INTEGRATED PEST MANAGEMENT MANUAL

CEDAR FALLS SCHOOLS

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Background:

In late 1998, the Cedar Falls Community School District began a project to develop effective pest management strategies that would reduce the potential for pesticide exposure to children and staff.

The first step was to develop written documentation concerning our lawn care practices. We identified pest control problems including when, where, and how often pesticides were used, which pesticides were used, who applies them, and what precautions were taken to reduce the potential for exposure.

The second step was to convene an advisory committee to assist in developing a complete pest management program that would provide necessary pest control while minimizing pesticide use and the potential for exposure of children and staff.

Plan was reviewed and revised in February 2015.

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Introduction

Insects, weeds, and rodents are undesirable residents of a school setting. These pests cause damage to the school building, food supplies, and students. Some can sting, bite and cause severe allergic reactions. Pests need to be controlled in the school setting, but there are better options available than traditional pesticide use.

Traditionally, pesticides are the first line of defense against pests. Pesticides are used regularly, both when actual pest problems exist and to prevent future pest problems from occurring. The problem with this method is that pesticides are potentially harmful chemicals that can harm humans, upon exposure. This means that both pests and pesticides are undesirable in the school setting. Because children are still growing and developing physically, pesticide exposure to children is more harmful than adult exposure. Schools, therefore, should logically evaluate methods of pest control.

There are other ways to manage pest problems and benefits that come with them. Often sanitation and maintenance can keep pest problems from occurring by paying attention to pest habits and needs. Trapping pests can sometimes replace pesticide use for pest control. Sometimes pests are seasonal problems and will leave within a few days without any control at all. Wise and judicious pesticide use can greatly reduce the risk of pesticide exposure and the amount of pesticides used. Using fewer pesticides for pest management also often reduces the costs of pest management. For these reasons and others, it is wise to incorporate other methods of pest management into our school.

The Department of Agriculture, Trade, and Consumer Protection supports the use of an Integrated Pest Management approach to managing pests in school settings. Integrated Pest Management (IPM) is an approach to pest control that focuses on minimizing pest problems by making an environment unfavorable to pest inhabitation. School staff will monitor for pests, and if they are seen, there will be an attempt to remove the problem without pesticide use. If the pest problem still exists after these measures are taken. Responsible, controlled and targeted pesticide use will be carried out to remove the problem. Minimally toxic pesticides that will reduce human exposure (such as baits) will be used whenever possible for these treatments. An IPM approach to pest control, when used properly, will reduce both pest problems and potential pesticide exposure.

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What is Integrated Pest Management?

Integrated Pest Management (IPM) is a decision-making process that uses all available pest management strategies to prevent economically damaging pest outbreaks while reducing risks to human health and the environment. IPM is a continuum along which there are many levels of adoption. It can range from simple monitoring to properly timed pesticide use all the way to "biointensive" IPM in which there is total elimination of synthetic pesticides, such as in organic farming.

Goals of IPM

IPM in schools protects human health by:

- suppressing pests that may carry diseases
- reducing pest damage
- reducing environmental pollution
- reducing human exposure to pesticides

In an IPM program, treatments are not made without first monitoring the situation and evaluating whether a pest is likely to be a problem. In schools, there are three injury levels used to determine when to implement pest management strategies:

- ***Economic Injury Levels*** determine the level of damage to a structure or plant. Once damage has reached a level that is severe enough to cause economic loss, control should be implemented. An example would be a termite infestation that requires replacement of some structure.

- ***Aesthetic Injury Levels*** are the levels at which a pest becomes a nuisance for whatever reason. Perhaps this is the level at which an aphid population drops enough honeydew onto a picnic table beneath a shade tree to disturb the people using the table or a number of mature dandelions going to seed. Aesthetic injury levels are subjective, that is, what is tolerated by one person may not be tolerated by another.

- ***Medical Injury Levels*** are used whenever a pest can cause illness to humans either directly or indirectly. Rodent-transmitted diseases would be one example, or pollen from excessive weed growth may be another.

Components of an IPM Program

All IPM programs, regardless of the situation, share the same components.

- monitoring the pest population and other relevant factors
- accurate identification of the pest
- determining injury levels and thresholds that trigger treatments
- timing treatments to the best advantage

- spot-treating for the pest
- selecting the least-disruptive tactics
- evaluating the effectiveness of treatments to fine-tune future actions
- educating all people involved with the pest problem

Each of these components will be discussed throughout this manual when discussing pest management in each of the various situations.

IPM is a Decision-Making Process

IPM requires continuous assessment of a situation. There are four key questions that must be answered before implementing any management strategy.

Is treatment necessary? The mere presence of a pest doesn't necessarily warrant treatment. Sometimes a fairly large population of pests can be tolerated while other times the presence of a single pest is intolerable. In addition, the determination of treatment will vary among individuals.

Where should the treatment take place? Pest managers must look at the whole system to determine the best place to solve the problem. Apply treatments where the actions will have the greatest effect. In order to do this you must completely understand the biology and behavior of the pest at hand.

When should action be taken? Timing is very important. There are optimum times in weeds insects and disease life cycles when they are most susceptible to control. Again, it is very important to understand the biology and behavior of your pest.

Which strategies should be used? IPM uses a multi-tactic approach. Because biological systems are complex, management strategies must also integrate several strategies. Rarely will a single tactic solve the problem for long. Implementing an IPM program means taking a "whole system" or ecosystem approach to solve a pest problem. You must think of both the living and non-living components when determining which approach to take. Each component has an impact on every other component.

There are four control strategies that can be used in developing an IPM program.

- ***Cultural*** control uses fertilization, irrigation, site selection, plant selection and/or sanitation to prevent pest problems in the first place

- ***Physical*** control is another preventative strategy. It includes screens or other barriers, temperature and humidity modification, traps, physical repellents, and hand removal of weeds.

- ***Biological*** control uses beneficial organisms (insects, bacteria, etc.) to control pests. IPM programs seek to conserve naturally occurring beneficial insects by providing them with food and shelter and not using broad-spectrum insecticides that will inadvertently kill the beneficial insects.

- ***Chemical*** control is used after other suitable control strategies are not effective or practical. Always use chemicals in an environmentally responsible manner and in accordance with the label.

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Sanitation – Indoors

- Clean all areas of the school regularly.
- Pay special attention to cleaning areas where food is eaten, stored, served, cooked or disposed.
- Keep areas around sinks and toilets dry
- Clean up spills as they happen. Possibly make spill clean up the responsibility of the group that makes them.
- Focus cleaning efforts on areas that have more pest problems.
- Remove trash more frequently in problem areas. Empty any trash receptacles that have food or food-related items in them at least daily.
- Maintain school interiors to reduce the areas where pests can hide and to reduce food and water sources.

Sanitation - Outdoors

- Clean areas around dumpsters and outdoor trash receptacles at least once a week.
- Keep grass and brush along the sides of the school well trimmed. A two-foot vegetation-free barrier of stone or dirt around the school is ideal.
- Pick up outdoor trash regularly. Too much clutter can interfere with plant and grass growth and food and drink containers will attract wasps and other insects.
- Manually remove weeds from flowerbeds and around buildings whenever possible.

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Maintenance/Pest Exclusion

Indoors

- Caulk or fill all holes and cracks in the walls, around pipes, etc.
- Fix leaky or "sweaty" piping to reduce water supplied to pests.
- Make sure all doors that lead outdoors are self closing, or if they will be kept open, have another self closing screen door present.
- Doors should be tight fitting with weather-stripping and door sweeps to keep out crawling pests.

Outdoor Animals

- Use pest resistant, self-closing trash receptacles and dumpsters. Keep them closed and remove garbage before it keeps the trash receptacle or dumpster open.
- Do not allow high grass or shrub areas to border athletic fields and other turf areas.

Weeds

- Mow turf frequently, ideally cutting less than 1/3 of the grass height with each mowing.
- Fertilize turf at appropriate rates and times.
- Use aerification of the soil.
- Topdress turf areas for better performance of athletic turf.

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Monitoring

- Monitor for pests or evidence of pests (droppings, chew marks or other damage) routinely. Incorporate monitoring into other activities such as cleaning or mowing the lawn.
- Routinely check these key areas:
  - Food storage and preparation areas.
  - Garbage storage areas.
  - Areas round water pipes in kitchen and bathrooms (and anywhere else they are).
  - Place sticky traps in key areas (useful for insects as well as rodents)

Record Keeping

Keep records for both pest sightings and pesticide use on school grounds. Knowing where, when, and what pests are seen on school grounds will help focus pest control efforts and will be helpful to professional pest control operators. Sample pest sighting and pesticide use logs are included in the pest management plan at the end of the manual. Maps of the school building and grounds will aid in describing where pests are sighted and pesticides are used.

Maintenance staff, teachers, and students should contribute to pest sighting logs. Pesticide use logs should be filled out by the person applying pesticides.

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Considerations and Precautions to take in Selecting and Using a Pesticide

- Monitor for pests. Only treat a problem if insects are present in the school at an unacceptable level.
- Identify the pest and understand its biology.
- See what measures as far as site modification, sanitation and exclusion can be utilized.
- Look into the effectiveness of pest trapping for pest control.

If the above suggestions do not provide control of the problem, pesticides may be necessary.

- Choose products wisely. The pesticide section of the appendix discusses many different types of pesticides and should aid your decision.
- Choose pesticide baits over sprays when possible.
- Try to use products with the lowest level of risk. All pesticide product labels have "signal words" that help identify the level of risk. Pesticides with the signal word "caution" have the lowest level of risk.
- Use all pesticides with care. Choose pesticides with the least potential for exposure. Use pesticides only when and where people cannot be exposed to these pesticides through direct contact, inhalation of vapors, or allowing premature access to treated areas.
- If pesticides are used, apply them at times when the building will not be occupied for an extended period of time, and especially when children are not present**.**
- If pesticides must be used when children are present, isolate treated area from any activity.

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Notification Guidelines

Mechanism for providing notification.

At the beginning of the school year, we provide written information summarizing the school's pesticide use policy to all school staff, students, and parents. The notification will be included in the secondary student handbooks and staff handbooks. Materials will be available for elementary parents during registration.

A sample notice to be annually provided to parents and staff at the beginning of the school year:

An Integrated Pest Management (IPM) approach for controlling insects, rodents and weeds is used at Cedar Falls Community Schools. Our IPM approach focuses on making the school building and grounds an unfavorable habitat for these pests by removing food and water sources and eliminating their hiding and breeding places. We accomplish this through routine cleaning and maintenance. We routinely monitor the school building and grounds to detect any pests that are present. The pest monitoring team consists of our building maintenance, office, and teaching staff and includes our students. Pest sightings are reported to our supervisor of buildings and grounds who evaluates the "pest problem" and determines the appropriate pest management techniques to use to address the problem. The techniques can include increased sanitation, modifying storage practices, sealing entry points, physically removing the pest, etc.

We only use chemicals (pesticides) when necessary to eliminate a pest problem. The school will try to use the least toxic products when possible. Applications will be made at times when accidental exposures to unauthorized persons can be minimized.

Information requiring specific pesticide use is available to any school staff, student or parent seeking additional information by contacting the supervisor of buildings and grounds or the director of business affairs.

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Posting of Pesticide Applications

On site information about pesticide applications will help reduce pesticide exposure, and for some pesticide applications, posting of pesticide application information is required by state law. Students and other school staff can learn to avoid treated areas when they are posted.

When is posting required for pesticide applications?

Landscape pesticide applications made by any commercial applicator must be posted with warning signs. Landscape pesticide applications include all insect, fungus, and weed killer applications (including weed and feed products) to turf, mulch or gravel beds, flowers, shrubbery, and trees on school property.

