do it.
- Tires properly filled. Note and report deficient conditions.
- Check belts for wear and cracks, note and report deficient belts.
- Check all lights and wiring. Replace bulbs if needed.
- Machine is to be thoroughly cleaned, engine underbody completely cleaned. Waxed whenever possible.
- Battery water level checked and battery charged, either by operating the machine or with a charger.
- Machines that are stored in cold storage should have the batteries charged and then disconnected. See mechanic for details on the particular piece of equipment.
- Tag the piece of equipment with the date it was stored.
- Note any deficiencies that need to be addressed. Put that on the stored equipment tag along with date.

This process applies to ALL equipment. All equipment should have this process completed within 30 days of end of use.

Created by Jim Weber at University of Minnesota Landcare Department

EXAMPLE: Daily Maintenance Checklist

Equipment_____Unit Number_____

Check Items:	MON	TUES	WED	THURS	FRI
DATE:					
OPERATOR:					
1. CHECK ENGINE OIL					
2. CHECK TIRES & AXLES					
3. CHECK ALL BOLTS & FASTENERS					
4. CHECK TINE BOLTS & MECHANISM FOR WEAR OR DAMAGE					
5. CHECK STARTER ROPE FOR WEAR					
6. CHECK CHAINS AND LUBRICATE BIO DAILY					
7. CHECK BELTS RACKS FOR CRACKS AND WEAR					
8.LUBRICATE EIGHT GREASE FITTINGS DAILY					
9. CLEAN AIR FILTER					
10. CHANGE ENGINE OIL MONTHLY (10W-30) please date last oil change					

VERY IMPORTANT

* If there is any doubt as to the condition and/or safe operation of the equipment specified above, notify your gardener immediately so he/she can notify the proper repair technician.

IF THERE ARE ANY KNOWN DEFICIENCIES, PLEASE NOTE BELOW.

Created by Jim Weber at University of Minnesota Landcare

EXAMPLE: MAINTENANCE VISIT FORM

Property Name: _____
Date: _____/_____/_____

Work Completed on Property

Name of employee	Shop	Travel	Weed/ Trash	Mow/ Trim	Edge Sidewalk	Edge Bed	Cultivate	Prune	Cleanup		Total Time

Observations: **Comments:**

1) Initial Walk

a) TREES, SHRUBS, PERENNIALS & ANNUALS

Differences from past wks	yes/no	Explain: _____	Where:	_____
Insects or pests detected	yes/no	Explain: _____	Where:	_____
Dead or dying plant material	yes/no	Explain: _____	Where:	_____

b) TURF

Differences from past wks	yes/no	Explain: _____	Where:	_____
Insects or pests detected	yes/no	Explain: _____	Where:	_____
Dead or dying plant material	yes/no	Explain: _____	Where:	_____

c) OPPORTUNITIES FOR ADDITIONAL WORK _____

Property Name: _____
Date: _____/_____/_____

2) Final Walk

a) CLEANUP

1) Debris, waste and tools away	yes/no	Explain: _____	Where:	_____
2) Any injury to turf or beds	yes/no	Explain: _____	Where:	_____

3) Completion

a) Plan for next week _____

b) Problems on site _____

Future work on Property:

	March	April	May	June	July	Aug	Sept	Oct	Nov	
Edge Beds										
Mulch Cultivation										
Edge Sidewalks/Curbs										

Created from Quercus, Inc. form

References

Last updated 6/25/14
Problems with links? Please notify Fortin Consulting, Inc. www.fortinconsulting.com

Bierman, Peter; Brian Horgan; Carl Rosen; and Andrew Holman, University of Mn; and Paulo Pagliari, University of WI. 2010. Phosphorus Runoff from Turfgrass as Affected by Phosphorus Fertilization and Clipping Management. J. Environ. Qual. 39:282–292 (2010).

Fagerness, Matthew J. (2001, September). *Thatch-A Hidden Lawn Concern.* Retrieved February 17, 2010 from Kansas State University website: http://www.ksre.ksu.edu/bookstore/pubs/mf2131.pdf.

Fong, Alison L. (2000). *Water-Quality Assessment of Part of the Upper Mississippi River Basin, Minnesota and Wisconsin: Ground-Water Quality in Three Different Land-Use Areas, 1996-98.* United States Geological Survey [USGS] Water Resources Investigation Report 00-4131. Retrieved from USGS website: http://pubs.er.usgs.gov/usgspubs/wri/wri20004131.

Fraedrich, Bruce R. n.d. Diagnosing and Preventing Herbicide Injury to Trees. Bartlett Tree Research Laboratories Technical Report.

Greater Madison Healthy Lawn Team, Inc. (2003). *Common Herbicides.* Retrieved March 5, 2010 from website: http://www.healthylawnteam.org/lawnChemicals-commonHerbicides.htm (website is no longer active).