Where must signs be placed when posting is required?

Warning signs must be posted so that they are clearly visible from each point of entry into the treated landscape. Warning signs should be visible from roads, sidewalks, driveways, doorways, or adjacent yards. Warning signs are not required in areas where a fence, wall, hedge, or similar structure effectively prevents access to a treated landscape. If an area is fenced, warning signs must be posted near the gate area.

How long must signs remain in place?

Warning signs must be posted. Many commercial applicators post just before starting an application. Signs must be posted even if the pesticide label does not state a prescribed re-entry interval. Signs must remain in place following current Iowa law following the application.

All signs must indicate the date on which they may be removed.

What information must warning signs contain?

Warning signs must be at least 4 inches by 5 inches, have a white background with red lettering and be attached to a stable supporting device. The use of vinyl flagging material is permitted as long as the information on the sign is visible when posted. Vinyl flags that fold over themselves when posted are unacceptable. Signs must be professionally printed, only the date on which the sign may be removed may be written by hand.

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What information must be provided to the public upon request?

Persons wanting additional information about a specific landscape pesticide application may request information from either a commercial applicator (for hire or not for hire) or commercial application business. The applicator or business must provide the requester the following information:

- The complete name and address of the person making the application or the business entity (e.g., school)
- The common chemical or brand name of each pesticide applied and the EPA registration number of that pesticide.
- The concentration and total quantity of each pesticide applied, or the amount of pesticide active ingredient applied per unit area, and the total area treated.
- The date and approximate time of application.
- Any post-application precautions stated on the pesticide label including precautions related to re-entry into or use of treated areas.
- A copy of the pesticide label for each pesticide applied.

The applicator or business may provide the information requested either orally or in writing. The commercial applicator or business may require the requester to pay reasonable copying and postage costs.

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Things to consider when hiring a professional pest control operator

Qualities to look for in a professional pest control operator (PCO)

Require professional pest control businesses to have a business license. In addition, all employees that make pesticide applications must be both licensed and certified by the - state.

Applicators should be able to identify pests and should know about pest behavior and control methods. If an applicator is being hired to help maintain school grounds, knowledge of plant health maintenance is beneficial. Experience in school pest control is helpful but not required.

Professional applicators should provide proactive suggestions that identify housekeeping and structural deficiencies that contribute to pest problems. The Business should offer an IPM service program including:

- development of a pest monitoring program including:
  - a regular inspection of potential problem sites
  - identification of pests
  - classification of outdoor areas
  - discuss and establish pest thresholds with school staff
  - recommendations for control
  - evaluation of control measures
- making pest control recommendations
  - emphasis on maintenance and sanitation
  - pesticide applications only when necessary, i.e. when the established pest threshold is exceeded.
  - provide schools with pesticide labels and toxicity information for each pesticide that may be used
  - use of low risk pesticides when other means of control are not feasible
  - scheduling applications when school or grounds are not occupied

Other things to consider when hiring a professional pest control service

Discussion With the Applicator

- Provide a copy of the school's pest control policy.

- Goals of the IPM Program (pest tolerances limited pesticide use).
- History of the school's pest problems.
- Pest management actions that school or district will be responsible for.
- Request that the applicator develop a written pest management plan for the school.

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School Management Zones

In order to help develop planning strategies for integrated pest management, various school grounds areas are identified based on their function and requisite level of quality, e.g., athletic fields versus general lawns. These areas are further designated as a series of zones or levels: A, B, and C. Level A areas are high maintenance, high use areas where few if any weed and pest problems would be allowed. Levels B and C areas would require less management and tolerate more pests, and have lower aesthetic quality compared to Level A.

Since athletic fields generally have the most amount of traffic and least tolerance for bare, compacted soil areas and pests (including weeds), the manual will start with these areas. Landscape areas are discussed next, followed by miscellaneous areas which include playground cribs, fence lines, parking lots and sidewalks.

Designating School Turf Areas

There are three general areas on school grounds, athletic fields, turf landscape areas, and non- turf areas such as parking lots, fence lines, and playground cribs. Each of these areas have different levels of use. For example, high school playing fields have a higher level of maintenance than elementary school general use playing fields. These areas will have different acceptance for weed pressure and different amounts of effort will be needed to produce these results.

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Level A Athletic Fields

IPM Action Points

- Mowing - Mow with enough frequency to adhere to the "l /3 rule" which states that one-third or less of the leaf tissue is removed at any one mowing.

- Irrigation - Irrigate sufficiently to provide approximately one inch of water to the turf each week with rainfall amounts included. For example, if 1/4 inch of rain falls one week, supply 3/4 inch through irrigation.

- Fertilization - Apply a minimum of 4.5 pounds of nitrogen per thousand square feet annually to low use fields with light to medium traffic. Higher use fields may require six or more pounds of nitrogen per thousand square feet. Do not apply more than 1 lb. Nitrogen/l000 ft2 at any one time.

- Aerification - Perform aerification as needed to minimize compaction. Aerification can be performed at up to two to three week intervals during the growing season, although one aerification in spring and one in autumn may be sufficient.

- Topdressing - Topdressing consists of regular applications of soil and sand, ranging from 1/16 - 1/4 inch layers each time.

- Overseeding - Overseed thin areas in which the turf density provides less than 90-95% coverage as needed.

These are prime athletic fields, the high school football fields, Robinson/Dresser softball and baseball fields and junior high football fields. These fields should have dense turf (> 85% cover), good drainage, and irrigation. The soil type may be either sand based or native soil. The field must provide uniformly smooth surface (no major ruts, rapid divot repair, etc.) and an appropriate turf which will sustain a high level of traffic. Annual events should be limited to 50 or fewer. Practices may be held on these fields but since the logistics of practices often concentrate traffic in unusual areas, it is recommended practices be held on non-game fields or other turf areas to minimize traffic-related problems on game fields.

Primary cultural practices for Level A athletic fields include regular mowing, fertilization and irrigation. Secondary cultural practices include routine aeration, topdressing, and overseeding. Use of chemicals to control or manage weed, disease, and insect pests is allowed but only as a function of an overall integrated pest management program which stresses ideal turf management as a means to limit the extent of damage from pests.

Mowing

The turf needs to be mowed with sufficient frequency to adhere to the "1/3 Rule" which states one-third or less of the leaf tissue is removed at any one mowing. Mowing height will vary depending on the field's intended use (type and frequency of sport) but in general will be within one to three inches. Clippings should not need to be collected if the one-third rule is followed. Keep mower blades sharp to provide a clean cut which allow the cut leaves to quickly recover which will minimize disease and maintain stress tolerance.

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Irrigation

Irrigation should be supplied to replenish the amount of moisture lost from the turf on a weekly or daily basis. If information is unavailable, irrigate sufficiently to provide approximately one inch of water to the turf each week; rainfall amounts need to be considered n this calculation so it is important to monitor weekly rainfall using a simple rainfall collection device. Sand based root zones will usually require more irrigation and on a greater frequency than soil root zones, as often as three or even four times weekly during hot, dry summer periods. Irrigation systems in Level A athletic fields will often be permanent, in ground systems. Irrigate according to the soil permeability-do not try to supply all the weekly requirements with one irrigation if the soil cannot absorb all the water, instead, irrigate two or three times over one or more days to supply the necessary amount of water. The best time to irrigate is early morning (3 am or later); late afternoon or early evening irrigation can promote diseases which may necessitate fungicide applications. Do not irrigate fields less than 24-48 hours before events unless a light application is required to prevent wilting.

Fertilization

Apply a minimum of four pounds of nitrogen per thousand square feet (4 lb. N/M) annually to low use fields with light to medium traffic. Higher use fields may require up to six or more lb. N/M annually; fields with sand based root zones may require up to 10 lb. N/M annually (Table 2). Do not apply more than 1 lb. N/M at any one time. Fertilizers with an approximately 30-50% slowly available N are appropriate. Apply with a properly calibrated and functioning fertilizer spreader to obtain a uniform distribution. Phosphorus and potassium inputs on will be based on soil tests collected every two to three years. Since phosphorus requirements are significantly less than nitrogen or potassium, little to no phosphorus is usually required unless indicated by a soil test.

Aerification

Aerification is used to aid drainage, alleviate compaction, and promote turf growth, particularly rooting, resulting in increased stress tolerance, improved nutrient uptake, and reduced weed invasion. Aerification can also manage thatch buildup. Aerification should be performed as needed to minimize compaction, up to two to three week intervals during the growing season, although one aerification in spring and/or autumn may be sufficient. Use hollow tines which pull cores out of the field rather than solid tines or water injection systems. The cores can be left on the surface and will disintegrate within a few weeks, or they can be broken up using a drag mat. The soil must be moist enough to allow good penetration of the tines but not so moist as to result in rutting or compaction from the machinery.

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Topdressing

Athletic fields require topdressing to maintain a uniform surface and a crown that is imperative for surface drainage. Soil based fields rely almost solely on surface drainage. Topdressing consists of regular applications of soil or sand, ranging from 1/1 6 – 1/4 inch layers each time. Topdressing equipment ranges from fertilizer spreaders which take a very long time to properly topdress a field to dedicated topdressers. Drop-type topdressers which apply a uniform application of material are superior to those which sling topdressing out from a hopper using side to side movement. The amount and frequency of topdressing will depend on the soil type of the field and the types and amounts of traffic: frequent use by high school football players will require more frequent topdressing than infrequent use by middle school soccer players.

The topdressing source must:

- be free from glass, rocks, or other debris
- match the soil type of the root zone, a requirement which is almost impossible for native soil fields
- be able to supply a consistent material (both size and type) for years to come which further limits the types of acceptable topdressing. If a soil type is used which has finer particle sizes than the underlying soil root zone, a surface layer will be formed which prevents proper water infiltration and root growth

Sand is generally the topdressing type of choice, since sand can readily be matched to a sand based root zone and, if the root zone is a native soil, sand topdressing will not cause a "perched" water table since the particle size range of sand is coarser than native soils. Over time a sand layer may be built up which will require increasingly more sophisticated levels of management, although consistent aerification will help "mix" the sand into the upper few inches of the root zone to prevent this from occurring. The sand topdressing may be amended with no more than 15% peat or soil.

Overseeding

Thin areas in which the turf density provides less than 90-95% coverage should be overseeded as needed to maintain a weed-free, un form surface to minimize injury resulting from ruts and compaction. Overseeding can be performed using either broadcast or slit seeding. Slit seeders (sometimes referred to as drilling) place the seed directly in the soil-slit seed largely or totally bare areas in two to three directions to provide sufficient seed, otherwise a single pass is sufficient. Broadcast seeding can be performed a variety of ways. One o f the best methods is to overseed concurrent with aerification. Spikers or vertical mowers may also be used to expose soil to aid seedling establishment: some units are available which perform spiking and overseeding at the same time. Once an area has been overseeded, apply topdressing to help ensure seed to soil contact to aid germination. An area may also be overseeded shortly before a game in which case the cleats from the athletes will help push the seed into the soil.

Use Kentucky bluegrass (Poa pratensis) and/or perennial ryegrass (Lolium perenne) for overseeding. Kentucky bluegrass plants form rhizomes (underground lateral shoots) which are important for providing traction and allow the plant to fill in bare areas, while perennial ryegrass germinates quickly (3-5 days) and can provide quick cover. Since

ryegrass plants may not provide the most stable footing and are less winter tolerant than Kentucky bluegrass, ryegrass should not compose more than 15% of a Kentucky bluegrass/perennial ryegrass seed mixture or a turf of predominantly ryegrass will result. In some cases this may be acceptable, though on the highest quality athletic fields Kentucky bluegrass is preferred for the traction it provides to athletes. Use fast growing cultivars of Kentucky bluegrass with good rhizome development for overseeding: Touchdown, P-105, Fairfax, Limousine. On soccer fields, Supina bluegrass (Poa supine) can be used-this stoloniferous grass can be mowed shorter than other grasses (making it ideal for soccer), provides dense cover, and quickly recuperates from damage. Supina bluegrass, however, is more easily ripped from the soil than Kentucky bluegrass and therefore is not as desirable for football fields. The only cultivar of Supina bluegrass on the market is Supranova. Cultivars of perennial ryegrass are less variable in their regards to use for athletic fields.

Seeding rates will vary depending on the amount c f area exposed and the seed mix used. Seeding rates range from approximately ½ lb. per thousand square feet when used as a maintenance overseeding to turf which has 95% or higher cover, to 2-3 lbs per thousand square feet when more than 25% of the soil is exposed in an area.

Areas which are overseeded or sodded will require addition of a starter fertilizer (1 2-1 ratio of N-P-K) which is high in phosphorus to promote establishment. In general, apply one to two applications of starter fertilizer over a three to eight week period, supplying approximately ¾ -l lb. N/1,000 ft^2 each time. Irrigate the area as needed to promote seedling establishment.

Pest Management

Proper turf management will greatly reduce the need for pesticides by providing dense, healthy turf that will crowd out weeds and tolerate moderate levels of disease, insect, or vertebrate damage. In integrated pest management, pesticides are used only when pests damage the turf up to or past a pre-determined threshold level despite proper conventional management techniques.

When pesticides are applied to turf, the area should be fenced in or at least marked with pesticide application flags ("posting") until the product has dried and the reentry interval listed on the product label has passed. If no reentry intervals are listed on the label, keep people off the turf for a minimum of 24 hours or longer, if required, for the herbicide to dry on the turf. Most pesticide applications dry on the turf within 60 minutes so the 24 hour reentry interval actually provides a large safety margin.

Some granular pesticides also require a re-entry interval following application so the label must be read and understood in order to comply with the law. Granular pesticides which are designed to be applied to the soil may require an irrigation or rainfall event of greater than 1/4" water before the area may be entered. Weed and feed products, or any fertilizer which contains a pesticide, must be considered and treated as a pesticide. Weed and feed products designed to control soil borne pests or provide pre-emergent weed control can be useful for turf areas if the product is properly watered in following application and before children are allowed on the area. Weed and feed products designed to stick to the foliage for post-emergent weed control should not be used in areas children or adults are likely to run or play in, as the granules which contain the pesticides need to rest on the leaf surfaces in order to be effective, yet are easily dislodged by contact. Dislodging the weed and feed products before the herbicide has been absorbed negates the usefulness of the application and may increase the potential exposure to the herbicide.

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Weed Management

Level A athletic fields have a threshold population of no more than 5% weeds. Use the transect method to monitor the weed population at least once a year (see "Monitoring Weed Populations" in appendix). Note the type and location of the weeds in order to be able to use the appropriate control measures and time them appropriately. Weeds can be classified according to their life cycle. Annual weeds are those that complete their life cycle in one year and include crabgrass, common chickweed, and knotweed. Perennial weeds survive) for two years or more and include dandelion, mouse-ear chickweed, and ground ivy. Weeds are also classified botanically: dicots include all broadleaf weeds, while monocots include all grasses and sedges. It is important to understand which type of weed you are dealing with since management options will vary. The type of weeds present can indicate an underlying problem that cultural management may be able to control. For example, the presence of knotweed (Polygunum aviculare) is indicative of compacted soils while an abundance of clover (Trifolium repens) is typical in areas with low fertility. Annual weeds such as crabgrass may not require chemical control providing plans are followed to increase turf density in the autumn when the annual weeds die off, while perennial weeds such as quackgrass or plantain may require specific herbicides for control. By law, noxious weeds must be removed. Noxious weed species vary according to federal, state and local ordinances.

Herbicides are a special class of pesticides used to kill weeds. In general, chemical controls should be used as a last line of defense in an integrated pest management program in order to obtain an acceptable turf. Good management practices can be followed although weeds may still increase in number over a period of months or years which will necessitate another herbicide application.

Non-chemical Control
Non-chemical control of weeds includes good management practices and should be the first line of defense in any IPM program. Proper turf management including mowing and fertilization practices can reduce potential weed populations 70% or more. Control minor weed infestations by hand-pulling. Biological controls relying on microbes are currently in development for a few weeds such as annual bluegrass (Poa annua) but are not proven techniques and therefore are not commercially available.

Chemical Control
Herbicide selection should be based on several factors: ability to control the target weed(s), relative safety (both to the applicator and the environment), formulation (ester forms are more effective than salt-based amines during cool periods but can cause phytotoxicity and are more likely to drift during hot, dry periods), and cost. Apply herbicides when children are not present (e.g., after school, weekends). Spot spraying, though sometimes more time-consuming than broadcast application, uses less product which results in less chance for drift and the resulting non-target damage and less potential environmental contamination.

Granular formulations of herbicides work well when applied as pre-emergent herbicides for control of annual weeds but are relatively ineffective when applied to the foliage of existing weeds as a weed-and-feed application. Use a drop spreader instead of a rotary spreader to apply granular fertilizers if the site is near surface water, a play or natural area, or concrete or asphalt area to prevent the herbicide from moving off the target site. Apply liquid herbicides for control of existing weeds (post-emergent application) since liquid herbicides provide better coverage and are typically more effective at controlling existing weed, than granular applications. If a boom sprayer is used to apply liquid

herbicides, consider using a shield around the boom to minimize potential spray drift. Always read the label prior to applying any herbicide-labels are subject to change annually.

Disease Management

Although dozens of diseases can affect turf grass, there are less than six that typically affect athletic fields. The most common diseases are listed in the insect and disease management section with brief descriptions of the disease and potential management strategies. Due to the difficulty of properly identifying diseases and the differences in proper chemical controls, seek professional advice whenever a disease seems likely to become a significant problem or a chemical control is being considered.

Generally, appropriate fertility and irrigation will keep disease problems to a minimum. Plant a mix of species and include at least three cultivars of each species to take advantage of the different disease tolerant/resistances of each variety or species. Call your local extension agent to request the latest information regarding species and cultivar selection.

Insect Management

Turf insects are discussed in depth in the turf insect section of the manual. Insect problems on athletic fields in Iowa are rare but may occur periodically; many fields may never have an insect problem. Other states may have severe and constant insect problems on athletic fields. In Iowa, only white grubs, cutworms, and perhaps chinch bugs are likely to occur on turf, in this order. On level A fields broadcast application of insecticides may be warranted based on scouting reports which indicate sufficient pest activity exist (numeric thresholds have been established for some insect pests, particularly white grub species). Severe turf loss may occur if infestations are not treated. An appropriate bacterium for white grub control should be used instead of conventional insecticides if trained personnel are available for the applications as the application needs to be conducted properly if it is to succeed

Vertebrate Management

Vertebrate problems are likely to consist of rodent holes or occasionally skunks rooting for grubs. Rodent holes should be filled with suitable soil and overseeded or sodded. Rodents need to be controlled to prevent new holes. See appendix for suitable vertebrate control measures. Refer to the vertebrate section of the manual for specific information.

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Level B Athletic Field
IPM Action Points

- Mowing - Mow the turf at a 2 - 1/2 to 3 inch height at least once weekly. If possible, comply with the "1/3 rule".
- Irrigation - Irrigation will only be used to restore damaged turf areas.
- Fertilization - Apply a minimum of 4.5 pounds of nitrogen per thousand square feet annually to low use fields with light to medium traffic. Higher use fields may require six or more pounds of nitrogen per thousand square feet. Do not apply more than 1.5lb. N/M at any one time.
- Aerification - Aerification should be performed (once in spring and once in autumn.
- Topdressing - Topdressing should be concentrated in the center and other problem wear areas in the field.
- Overseeding - Thin areas in which the turf density provides less than 70% coverage should be overseeded as needed.

Level B athletic fields include general use and practice fields. These fields have moderate to good turf (> 70% cover) with up to 30% of the surface covered by weeds but no more than 10% bare ground. The soil type is native soil. Surface drainage generally provides all the drainage; native soil and lack of tiling preclude internal drainage. The field must provide a uniformly smooth surface (no major ruts, rapid divot repair, etc.) and an appropriate turf which will sustain a high level of traffic. No limits are placed on the number of events the turf will support but good management practices should be used to prevent unnecessary rotation of practice areas, proper mowing and fertilizing, etc.).

Primary cultural practices for Level B athletic fields include regular mowing and fertilization. Irrigation is used only for restoration or establishment. Secondary cultural practices include occasional aeration, topdressing, and overseeding or sodding to replace worn areas. Use of chemicals to control or manage weed and insect pests is allowed as part of an overall integrated pest management program.

Mowing

Mow the turf at a 2-1/2 to 3" height at least once weekly. This may or may not comply with the "1/3 rule" which states one-third or less of the leaf tissue is removed at any one mowing. During periods of rapid foliar growth (i.e., spring), clumps of turf may occasionally be present on the turf surface. When possible, mowing should be conducted frequently enough to comply with the 1/3 rule, realizing this may reduce weed populations and subsequent herbicide use at later dates. Clippings will not be collected but will be allowed to decompose on the turf.

Irrigation

Irrigation will only be used to restore damaged turf areas, whether seeded or sodded.

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Fertilization

Apply a minimum of four pounds of nitrogen per thousand square feet (4.5 lb. N/M) annually. Do not apply more than 1 lb. N/M at any one time. Use fertilizers with approximately 30-50% slowly available N (Table 6). Have the soil tested every 3 years.

Aerification

Aerify level B athletic fields once in the spring (May) and once in the fall (September, early October) when the grass is actively growing. Severely compacted soils may require additional aerification.

Topdressing

Topdress the fields as needed to maintain a crown and repair ruts or other irregularities in the field. Topdressing will not be applied uniformly across the field on level B athletic fields, but will be concentrated in the center and other problem wear areas.

Overseeding

Overseed worn or thin areas as needed to prevent weed encroachment and avoid excessive compaction and soil erosion. Fields need not be irrigated following overseeding unless an area is large enough (greater than 1 ft^2) to be considered "under repair".

Use Kentucky bluegrass (Poa pratensis) and/or perennial ryegrass (Lolium perenne) for overseeding. Kentucky bluegrass plants form rhizomes (underground lateral shoots) which are important for providing traction and allow the plant to fill in bare areas, while perennial ryegrass germinates quickly (3-5 days) and can provide quick cover. Since ryegrass plants may not provide the most footing and are less winter tolerant than Kentucky bluegrass, ryegrass should not compose more than 15% of a Kentucky bluegrass/perennial ryegrass seed mixture or a turf of predominantly ryegrass will result.

Seeding rates will vary depending on the amount of area exposed and the seed mix used. Seeding rates range from approximately 1/2 lb, per thousand square feet when used as a maintenance overseeding to turf which has 95% or higher cover, to 2-3 lbs per thousand square feet when more than 25% of the soil is exposed in an area.

Areas which are overseeded or sodded will require addition of a starter fertilizer (1-2-1 ratio of N-P-K) which is high in phosphorus to promote establishment. In general, apply one to two applications of starter fertilizer over a three to eight week period, supplying approximately ¾ -l lb. N/1 000 ft^2 each time. Irrigate the area as needed to promote seedling or sod establishment.

Pest Management

Proper turf management will greatly reduce the need for pesticides by providing dense, healthy turf that will crowd out weeds and tolerate moderate levels of disease, insect, or vertebrate damage. In integrate d pest management, pesticides are used only when pests damage the turf up to or past a pre-determined threshold level despite proper conventional management techniques.