Greater Madison Healthy Lawn Team, Inc. (2009). Retrieved February 17, 2010, from website: http://www.healthylawnteam.org/environment.htm (website is no longer active).

Greyhawk, Sam. (n.d.). *The Environmental Cost of U.S. Lawns.* Retrieved February 17, 2010, from Ezine Articles website: http://ezinearticles.com/?The-Environmental-COst-of-US-Lawns&id=1118004.

Lindsey, Rebecca. (2005, November 8). *Looking for Lawns.* Retrieved February 17, 2010, from NASA's Earth Observatory website: http://earthobservatory.nasa.gov/Features/Lawn/lawn2.php.

Metropolitan Council. (n.d.). *How Sustainable is Minnesota's Ground Water: Model Predicts Metro Decline.* Retrieved March 8, 2010 from Freshwater Society website: www.freshwater.org/images/stories/PDFs/facets/Dec.-08-Facets.pdf.

Metropolitan Council. (n.d.). Retrieved March 8, 2010 from website: http://www.metrocouncil.org/Wastewater-Water/Planning/Water-Supply-Planning/Water-Conservation-Toolbox-Customers.aspx.

Minnesota Department of Health. (July, 2000). *Comparative Risks of Multiple Chemical Exposures, Final Report for the Legislative Commission on Minnesota Resources*.

Minnesota Department of Agriculture [MDA]. (2007, March 15). *Report to the Minnesota Legislature: Effectiveness of the Minnesota Phosphorus Lawn Fertilizer Law.* Retrieved February 17, 2010, from website: http://www.mda.state.mn.us/en/protecting/waterprotection/phoslaw.aspx

Minnesota Department of Agriculture [MDA]. (2008, August). *2007 Water Quality Monitoring Report Surface Water Monitoring.* Retrieved February 17, 2010, from website: http://www.mda.state.mn.us/chemicals/pesticides/~/media/Files/chemicals/2007watqualmonrpt.aspx.

Minnesota Department of Agriculture [MDA]. (2010). *Non-agricultural pesticide sales. 2006-2007*.http://www.mda.state.mn.us/chemicals/pesticides/~/media/Files/chemicals/pesticides/2006-2007nonagpesticidesales.ashx

Minnesota Department of Agriculture [MDA]. (2011, June). *2010 Water Quality Monitoring Report Surface Water Monitoring.* Retrieved March 13, 2013, from website: http://www.mda.state.mn.us/~/media/Files/chemicals/wqm/2011wqmreport.ashx

Minnesota Department of Agriculture [MDA]. 2012, June). *2011 Water Quality Monitoring Report Surface Water Monitoring.* Retrieved March 8, 2013, from website: http://www.mda.state.mn.us/~/media/Files/chemicals/wqm/2011wqmreport.ashx

Minnesota Department of Agriculture [MDA]. (2013, June). Pesticide Management Unit. Personal Communication.

Minnesota Department of Agriculture [MDA], Pesticide Sales Database. Retrieved June 2013. http://www2.mda.state.mn.us/webapp/lis/chemsold_default.jsp

Minnesota Pollution Control Agency [MPCA], *Minnesota's Impaired Waters and TMDLs.* 2010 draft TMDL list. Retrieved March 15, 2010 from website: http://www.pca.state.mn.us/water/tmdl/tmdl-303dlist.html.

Minnesota Pollution Control Agency [MPCA], n.d. Basins and Major Watersheds in Minnesota (map) http://www.pca.state.mn.us.

Mississippi River Basin Panel. (2010, February 2). *Mississippi River Basin Panel on Aquatic Nuisance Species.* Retrieved March 15, 2010 from website: http://www.mrbp.org/.

Mugaas, Bob. (2005, February). *A Home Lawn Care Primer.* University of Minnesota Extension Service.

Mugaas, Bob. (n.d.). *Common Terms Associated with Weed Biology and Growth.* University of Minnesota Extension.

Mugaas, Bob. (n.d.). *Common Weeds in Minnesota Lawns.* University of Minnesota Extension.

Mugaas, Bob. (n.d.). *Lawn Weed Management Summary: Selecting and Using Herbicides Based on Plant Life Cycles.* University of Minnesota Extension.

Mugaas, Bob. (n.d.). *Post-emergence Herbicide Timing for Broadleaf Weeds* [PowerPoint slides]. Provided by Bob Mugaas.

Mugaas, Bob. (n.d.). *Pre-emergence Herbicide Application Timing* [PowerPoint slide]. Provided by Bob Mugaas.

Mugaas, Bob. (2002). *Purchasing Seed and Understanding Seed Labels.* University of Minnesota Extension.

Mugaas, R.J. & B.W. Pedersen. (2010). *Lawn Renovation.* University of Minnesota Extension Publication WW-03194. Retrieved from website: http://www.extension.umn.edu/garden/yard-garden/lawns/lawn-renovation/

Natural Resources Defense Council [NRDC]. (1998, November 25). *Endocrine Disruptors.* Retrieved February 17, 2010, from website: http://www.nrdc.org/health/effects/qendoc.asp.