When pesticides are applied to turf, the area should be fenced in or at least marked with pesticide application flags ("posting") until the product has dried and the reentry interval listed on the product label has passed. If no reentry intervals are listed on the label, keep people off the turf for a minimum of 24 hours or longer, if required, for the herbicide to dry on the turf. Most pesticide applications dry on the turf within 60 minutes so the 24 hour reentry interval actually provides a large safety margin.

Some granular pesticides also require a re-entrv interval following application so the label must be read and understood in order to comply with the law. Granular pesticides which are designed to be applied to the soil may require an irrigation or rainfall event of greater than 1/4" water before the area may be entered. Weed and feed products, or any fertilizer which contains a pesticide, must be considered and treated as a pesticide. Weed and feed products designed to control soilborne pests or provide pre-emergent weed control can be useful for turf areas if the product is properly watered in following application and before children are allowed on the area. Weed and feed products designed to stick to the foliage for post-emergent weed control should not be used in areas children or adults are likely to run or play in, as the granules which contain the pesticides need to rest on the leaf surfaces in order to be effective, yet are easily dislodged by contact. Dislodging the weed and feed products before the herbicide has been absorbed negates the usefulness of the application and may increase the potential exposure to the herbicide.

Weed Management

Level B athletic fields have a threshold population of no more than 30% weeds. Use the transect method to monitor the weed population (see "Monitoring Weed Populations" in appendix) at least once a year. Note the type and location of the weeds in order to be able to provide the appropriate types of control measures at the best times.

Disease Management

Although dozens of diseases can affect turfgrass there are less than six which typically affect athletic fields. The most common diseases on level B athletic fields will be rust, leafspot, necrotic ring spot, and occasionally red thread. Due to the low likelihood of diseases causing severe damage on a level B athletic field turf, combined with the relatively high cost and concern surrounding pesticide use, level B athletic fields should not be sprayed to control turfgrass diseases.

Insect Management

On level B athletic fields, insects will not be monitored. Due to the less dense nature of the turf compared to level A athletic fields, cutworm and chinch bug damage will not likely to be of sufficient severity to warrant control. Spot treatments of insecticides may be required but should be used only when the infestations are severe and major turf loss may be expected in the absence of control measures.

Vertebrate Management

Vertebrate problems are likely to consist of rodent holes or occasionally skunks rooting for grubs. Rodent holes should be filled with suitable soil and overseeded or sodded. Rodents need to be controlled to prevent new holes. See appendix for suitable vertebrate control measures. Refer to "vertebrate pests" section in manual for further information.

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Level C Athletic Fields

IPM Action Points

- mowing - Mow the turf at a 2 - 1/2 to 3 inch height at least at seven to 1 0 day intervals. If possible, comply with the "1/3 rule".
- Irrigation - Irrigation will only be used to restore damaged turf areas.
- Fertilization - Fertilization rates will vary from 0, o 2 pounds of nitrogen annually per 1000 square feet.
- Aerification - Aerification will likely be once a year.
- Topdressing – Level C fields will not be topdressed.
- Overseeding - Level C fields generally will not be overseeded. Large bare areas may need to be overseeded.

Level C athletic fields include elementary fields and practice areas at primary and secondary schools. See map areas marked C. These fields have poor to moderate turf with 50% or more of the surface covered by weeds. A fair portion of the fields may be bare ground but this should be kept to no more than 10% bare ground for safety reasons. The soil type is native soil. Surface drainage generally provides all the drainage; native soil and lack of tiling preclude internal drainage. The field should have a relatively smooth surface (no major ruts, rapid divot repair, etc.) for safety reasons. No limits are placed on the number of events the turf will support but common sense should be used to prevent unnecessary damage (e.g., rotation of practice areas, regular mowing).

Primary cultural practices for Level C athletic fields include regular mowing and fertilization. Irrigation is used only for restoration or establishment. Secondary cultural practices may, but are not likely to, include overseeding or sodding to replace worn areas. Pesticides to control weeds, diseases or insects will generally not be used.

Mowing

Mowing will be conducted on a less frequent basis than level A and B turf. Mowing should be conducted at least at seven to 10 day intervals, particularly when the grass is actively growing in the spring and early autumn. Mow the turf at a 3" height. This may or may not comply with the "1/3 rule" which states one-third or less of the leaf tissue is removed at any one mowing. During periods of rapid foliar growth rate (i.e., spring), clumps of turf may occasionally be present on the turf surface. Clippings will not be collected but will be allowed to decompose on the turf.

Irrigation

Irrigation will not be expected on level C fields.

Fertilization

Fertilization rates will vary from 0 to 2 lbs of nitrogen annually per 1000 ft^2. Rates will vary depending on the type of turf present (fescue versus ryegrass or traffic levels will require some fertility to be applied), level of turf quality desired, and other factors. Some fertilizer will have to be applied periodically in order to maintain a balanced population of weeds and turf. It may be possible to skip a fertilizer application in a given year although fertilization should not be skipped for multiple years. Do not apply more than 1

lb. N/M at any one time. Fertilization should be applied during autumn and/or late spring. Use fertilizers with approximately 30-50% slowly available N (Table 9).

Aerification

Aerify level C when the grass is actively growing. Severely compacted soils may require additional aerification.

Topdressing

Level C athletic fields and areas will not be topdressed, although an occasional rut or rodent hole may need to be filled in with soil.

Overseeding

Level C fields will not be overseeded as a rule, although occasionally large bare areas may need to be overseeded if damaged by vehicles or other forces. Level C fields and areas need not be irrigated following overseeding.

Seeding rates will vary depending on the amount of area exposed and the seed mix used. Seeding rates will vary from approximately ½ lb. per thousand square feet when used as a maintenance overseedinq to turf which has 95% or higher cover, to 2-3 lbs per thousand square feet when more than 21 % of the soil is exposed in an area.

Sodding is a faster method of establishment but not recommended for level C areas due to higher cost than seed and the need to irrigate the sod frequently for up to two or three weeks during establishment.

Pest Management

Proper turf management is the largest component o f pest management. Best management practices will greatly reduce the need for pesticides by providing dense, healthy turf which will crowd out weeds and tolerate moderate levels of disease, insect, or vertebrate damage. On level C athletic fields and areas, turf management practices will likely not be ideal, but a greater level of pests and poorer turf will be tolerated. Pesticides will not be applied except in emergency situations.

Weed Management

Level C athletic fields have a threshold population of 50% or more weeds on a surface area basis. Weed populations and types generally will not need to be monitored, except for the presence of noxious weeds which, by law, must be destroyed. Noxious weed species vary according lo federal, state and local ordinances

Disease Management

Although dozens of diseases can affect turfgrass there are less than six which typically affect athletic fields and high traffic areas. The most common diseases on level C athletic fields will be rust, leafspot, necrotic ring spot, and occasionally red thread. Due to the low likelihood of diseases causing severe damage on a level C athletic field turf,

combined with the low level of expectation for turf quality and the relatively high cost and concern surrounding pesticide use, level C athletic fields should not be sprayed to control turfgrass diseases.

Insect Management

Insect problems on athletic fields in Iowa are rare but may occur periodically; many fields may never have an insect problem. Other states may have severe and constant insect problems on athletic fields. In Iowa, only white grubs, cutworms, and perhaps chinch bugs are likely to occur on turf, in this order. On level C athletic fields and areas, insects will not be monitored. Due to the less dense nature of the turf compared to level A or B athletic fields, insect damage thresholds will not likely be of sufficient severity to warrant control.

Vertebrate Management

Vertebrate problems are likely to consist of rodent holes or occasionally skunks rooting for grubs. Rodent holes should be filled with suitable soil and overseeded or sodded. Rodents need to be removed or otherwise controlled to prevent new holes. Refer to the vertebrate section of the manual for specific information.

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Landscape Area A: Ornamentals and Turf

IPM Action Points

Ornamentals

- Pruning - Remove dead, damaged, or diseased limbs as necessary during the dormant season. Prune for form every 3-6 years.
- Irrigation - water all newly planted trees with 1 inch of water per week for the first 2 years. Water perennial plants with 1 inch of water weekly.
- Mulching - mulch trees, shrubs, and perennial beds to conserve water and moderate soil temperature.
- Fertilization - fertilize trees and shrubs annually in the spring. Use a slow release granular fertilizer at planting for flowers.

Turf

- Mowing - Mow the turf at a 2 - 1/2 to 3 inch height at least once weekly. If possible, comply with the "1/3 rule". During hot, droughty summer periods, the mowing frequency may be reduced.
- Irrigation - Irrigation will not be supplied except if desired for restorative purposes.
- Fertilization - Apply at most 2 pounds of nitrogen per thousand square feet annually. Do not apply more than 1 lb. N/M at any one time.
- Aerification - Aerification is not needed unless the area is under heavy traffic.
- Topdressing - Topdressing is not necessary in landscape turf areas.
- Overseeding - Ornamental turf areas will gene rally not need to be overseeded as there will be little wear damage.

Ornamentals

Ornamental landscape areas are highly visible areas associated with a school. This category includes trees, shrubs, ground covers, and annual and perennial flowers. It is important to properly identify all plants in this landscape area and become familiar with their specific requirements. The most common pest problems will be caused by insects, diseases, and environmental stresses. The level of weeds is generally not a consideration since beds will be mulched or have weed barriers in place to reduce weed pressure.

In any landscape IPM program, it is important to maintain the balance of nature by preserving diversity and encouraging harmonious coexistence of plants in the landscape, i.e. group plants together that have similar requirements. It is best to use plants that are suited to Iowa's climate and soil types. Plants should require little maintenance.

Key Plants

Not all plants in the landscape will require the same level of care. Key Plants are those plants that provide aesthetic or functional attributes to the landscape's value or are more likely to suffer from serious, annual problems that will dominate your control practices. These are the plants that will require more time and money to maintain. Perhaps they are at the main entrance to the building or some other visually-prominent area. There are 1 0 groups of woody landscape plants that can be considered key plants: birch, crabapples,

dogwoods euonymus, junipers, maples, oaks, pines, flowering plums, and any plant in the rose family.

Horticultural Practices

Over 50% of the problems associated with landscape plants are not attributable to insects or diseases but are the result of various environmental stresses. Some common causes of plant stress include drought, poor drainage, temperature extremes, nutrient imbalances, transplant shock, deicing salt injury, and air pollution. Stress related problems are easily prevented through proper site selection and cultural management practices that provide the plant with all of the necessary requirements for optimal growth such as proper pruning , watering during dry periods and fertilizing on a regular basis. Providing a plant, with all of its basic requirements will also help it withstand attack by plant diseases and pest insects. Each of these requirements will now be discussed.

Pruning

Pruning to remove dead, damaged or diseased limbs is essential. Except in emergency situations, pruning is generally done during the dormant season - winter in Iowa. This will prevent the spread of diseases or the attraction of insect pests to the wound sites. Pruning schedules vary but a routine schedule of every 3-6 years is suitable to most situations

Irrigation

All newly planted trees and shrubs will require regular watering throughout the first two years in their new site. This will help the plant overcome the stress of transplanting without succumbing to pest problems. After the first two years, irrigation is only necessary during dry periods. Other plants such as annual and perennial flowers will require 1 inch of water per week either by rain or irrigation.

Fertilization

Trees and shrubs should be fertilized annually either in early spring or late fall after the leaves have dropped. Avoid fertilizing woody plants after July 1 and before November 1 as this will delay the plant's hardening- off response and may make the plant less winter-hardy. Deep root feeding is the best method since it delivers the fertilizer in the root zone and out of the reach of turf roots. Root fertilizers are available at most hardware stores and garden centers. Many landscape maintenance companies also offer this service. Keep in mind that most of the roots that are capable of taking up fertilizer are located in the top 2 feet of soil within the drip line of the tree - generally the area below the canopy of the tree. Use a fertilizer high in nitrogen and apply 1-2 pounds (1-2 pints if using a liquid) of fertilizer per inch of trunk diameter.

Flowers should also be fertilized. The use of a slow-release granular fertilizer at planting time will provide the plants with the necessary nutrients all season long. Mulching beds with bark mulch will provide a constant source of slow-release, natural fertilizer at no additional cost.

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Turf

These are highly visible lawns surrounding school buildings, primarily in the front of the building which are easily viewed by visitors, students, and passers-by. High quality turf is expected to maintain a school's image which may affect both public perception and student conduct. Up to 15% of the turf surface may be composed of weeds, but less than 10% of the turf surface should be bare soil; the remaining 75% or more of the area should be turfgrasses. Mowing will be conducted on a regular basis and irrigation may be used. Pest control measures may be periodically applied. If children regularly gather on these areas, these areas may more appropriately be level B landscape areas. With children regularly in these areas, all of the turf management practices in this section may be used to keep a high turf quality, but pesticide use should be limited and avoided if at all possible.

Mowing

Turf should be mowed at least once weekly during periods of active growth. During hot, droughty summer periods mowing frequency may be reduced. Clippings should be returned and allowed to decompose into the turf. The 1/3 rule should be followed whenever possible, this will reduce the amount of clippings on the turf and enhance the stress tolerance of the turf. The 1/3 rule states that "no more than 1/3 of the height of the turf foliage should be removed at any single mowing", e.g., if the grass is 3 inches tall, the mower should be set at 2" or higher.

Irrigation

Irrigation may or may not be supplied, depending on availability and level of turf quality desired. Most turf require approximately 1" of water weekly in the form of rainfall or irrigation.

Fertilization

A thick turf resulting in part from proper fertilization can significantly reduce weed populations. Apply three to four pounds of nitrogen per thousand square feet (3-4 lb.N/M) annually (Table 10). Do not apply more than 1 lb. N/M of a rapidly available nitrogen source at any one time. If a 100% organic or other slow release fertilizer is used, then the total application may be as high as 2 lb. N/M. Generally, fertilizers with approximately 30-50% slowly available N should be used (Table 10).

Aerification

Aerification is used to aid drainage, alleviate compaction, disrupt incompatible soil layers manage thatch, and promote turf growth, particularly rooting (Turgeon, 1998). The vigorous growth which results from aerification increases the turf s stress tolerance, improves nutrient uptake, and can reduce weed invasion. Landscape Level A turf areas will likely be aerified once per year to minimize compaction effects.

Topdressing

Athletic fields require topdressing to maintain a uniform surface for safety and playability reasons and to maintain a crown which is imperative for surface drainage. Turf

landscape areas generally will not require topdressing, although an occasional rut or rodent hole may need to be filled in with soil.

Overseeding

Overseeding is performed to help thicken the turf stand to provide safer turf, avoid excessive compaction, minimize soil erosion, and inhibit weed encroachment. Ornamental turf areas will generally not need to be overseeded as there will be little wear damage and proper turf management will keep pest-related problems to a minimum.

Sodding is a faster method of establishment than seeding but generally not recommended for ornamental turf areas due to higher cost than seed and the need to irrigate the sod frequently for up to two or three weeks during establishment.

Pest Management

Proper turf management will greatly reduce the need for pesticides by providing dense, healthy turf which will crowd out weeds and tolerate moderate levels of disease, insect, or vertebrate damage. In integrated pest management pesticides are used are used only when pests damage the turf up to or past a pre- determined threshold level despite proper conventional management techniques.

When liquid pesticides are applied to turf, the area should be fenced in or at least marked with pesticide application flags until the product has dried and 24 hours have elapsed. Some herbicide labels will contain specific reentry intervals. If no reentry intervals are listed on the label, keep people off the turf for a minimum of 24 hours or longer if required for the herbicide to dry on the turf. Most pesticide applications dry on the turf within 60 minutes so the 24-hour reentry interval actually provides a large safety margin.

Some granular pesticides also require a re-entry interval following application so the label must be read and understood in order to comply with the law. Granular pesticides which are designed to be applied to the soil may require an irrigation or rainfall event of greater than 1/4" water before the area may be entered. Weed and feed products, or any fertilizer which contains a pesticide, must be considered and treated as a pesticide. Weed and feed products designed to control soilborne pests or provide pre-emergent weed control can be useful I for turf areas if the product is properly watered in following application and before children are allowed on the area. Weed and feed products designed to stick to the foliage for post-emergent weed control should not be used in areas children or adults are likely to run or play in, as the granules which contain the pesticides need to rest on the leaf surfaces in order to be effective, yet are easily dislodged by contact. Dislodging the weed and feed products before the herbicide has been absorbed negates the usefulness of the application and may increase the potential exposure to the herbicide.

Weed Management

Level A turf landscape areas have a threshold population of up to 15% weeds. Weed populations should be monitored at least twice a year to determine the effectiveness of current cultural practices against weed encroachment. Weed population can be monitored using the transect method (see "Monitoring Weed Populations" in appendix). Note the type and location of the weeds in order to be able to use the appropriate control measures and time them appropriately. Weeds can be classified according to their life

cycle. Annual weeds are those that complete their life cycle in one year and include crabgrass, common chickweed, and knotweed. Perennial weeds survive for two years or more and include dandelion, mouse-ear chickweed, and ground ivy. Weeds are also classified botanically: dicots include all broadleaf weeds, while monocots include all grasses and sedges. The type of weeds present can indicate an underlying problem which cultural management may be able to control. For example, the presence of knotweed (Polygunum aviculare) is indicative of compacted soils while an abundance of clover (Trifolium repens) is typical in areas with low fertility. Annual weeds such as crabgrass may not require chemical control providing plans are followed to increase turf density in the autumn when the annual weeds die off, while perennial weeds such as quackgrass or plantain may require specific herbicides for control. Certain weed species are classified as noxious weed; and by law must be removed. (See federal noxious weed list in appendix).

Herbicides are a special class of pesticides used to kill weeds. In general chemical controls should be used as a last line of integrated pest management in order to obtain an acceptable turf. Good management practices can be followed although weeds may still increase in number over a period of months or years which will necessitate another herbicide application. (See appendix for a listing of herbicides and weeds controlled).

Non-chemical control

Non-chemical control of weeds includes good management practices. Proper turf management including mowing and fertilization practices can reduce potential weed populations 70% or more. Control minor weed infestations by hand-pulling. This is more practical for small areas than for large areas. Biological controls relying on microbes are currently in development for a few weeds such as annual bluegrass (Poa annua) but are not yet ready for commercialization or are not proven techniques.

Chemical control

Pesticide selection, including herbicides, should be based on several factors: ability to control the target weed(s), relative safety (both to the applicator and to the environment), formulation (ester forms are more effective than salt-based amines during cool periods but can cause phytotoxicity and are more likely to drift during hot, dry periods), and cost. Apply herbicides when children are not present (e.g., weekends or during the summer when school is not in session). Although the timing may not be the most appropriate for killing weeds, the allowance of up to 15% weeds and the idea of integrated pest management does not require complete control. Whenever possible, weeds should be spot treated rather than having a broadcast application over the entire turf area. Broadcast applications may be appropriate when the weed pressure is high and the weeds are randomly or uniformly distributed over a large area. Spot spraying, though sometimes more time consuming than broadcast application, uses less product which results in less chance for drift and the resulting non-target damage and less potential environmental contamination. Granular formations of herbicides work well when applied as pre-emergent herbicides for control of annual weeds but are relatively ineffective when applied to the foliage of existing weeds as a weed-and-feed application. Use a drop spreader instead of a rotary spreader to apply granular fertilizers if the site is near surface water, a play or natural area, or concrete or asphalt area to help prevent getting herbicide off the target site. Apply liquid herbicides for control of existing weeds (post-emergent application) since liquid herbicides provide better coverage and are typically more effective a controlling existing weeds than granular applications. If a boom sprayer is used to apply liquid herbicides, consider using a shield around the boom to minimize

drift. Always read the label prior to applying any herbicide - labels are subject to change annually. Applications which don't adhere to label requirements are illegal and subject to persecution by law.

Disease Management

Although dozens of diseases can affect turfgrass there are less than six which typically affect lawns to any significant degree. The most common diseases are listed in the turf diseases section with brief descriptions of the disease and potential management strategies. Due to the difficulty of properly identifying diseases and the differences in proper chemical controls, seek professional advice whenever a disease seems likely to become a significant problem or a chemical control is being considered.

Generally appropriate fertility and irrigation will keep disease problems to a minimum. Plant a mix of species and include at least three cultivars of each species to take advantage of the different disease tolerances/resistances of each variety or species. Call your local extension agent to request the latest information regarding species and cultivar selection.

Insect Management

Insect problems on turf lawns in Iowa are rare but may occur periodically; many lawns may never have a serious insect problem. Lawns in other states may have severe and constant insect problems. In Iowa, only white grubs, cutworms, and perhaps chinch bugs are likely to occur on turf, in this order. (Will list insecticides, incl. Biologicals, in appendix).

Vertebrate Management

Vertebrate problems are likely to consist of rodent holes or occasionally skunks rooting for grubs. Rodent holes should be filled with suitable soil and overseeded or sodded. Rodents need to be removed or otherwise controlled to prevent new holes. Refer to the vertebrate section of the manual for specific information.

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Landscape Area B: Turf

IPM Action Points

- Mowing - Mow the turf at a 2 - 1/2 to 3 inch height at least once weekly. If possible, comply with the "1/3 rule". During hot, droughty summer periods, the mowing frequency may be reduced.
- Irrigation - Irrigation is not necessary. If irrigation is used during a drought, it should continue by rainfall or irrigation throughout the rest of the summer because the grass may not have enough energy reserves to handle two droughts in one summer.
- Fertilization - Apply three to four pounds of nitrogen per thousand square feet annually. Do not apply more than 1 lb. N/M at any one time.
- Aerification - Aerification is not needed unless the area is under heavy traffic.
- Topdressing - Topdressing is not necessary in landscape turf areas.
- Overseeding - Ornamental turf areas will generally not need to be overseeded as there will be little wear damage.

These are not highly visible lawns around school buildings and are often on the sides or in the back of the building. Depending on the school, especially elementary schools, all of the general purpose turf may be classified as Landscape Area B turf. Low to moderate quality turf will generally satisfy all expectations of Landscape Area B turf. Up to 50% or more of the turf surface may be composed of weeds; individual schools should set their own standards for Landscape Area B turf. Mowing will be conducted on a regular basis and the area may occasionally be fertilized. Generally other cultural practices will not be used. Pesticides will rarely if ever be applied.

Mowing

Turf should be mowed at a 3 inch height approximately every week during periods of active growth. During hot, droughty summer periods the mowing frequency may be reduced. Clippings should be returned and allowed to decompose into the turf. The 1/3 rule should be followed whenever possible, but is less crucial than with Landscape Area A turf. The 1/3 rule states that "no more than 1/3 of the height of the turf foliage should be removed at any single mowing", e.g., if the grass is 3 inches tall, the mower should be set at 2" or higher. (Refer to appendix for additional information on mowing and related items).

Irrigation

Irrigation will not be supplied except if desired for restorative purposes.