Nishioka, Marcia G., Hazel M. Burkholder, Marielle C. Brinkman & Sydney M. Gordon. (1996, November 11). *Measuring Transport of Lawn-Applied Herbicide Acids from Turf to Home: Correlation of Dislodgeable 2,4-D Turf Residues with Carpet Dust and Carpet Surface Residues.* Environmental Science and Technology. Vol. 30, No. 11, 3313-3320. Retrieved March 05, 2010 from Beyond Pesticides website: http://www.beyondpesticides.org/documents/24Dcarpetstudy.pdf.

Pedersen, Brad & Bob Mugaas. (2010). *Weed Control in Lawns and Other Turf.* Retrieved February 17, 2010 from University of Minnesota Extension website: http://www.extension.umn.edu/distribution/horticulture/DG1137.html.

Pedersen, T.L. (1997, June). *Pesticide Residues in Drinking Water.* Retrieved February 17, 2010 from Extoxnet website: http://extoxnet.orst.edu/faqs/safedrink/pest.htm.

Quercus, Inc. (2010) *Maintenance Visit Form*. Provided by Brad Tabke.

Reicher, Zac & Glenn Hardebeck. (2000, June 20). *Leaf Mulching Effects on Turf Performance.* Retrieved February 17, 2010 from University of Purdue website: http://www.agry.purdue.edu/turf/report/1999/page24.htm.

Rosen, Carl J. et. al. (2013) Soil Test Interpretations and Fertilizer Management for Lawns, Turf, Gardens and Landscape Plants. University of Minnesota Extension. http://www.extension.umn.edu/distribution/horticulture/DG1731.html.

Saviodsilva. (n.d.) *Photosynthesis diagrams.* Retrieved March 15, 2010 from website: http://www.osovo.com/diagram/photosynthesisdiagrams.htm.

Smith, Ron. (n.d.) *Growth and Development in Turfgrass.* Retrieved March 15, 2010 from North Dakota State University website: http://www.ag.ndsu.edu/archive/dickinso/grassland/1022.htm.

Three Rivers Park District (formerly Hennepin Parks). (1999.). *Green Lawns - Green Lakes, The Phosphorus Connection.*

United States Environmental Protection Agency [EPA]. (2009, July 24). *Gulf of Mexico Dead Zone Surprisingly Small in Area, but Severe.* USEPA press release. Retrieved February 17, 2010, from website: http://www.epa.gov/reg4gmpo/pdf/2009-0724-press-release.pdf (website is no longer active).

United States Environmental Protection Agency [EPA]. (n.d.). Retrieved from website: http://www.epa.gov/watersense/our_water/what_you_can_do.html.

United States Environmental Protection Agency, 2001. *Removal of Endocrine Distruptor Chemicals Using Drinking Water Treatment Process*. EPA/625/R-00/015. http://nepis.epa.gov/Adobe/PDF/30004HGG.pdf.

University of Michigan. (2006, January 4). *Human Appropriation of the World's Fresh Water Supply.* Retrieved February 17, 2010 from http://www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html.

University of Minnesota Extension. (n.d.). *Summer Herbicide Tips for Protecting Water Quality.* Provided by Bob Mugaas.

University of Minnesota Extension. (n.d.) Understanding your Soil Test Report for Lawn, Garden and Landscape Plants. Retrieved March 13, 2013 from website: http://soiltest.cfans.umn.edu/understanding-your-report/lawn-garden-and-landscape-plants/#interpretation.

University of Minnesota Extension, (1989) *Guide to Computer Programmed Soil Test Recommendations for Field Crops in Minnesota*. Publication AG-BU-0519.

University of Minnesota. (2006). *Mowing Practices.* Retrieved March 23, 2010 from website: http://www.extension.umn.edu/garden/landscaping/maint/mowing.htm.

University of Minnesota. (2006). *Grass Plant Growth and its Relationship to Lawncare*. Retrieved February 17, 2010 from website: http://www.extension.umn.edu/garden/landscaping/maint/grasspla.htm.

University of Minnesota. (2006). *Sustainable Urban Landscape Information Series: Mowing Practices.* Retrieved from website: http://www.extension.umn.edu/garden/landscaping/maint/maint.htm.

University of Minnesota Landcare (2010). *Daily Maintenance Checklist* and *Guidelines for Equipment Storage/Idle Equipment.* Provided by Jim Weber.

Ward, Alan. (2003, December 23). *Weighing Earth's Water from Space.* Retrieved March 1, 2010 from NASA's Earth Observatory website: http://earthobservatory.nasa.gov/Features/WeighingWater/.

Wetzel, Robert G., 2003. Limnology, Second Edition. CBS College Publishing. p. 285.