Fertilization

A thick turf resulting in part from proper fertilization can significantly reduce weed populations. However, due to the low quality expected for Landscape Area B turf, little to no fertilizer is expected. At most, no more than 2 lbs N per 1000 ft2 should be applied annually. (Table 12) Some fertilizer will have to be applied periodically in order to maintain a balanced population of weeds and turf. It may be possible to skip a fertilizer application in a given year although fertilization should not be skipped for multiple years or the turf may be overtaken by weeds with areas of bare soil which will be subject to

erosion and runoff. Do not apply more than 1 lb. N/M at any one time. Fertilization should be applied during autumn and/or late spring. (Table 12) Use fertilizers with approximately 30-50% slowly available N. (Table 13) Apply with a properly calibrated and functioning fertilizer spreader to obtain a uniform distribution. If a drop spreader is used, apply at half the desired rate but in two perpendicular directions. (For additional information on fertilizer application, see "Calibration" section in appendix). Fertilize shortly before or during rainfall to help move the fertilizer into the soil and prevent phytotoxicity. Have the soil tested every 3 years to check on needed phosphorus and potassium inputs. Otherwise, use a fertilizer which supplies at least a 2:1 ratio of nitrogen to potassium. Since phosphorus is requirements are significantly less than nitrogen or potassium, little to no phosphorus is usually required unless indicated by a soil test. Other nutrients are rarely if ever limiting and should not need to be applied.

Aerification

Aerification is used to aid drainage, alleviate compaction, disrupt incompatible soil layers, manage thatch, and promote turf growth, particularly rooting. The vigorous growth which results from aerification increases the turf's stress tolerance, improves nutrient uptake, and can reduce weed invasion. Landscape Level B turf areas will likely never be aerified, although trafficked areas could occasionally be aerified (once every year or so) to minimize compaction effects.

Topdressing

Athletic fields require topdressing to maintain a uniform surface for safety and playability reasons and to maintain a crown which is imperative for surface drainage. Turf landscape areas generally will not require topdressing, although an occasional rut or rodent hole may need to be filled in with soil.

Overseeding

Overseeding is performed to help thicken the turf stand to provide safer turf, avoid excessive compaction, minimize soil erosion, and inhibit weed encroachment. Ornamental turf areas will generally not need to be overseeded as there will be little wear damage and proper turf management will keep pest-related problems to a minimum.

Sodding is a faster method of establishment than seeding but generally not recommended for ornamental turf areas due to higher cost than seed and the need to irrigate the sod frequently for up to two or three weeks during establishment.

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Landscape Area C: Naturalized Areas

These include native plantings and prairie restoration projects. These areas will not require nearly the level of care of conventional turf areas. Mowing may be necessary once every two or more years to prevent woody plants from overtaking the area; some locales will allow burning. In the future, additional research results may suggest a better frequency or alternative measures for controlling the spread of woody and other non-desirable species (thistle, sweet vernal) in naturalized plantings. It is important to closely monitor naturalized areas for the invasion of non-native plants. Honeysuckle and buckthorn are two extremely invasive shrubs that have been displacing native understory plants in Iowa woodlands. Garlic mustard and purple loosestrife are invasive herbaceous plants. Elimination of these non-native plants is necessary to prevent their becoming established in natural areas. The naturalized area should not be close to buildings due to the likelihood of field mice and other rodents living in the area which may be attracted to buildings, particularly during cold weather.

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Miscellaneous Areas A, B, and C

IPM Actions Points

These areas include non-turf areas such as playground cribs, fence lines, and parking lots.

- Pulling or weed whacking weeds is a preferred method of control
- Burning weeds may be an option to parking lots
- If pesticides are used, glyphosate (Round-up) is preferred, and should only be used when children will not be present, preferably for a few days.

Miscellaneous Area A

Miscellaneous area A includes playground cribs with a perimeter fall zone. Weed barriers (e.g., landscape fabrics) should be used to underlay the mulch when the cribs are built. Suitable mulch includes wood, pea gravel, sand, rubber chips and rubber mats. Wood and rubber mulches may provide the softest landing surfaces, but wood, while inexpensive, may also increase weed and insect problems. Shredded bark mulch should be avoided because it rapidly disintegrates. Sand will also harbor weeds but fewer insects than wood. Crumb rubber and rubber mats offer the least amount of weed infestation but are expensive. Weeds can also be expected to grow at the interface of the mulch and the side rails (often wood timbers) used to contain the crib. Weeds should be hand pulled or removed using a weed whacker. When school is out of session, limited use of an herbicide may be considered to reduce hard to control weeds such as Canada thistle, which cannot be controlled by hand pulling or cutting due to their underground storage organs and creeping growth habits. Fencing the areas during pesticide application and during the restricted reentry period may be necessary. Weeds may also be controlled by periodic restoration of the crib.

Miscellaneous Area B

Miscellaneous area B includes areas under fences, bleachers and other structures. Turf may or may not be present or desired.

Cultural practices for pest management. Use hand weeding or weed wackers to minimize pesticide use. If the surface is blacktop, cracks should be sealed regularly. On asphalt, weeds may be burned with torches--this is more effective for annual weeds than perennial weeds. Proper sanitation (garbage removal, cutting grass, etc.) should be conducted to minimize weed, insect and rodent problems. If a fence is not needed yet weeds are a problem, the fencing could be removed.

Chemical controls for pest management. If chemicals are used they should be applied when school is not in session (weekend or summer). Chemical weed control may provide much longer lasting weed control than hand weeding or weed whacking, particularly for perennial weeds. Glyphosate (Roundup, Kleenup), a foliar-applied post-emergent herbicide, could be applied once or more annually as needed and should be considered for use in play or grassy areas over prometon due to its shorter residual in soil and less toxic signal word. Prometon (Pramitol) is another non-selective herbicide designed primarily for industrial sites, rights-of-way, fence lines, etc. Prometon is meant to be applied to the soil to control weeds both pre- and post-emergent. It is also useful for applying directly to, or mixing in with, asphalt to prevent weeds. Prometon has much

longer residual activity than glyphosate and can control weeds for up to one year after application.

Miscellaneous Area C

Miscellaneous area C includes parking lots, blacktop play areas and sidewalks. Weeds in these areas should be controlled by physical removal (hand-pulling, weed whacking) when possible. For hard-to-control weeds including many perennials, glyphosate or prometon could be used; glyphosate is preferred because it is a less toxic product. Chemical control is most appropriate for blacktop parking lots due to the need to protect the large investment of these areas as weeds can cause crumbling of the blacktop as they emerge through small cracks or pores in the surface. Spot treatments are appropriate and should be performed when school is out of session. Glyphosate will need to be applied when the weeds are actively growing for best control; the ideal time is once the school year is finished in June.

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Outdoor Insect and Disease Management

Wasps and Bees
Turf Diseases:
- Dollar spot
- Fairy Ring
- Leafspot and Melting-out
- Necrotic Ring spot
- Powdery mildew
- Red thread
- Rust
- Brown Patch

Turf Insects
- White grubs
- Cutworms
- Chinch Bugs

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Outdoor Vertebrate Pest Management

Key to Small Mammals
Moles
Voles
Gophers
Ground Squirrels
Rabbits
Skunks
Canada Geese
Pigeons

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Indoor Pest Management

Rats and Mice
Ants
Cockroaches
Flies
Silverfish and Firebrats
Head Lice
Spiders
Occasional Invaders
Food Pests

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Introduction to the Pest Management Plan

The purpose of the pest management plan is to centralize all of the information of a school's pest management practices. This document explains the approach the school or district is taking towards pest control and what the school has and is currently doing. The purpose and content of the sections of this plan are discussed below:

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School Pest Management Policy Statement

Structural and landscape pests can pose significant problems for people and property. Pesticides can pose risks to people, property, and the environment. It is therefore the policy of the Cedar Falls Community School district to incorporate Integrated Pest Management (IPM) procedures for control of structural and landscape pests. The objective of this program is to provide necessary pest control while minimizing pesticide use.

Pest Management Plan

The Cedar Falls Community School district will manage pests to:

- Reduce any potential human health hazard or threat to public safety.
- Prevent lost or damage to school structures or property.
- Prevent pests from spreading into the community, or to plant and animal populations beyond the site.
- Enhance the quality of life for students, staff, and others.

These goals will be addressed by the establishment of a pest management plan.

IPM Coordinator

Schools should identify a person to serve as the IPM coordinator for the school or school district. This person will serve as a primary contact for pest control matters and will coordinate all pest control decisions for the school or school district. This individual will be responsible for maintaining records of pest sightings and pesticide use. This person will determine if the school's IPM policy is being followed correctly.

The Cedar Falls Community School District IPM coordinator, appointed by the superintendent, is the Supervisor of Buildings and Grounds. The coordinator will be responsible for implementing the IPM policy and plan. The coordinator's responsibilities will include the following:

- Recording all pest sightings by school staff and students.
- Recording all pesticide use.
- Meeting with the PCO to share information on what pest problems are present in the school.
- Assuring that all of the PCO's recommendations on maintenance and sanitation are carried out where feasible.
- Assure that any pesticide use is done when school is not in session or when the area can be completely secured against access by school staff and students.
- Evaluating the school's progress in the IPM plan.

Pesticide Applicators

Any person applying pesticides on school grounds must be trained and knowledgeable in the principles and practices of IPM. All use of pesticides must be approved by the Director of Business Affairs or the Supervisor of Buildings and Grounds. Applicators must follow state regulations and label precautions. Applicators must comply with the School IPM policy and Pest Management Plan.

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Selection of Pesticides

When pesticide use is necessary, the IPM coordinator must approve the pesticide for school use. The schools preferred pesticides for use are pesticide baits and pesticide sprays with the signal word of caution.

Notification

A notice will be provided to school staff, students, and parents at the beginning of each school year briefly explaining the school's pesticide use policy. It will indicate that pesticides may be used both indoors and outdoors, as needed. The school will provide, to the extent possible, notification of pending pesticide use to persons requesting the information.

Record Keeping

Records of pesticide use will be maintained by the IPM coordinator in accordance with the district's record retention policy. Records will be completed on the day of pesticide use. In addition, pest surveillance records will be maintained to help verify the need for pesticide treatments.

Education

Staff, students, pest managers, parents and the public will be informed about potential school pest problems, the IPM policies and procedures, and their respective roles in achieving the desired pest management objectives.

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Pest Management Procedures/Plan – EPA Recommendations

Indoor Sites

Typical Pests; Mice, rats, cockroaches, ants, flies, wasps, hornets, yellow jackets, spiders, microorganisms, termites, carpenter ants and other wood destroying insects. Although beneficial as predators, wasps, hornets, yellow jackets and spiders can be troublesome.

Entryways (doorways, overhead doors, windows, holes in exterior walls, openings around pipes, electrical fixtures, or ducts).

- Keep doors shut when not in use.
- Place weather stripping on doors.
- Caulk and seal openings in walls.
- Install or repair screens.
- Install air curtains.
- Keep vegetation, shrubs, and wood mulch at least 1 foot away from structures.

Classrooms and Offices (classrooms, laboratories, administrative offices, auditoriums, gymnasiums and hallways).

- Allow food and beverages only in designed areas.
- If indoor plants are present, keep them healthy; when small insect infestations appear, remove them manually.
- Keep areas as dry as possible by removing standing water and water-damaged or wet materials.
- In the science lab, store animal foods in tightly sealed containers and regularly clean cages. In all areas, remove dust and debris.
- Regularly clean lockers and desks.
- Frequently vacuum carpeted areas.
- If students get head lice, consult with your local health department and have their parents contact a physician. Discourage students from exchanging hats or caps at school.

Food Preparation and Serving Areas (dining room, main kitchen, teachers lounge, home economics kitchen, snack area, vending machines, and food storage rooms.)

- Store food and waste in containers that are inaccessible to pests. Containers must have tight lids and be made of plastic, glass, or metal. Waste should be removed at the end of each day.
- Place screens on vents, windows, and floor drains to prevent cockroaches and other pests from using unscreened ducts or vents as pathways.
- Create inhospitable living conditions for pests by reducing availability of food and water - remove food debris, sweep up all crumbs, fix dripping faucets and leaks, and dry out wet areas.
- Improve cleaning practices, including promptly cleaning food preparation equipment after use and removing grease accumulation from vents, ovens, and stoves. Use caulk or paint to seal cracks and crevices.

- Capture rodents by using mechanical or glue traps. (Note: Place traps in areas inaccessible to children. Mechanical traps, including glueboards, used in rodent control must be checked daily. Dispose of killed or trapped rodents within 24 hours.)

Rooms and Areas with Extensive Plumbing (bathrooms, rooms and sinks, locker rooms, dishwasher rooms, home economics, classrooms, science laboratories, swimming pools, and greenhouses.)

- Promptly repair leaks and correct other plumbing problems to deny pests access to water.
- Routinely clean floor drains, strainers, and grates. Seal pipe chases.
- Keep areas dry. Avoid conditions that allow formation of condensation. Areas that never dry out are conducive to molds and fungi. Increasing ventilation may be necessary.
- Store paper products or cardboard boxes away from moist areas and direct contact with the floor or the walls. This practice also allows for ease of inspection.

Maintenance Areas (boiler rooms, mechanical rooms, janitorial-housekeeping areas, and pipe chases.)

- After use, promptly clean mops and mop buckets; dry mop buckets and hang mops vertically on rack above floor drain.
- Allow eating only in designated eating areas.
- Clean trash cans regularly, use plastic liners in trash cans, and secure lids.
- Keep areas clean and as dry as possible, remove debris.

Outdoor Sites

Typical Pests; Mice and rats. Turf pests; broad leaf and grassy weeds, insects such as beetle grubs or sod web worms, diseases such as brown patch, and vertebrates such as moles. Ornamental plant pests, plant diseases, and insects such as thrips, aphids, Japanese beetles, and bag worms.

Playgrounds, Parking Lots, Athletic Fields, Loading Docks, and Refuse Dumpsters

- Regularly clean trash containers and gutters and remove all waste, especially food and paper debris.
- Secure lids on trash containers.
- Repair cracks in pavement and side walks. Provide adequate drainage away from the structure and on the grounds.

Turf (lawns, athletic fields, and playgrounds)

- Maintain healthy turf by selecting a mixture of turf types (certified seed, sod, or plugs) best adapted for the area. Check university or cooperative Extension service for recommendations on turf types, management practices, or other information.
- Raise mowing heights for turf to enhance its competition with weeds; adjust cutting height of mower, depending on the grass type; sharpen mower blades; and vary mowing patterns to help reduce soil compaction.

- Water turf infrequently but sufficiently during morning hours to let turf dry out before nightfall; let soil dry slightly between watering.
- Provide good drainage, and periodically inspect turf for evidence of pests or diseases.
- Allow grass clippings to remain in the turf (use a mulching mower or mow often) or compost with other organic material.
- Have soil tested to determine PH and fertilizer requirements.
- Use a dethatcher to remove thatch. Do this in early fall or early spring when the lawns can recover and when over seeding operations are likely to be more successful.
- Time fertilizer application appropriately, because excessive fertilizer can cause additional problems, including weed and disease outbreaks. Apply lime if necessary. Use aeration to place soil on top of thatch so microbes from soil can decompose thatch.
- Seed over existing turf in fall or early spring.
- Obtain more information on turf from EPA's brochure entitled, "Healthy Lawn, Healthy Environment: Caring for Your Lawn in and Environmentally Friendly Way."

Ornamental Shrubs and Trees

- Apply fertilizer and nutrients to annuals and perennials during active growth and to shrubs and trees during dormant season or early in the growing season.
- If using fertilizer, use the correct one at the suitable time, water properly, and reduce compaction.
- Prune branches to improve plants and prevent access by pests to structures.
- Use the appropriate pest-resistant variety (check with your local Cooperative Extension Service), and properly prune for growth and structure.
- Correctly identify the pest in question. When in doubt, send several specimens to your local Cooperative Extension Service. Once the pest is identified, recommendation can be made.
- Use pheromone traps as a time saving technique for determining the presence and activity periods or certain pest species. Pheromones are chemicals released by various organisms as means of communication with others of the same species, usually as an aid to mating.
- Select replacement plant material from among the many disease-resistant types being developed by plant breeders throughout the country.
- Check with local State Cooperative Extension Service or university for information on plant types appropriate for your site.
- Remove susceptible plants if a plant disease recurs and requires too many resources, such as time, energy, personnel, or money. Some ornamental plants, trees, and turf are so susceptible to plant diseases that efforts to keep them healthy may be futile.

Applying Pesticides Judiciously

Many different kinds of pesticides are currently available for use against urban and structural pests. An appropriate application uses the least toxic nature, these materials should be applied by qualified applicators when occupants are not present in areas where they may be exposed to materials applied.

Although EPA registers pesticides for use within the United States, the fact that a particular product is registered does not mean that it is "safe" under all conditions of use.

All pesticides used in the U.S. must be EPA registered, and the registration number must be listed on the label. Read and follow the pesticide label directions, know how to apply and handle these chemicals, and try to minimize the exposure to children, adults, and other non-target species.

The following general recommendations should minimize exposure to people and other non-targeted species when the application of pesticides is being considered.

- Read and follow all label instructions.
- Choose a pesticide that is labeled for the specific site, intended for the pest you are trying to control, and as target specific as possible, rather than broad spectrum.
- Use a spot-treatment method of application when pesticide treatments are required. Treat only the obviously infested plants in the area. This procedure helps conserve predators and parasites needed to reduce future pest populations and increases the time between pest outbreaks.
- Limit the use of sprays, foggers, or volatile formations. Instead use bait and crack and crevice application when possible. Look for crack and crevice label instructions on how to apply the pesticide. These treatments maximize the exposure of the pest to the pesticide while minimizing pesticide exposure for the occupants.
- Place all rodenticides either in locations not accessible to children and non-target species or in tamper resistant bait boxes. Outdoors, place the burrow entrance of an active rodent burrow, and then collapse the burrow entrance over the bait to prevent non-target species access. Securely lock or fasten shut the lids of all bait boxes. Place bait in the baffle-protected feeding chamber of the box. Never place the bait in the runway of the box.
- Apply only when occupants are not present or in areas when they will not be exposed to the material applied. Note any re-entry time limits listed on the label, and be aware that some residues can remain long after application.
- Use proper protective clothing or equipment when applying pesticides.
- Properly ventilate areas after pest application.
- Notify students, staff, and interested parents of upcoming pesticide applications if that is part of the school pest management policy. Pay particular attention to those individuals that may be higher risk.
- Keep copies of current pesticide labels, consumer information sheets, and Material Safety Data Sheets (MSDS) easily accessible.

Note: These pages are copies of EPA Pest Control in the School Environment: Adopting Integrated Pest Management Printed August 1993

Outline of a Typical Pest Control Official Visit in an IPM Program

This section is an outline of a progression of events during typical visit by a professional applicator who is following an IPM approach.

Communication

- Discuss recent pest sightings and active pest infestations with school representative.

Inspection of school and office premises for active rodent and insect infestations.

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- Check all monitoring stations (ketchalls, glue boards, and sticky traps)
- Inspect lunchrooms. Inspect for insect and rodent activity under and behind all sinks, cabinets, storage areas, and vending machines.
- Inspect locker rooms, pool, and rest rooms. Inspect for insect and rodent activity around toilets, sinks, and vanity cabinets.
- Inspect offices and faculty lounges. Examine office for pest evidence. Check snack areas for unsanitary conditions.
- Inspect classrooms. Inspect for insect and rodent control as needed. Pay special attention to rooms with children who have asthma. Pay special attention to ceilings and all heating and cooling units associated with outdoor ventilation.
- Inspect boiler room, utility rooms, and mechanical areas. Check for potential food sources and rodent harborages. Check all floor and wall joints, pipe openings, and uneven fitting door jams.
- Inspect entrances and courtyards. Check for possible entrances for pests into the building.

Application of pest management principals and techniques.

- Attempt to exclude all pests. (Eliminate all rodent runs and burrs.)
- Consider all non-pesticide control measures.
- Consider all pesticide control procedures. Choose pesticides only when they are necessary. Choose the least toxic method that provides the most effective control of the problem.

Evaluation of present Pest Management Procedures.

- Maintain records of pest sightings, pesticide use, non-chemical pest control measures, and monitoring station status.
- Discuss the findings of the inspection with school maintenance staff.
- Determine if the size of pest populations warrants any actions or chemical control.
- Discuss sanitation and maintenance actions that will improve pest management.

Establish a list of activities for school maintenance to perform before the next visit from the pest control contractor.

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APPENDIX

Mowing and Clippings

Seed Selection/Overseeding

Irrigation

Calibration

Herbicides for weed control in turf

Monitoring weed populations

Low maintenance turf grasses

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Mowing and Clippings

The 1/3 rule

The 1/3 rule states that no more than 1/3 of the leaf tissue should be removed at any one mowing. Thus, if the height of the grass is 3 inches, it should not be mowed shorter than 2 inches. Removing more than 1/3 of the leaf tissue severely stunts the regrowth of the grass because the youngest, most photosynthetically active tissue is removed, along with a significant portion of the carbohydrates (energy source). While this may seem like a good idea at first because the grass won't grow back as fast, it results in significantly more weeds and a weaker turf which is less able to resist disease and insect attack. When more than 1/3 of the turf grass leaf tissue is removed, bare soil areas may be exposed which allow weed seeds to germinate and colonization by creeping weed structures (stolons, rhizomes) which will form new plants in the bare areas. The low level of remaining carbohydrate (energy) reserves diminish the turf grass' ability to ward off disease and recover from insect and traffic damage.

Effect of mowing height on play and other variables

All turf grass species have optimal mowing heights under which they perform the best: best density, best color, best growth rate, best weed, disease and insect resistance, etc. (Table 14) When a turf is mowed outside the optimal mowing height range, pest problems can increase and turf quality will decrease. Within the range of optimal mowing heights, the lower end of the range can provide a smoother, more aesthetically pleasing, and sometimes more functional turf than at the higher end of the range. Mowing turf at the lower end of the range, though, will require slightly more inputs (fertilizer, irrigation, etc.) than if maintained at the higher end of the range. Reasons for altering the mowing heights may be as simple as the sports being played: soccer players like grass cut short for fast play, while football fields should be cut towards to upper end of the range (despite what the coaches say) to decrease the severe wear and tear from the football-type traffic. The mowing height may also need to be altered to increase environmental stress tolerance: if a turf is maintained at 2" during the spring for soccer, the mowing height should be raised to 2-1/2 to 3" for the summer to minimize the impact of summer heat stress on the turf. Two reasons are important for raising the mowing height slightly during the summer: 1) the increased leaf surface area buffers the soil from temperature extremes and allows the turf to cool itself better, and 2) lower mowing heights cause reduced root growth, and in summer the high soil temperatures themselves can reduce root growth and hasten root death, so it is important to manage turf to keep the root system alive.

Clipping return

Clippings almost never need to be removed from turf. Contrary to popular belief, clippings do not contribute to thatch nor are they responsible for spreading or increasing diseases. Clippings do not contribute to thatch buildup because clippings are approximately 90% water; the remaining 10% solids are readily decomposed organic constituents such as cellulose and proteins, and minerals such as nitrogen, phosphorus, potassium, and calcium which are recycled by the turf. Indeed, returning clippings to a turf adds approximately 1 lb. nitrogen per 1000 ft^2 back into the system each year, which saves on the fertilizer bill!

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Seed Selection/Overseeding

Less than 10 grass species are commonly used for turf grass in Iowa. Selection of the correct species and/or mix is critical for adequate turf performance and compliance with IPM principles. Each species, and often variety, has unique characteristics which make it suitable for a high traffic site, a shaded area, or other situations. The most common species are described below and summarized in. (Table 15)

Kentucky bluegrass is the most commonly used turf grass for lawns and athletic fields in Iowa due to its general adaptability to a range of mowing heights, traffic levels, environmental parameters, good disease/insect resistance, and rhizomatous growth habit which allows it to recolonize bare/thin areas of turf. The rhizomes can lead to thatch production which may require aerification.

Perennial ryegrass is often used for overseeding thin/bare areas due to its rapid germination. Perennial ryegrass is commonly used to overseed athletic fields. It is susceptible to Pythium blight, crown rust and other diseases. It is not as cold tolerant as Kentucky bluegrass. Its initial wear tolerance of mature plants is better than Kentucky bluegrass but it is slow to fill in bare areas as it lacks creeping structures (rhizomes and stolons).

Fine fescues (red, hard, and Chewings) are a group of species which require low inputs of fertilizer, water, and mowing. They are not traffic tolerant but are quite shade tolerant and perform well in relatively dry soils. The turf quality of fine fescues is poor to moderate but can be mixed with Kentucky bluegrass to provide a medium quality turf.

Tall fescues are generally considered for low quality turf which requires infrequent mowing and little or no fertilizer and irrigation. Tall fescue is shade and traffic tolerant. Newer cultivars require more frequent mowing, fertilization, and irrigation inputs than older cultivars.

Supina bluegrass is a perennial, stoloniferous bluegrass which performs well in moist environments. Its shade tolerance is excellent. The stoloniferous growth habit allows it to rapidly fill in bare areas in high traffic situations (athletic fields). It requires high levels of fertilization and irrigation to perform well. The preferred mowing height is lower than other cool season grasses, with best results obtained between 0.75-1.5 inches. It makes an ideal turf grass for well-maintained soccer fields but is expensive.

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Irrigation

Turf systems, like all plants, lose water both through evaporation from soil surfaces and from transpiration through plant stomates (pores) in the leaves. Combined, these two forces are simply termed ET (EvapoTranspiration). ET rates, or the amount of water lost, are a function of sun, wind, temperature and relative humidity. ET rates increase when the sun is shining, and/or conditions are windy, and/or temperature is high, and/or when relative humidity is low. On a cloudy but windy day (> 10 mph winds), ET losses may be as high as on a sunny but calm day with high humidity.

Water is important to maintaining a quality turf and minimizing pest problems, including weeds. When turf grasses do not have access to sufficient water they begin to turn bluish green. Wilt follows. If allowed to wilt for too long a period, the leaves will die. If water is not replenished in time, the crowns (growing points) will die, resulting in a dead turf. Even if only the leaves die, weeds may gain a foothold in the turf and increase in population. Mowing can also affect moisture loss: using dull blades which tear the grass, resulting in ragged ends, will significantly increase the amount of water lost from a turf and is more likely to result in drought stress.

ET rates can be estimated using weather stations which track environmental variables including rainfall. Although these are too expensive for most schools, ET can be estimated by measuring the amount of water lost from a large pan placed in the open. To do this, fill a large pan with water--the larger the better (officially the pan should be 4 ft diameter and 10 inches depth). Measure the amount of water lost each day. The results need to be summed weekly, with irrigation added to replace the estimated water loss. Since turf foliage actually reduces the amount of water lost from a bare soil surface, the amount of water (measured in inches) lost from a pan must be multiplied by 0.8 (a correction factor) to more accurately estimate the amount of water lost from a turf. Rainfall and irrigation will add water to the pan and this is OK, these additions need to be added into the weekly accounting. Soil moisture may also be monitored using electrical conductivity meters which retail for less than $1000 and provide rapid, fairly accurate measurements of soil moisture in the top several inches of soil.

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Calibration

Calibration of fertilizer and pesticide application equipment is the only way to ensure the correct amount of material will be applied. Over application wastes product (and money), may cause environmental harm, and possible phytotoxicity to the turf. Under application will not supply sufficient nutrients or pest protection, resulting in waste of time and money. Calibration also ensures proper working of the equipment, e.g., orifices are not clogged, distribution is uniform, etc. Bags of granular fertilizer sometimes list settings for several types of spreaders, but these should be used only as a guideline. Not all spreader types are listed on fertilizer bags, and many bags list no suggested settings for any spreaders. Over time, fertilizer orifices can become worn, resulting in over application. Variance among walking speeds of people is a major reason for actual settings being different than recommended settings.

Granular products. Proper calibration of fertilizer and pesticide equipment is critical because misapplications, whether too great or too little, result in reduced or no benefits, wasted time and money, and may enhance the potential for environmental damage, including turf and ornamental phytotoxicity.

Spreader types include broadcast (also called rotary or centrifugal) and drop spreaders. Broadcast spreaders can throw material 8-20 ft, depending on many factors including size and density of particles, spinner velocity, and spinner characteristics. Broadcast spreaders are useful for applying granular products to large areas with little if any "streaking". However, they are less likely to apply granular products uniformly than drop spreaders, as large, dense particles tend to be thrown greater distances than smaller, lighter particles. Drop spreaders are useful for smaller areas due to their lower output, typically a 2 to 4 foot width. When drop spreaders are used, "streaking" can result if each pass does not properly overlap the other pass: the area which did not have product applied will appear lighter green (if the product was fertilizer) or may show up as a line of weeds, disease, or insect problems (if the product was a pesticide). To eliminate problems with streaking, apply the product with a drop spreader at 1/2 the intended rate but in two perpendicular directions.

Calibrating a broadcast spreader

First, determine the spreader throw width:

- Place 20 deep buckets or other collection vessels in a straight line on one foot spacing to a total width of 16 ft. The width may need to be increased depending on circumstances. Leave a 2 ft spacing in the middle of the line (between beakers 10 and 11) to allow the fertilizer spreader to pass through.

- Fill the spreader hopper with the intended granular product (usually fertilizer). Make several passes back and forth through the middle of the row of buckets. The buckets will collect some of the product which will allow you to determine the throw width.

Calibrating using the Penn Pro

A PennPro is a device tailored to fit underneath a broadcast fertilizer spreader to collect the product as it is thrown out of the spreader. This or a homemade device make calibration of broadcast spreaders relatively quick and simple.

- Mark off a 50 ft length on the grass or the asphalt.
- Make sure the hopper is closed (small lever in middle of the handlebars), then fill the hopper approximately 50% full with fertilizer.
- Place the PennPro catch pan underneath the spreader. Make sure it's on properly.
- Take the spreader to the start of the calibration area.
- Open the fertilizer hopper with the small lever and immediately beginning walking at a constant pace, not too fast, not too slow.
- Shut the hopper lever immediately upon reaching the 50 ft mark.
- Tip the spreader forward slightly until the fertilizer caught in the main pan of the PennPro has fallen into the small bottom tray.
- Remove the bottom tray from the PennPro, being careful not to spill any of the fertilizer.
- Weigh the amount of fertilizer collected. Remember to account for the weight of the container.
- Replace the fertilizer into the bag or the fertilizer hopper.
- Determine the rate of fertilizer application at the setting used. The measured rate should be within 10% of the desired rate. If it is not, adjust the fertilizer spreader. Use the manufacturer's guidelines as a best estimate, however, these were developed under a different set of conditions and at a different walking speed than the one you will likely use.
- Calculations for determining fertilizer amounts:
  - Rate = lbs collected / area of coverage
  - To determine N rate = Desired rate of N (in lbs) / % N in fertilizer = lbs fertilizer required--if the throw width was 10 ft, and the travel distance was 50 ft, the effective coverage was 500 ft^2 in your test. If you desire 1 lb. N/1000 ft^2 using a 20-3-5 fertilizer, you will need to apply 5 lb. fertilizer per 1000 ft^2 (1/0.20 = 5 lb. fertilizer), thus, in your test area, you should have collected 2.5 lb. fertilizer (5 lb. fertilizer x 0.5 1000 ft^2 = 2.5 lb. Fertilizer.

Calibrating a drop spreader

Drop spreaders have typically been easier to calibrate than broadcast spreaders because a) the application width fixed and is easily measured and b) the material is distributed over a relatively small area which makes methods like the clean sweep method practical.

Clean sweep method:

- Set the calibration wheel (in back of spreader, under base of handle) to a mid-range value or a value suggested by the fertilizer/product manufacturer.
- Make sure hopper is closed, then fill hopper approximately 50% with the fertilizer/product.
- Mark off a 50 length on an asphalt or concrete surface.
- Open the fertilizer hopper and walk, at a normal pace, the 50 ft length. Shut the hopper bar immediately upon reaching the 50 ft mark.
- Sweep the fertilizer into a dustpan and weigh the amount collected.
- Determine the amount of fertilizer applied on a 1000 ft^2 basis (multiply spreader width by 50 ft then use the following calculation to arrive at the answer). Adjust the spreader setting if the amount of fertilizer/product differed from the desired rate by more than 10%.
- Keep notes of the fertilizer output at each of the settings you test. Over time you will build a list of settings you can use for future reference. (Table 16)

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Formula for calculating fertilizer/product output

- To determine N rate = Desired rate of N (in lbs) / % N in fertilizer = lbs fertilizer required per 1000 $ft^{2.}$
- Rate = lbs collected / area of coverage (*in* ft^2)
- Multiply lbs fertilizer required per 1000 ft^2 by the amount of test area, then divide the answer by 1000. For example, say the desired rate of fertilizer was 5 lb. per 1000 ft^2, and the spreader had a 4 ft spread width while the length of the test area was 50 ft for a total test area of 200 ft^2 (since 4 x 50 = 200) .5 lb. fertilizer x 200 ft^2 = 1000 lb. per ft^2 / 1000 ft^2 = 1 lb. fertilizer. If the amount of fertilizer applied during the test run was different than 1 lb. by more or less than 10% (0.9 to 1.1 lb.), then the spreader needs to be adjusted and the calibration repeated.

Catch pan method

The catch pan method is similar to using a PennPro for collecting the material thrown by a broadcast spreader. Catch pans are easily made on site though by fashioning a rectangular box from wood, aluminum or steel. Use a rubber cord (bungee cord) or similar instrument to attach the catch pan to the bottom of the spreader. The catch pan must be sized appropriately to catch <u>all</u> of the product being applied to provide accurate calibration.

- Set the calibration wheel (in back of spreader, under base of handle) to a mid-range value.
- Make sure hopper is closed, then fill hopper approximately 50% full with the fertilizer/product to be used. Record the analysis.
- Mark off a 50 length on the asphalt driveway.
- Place the catch pan underneath the hopper openings and secure in place with a bungee cord.
- Open the fertilizer hopper and walk, at a moderate pace, the 50 ft length.
- Shut the hopper bar immediately upon reaching the 50 ft mark. Remove the catch pan carefully from the spreader—do not spill the fertilizer.
- Determine the weight of the fertilizer collected.
- Determine the amount of fertilizer applied on a 1000 ft^2 basis as described above for the clean sweep method.
- How close is this to the desired amount? If it's off by more than 10%, readjust the calibration wheel and repeat the process. Remember, a larger opening will allow the application of more fertilizer. Use the same walking speed as used previously.

Liquid Applications

Liquid applications typically provide more uniform distribution than granular products. Liquid pesticides are also more effectively absorbed by weeds when applied post-emergent. Liquid products, whether fertilizers or pesticides, may be misapplied if the equipment is not properly calibrated. Regular calibration also provides an opportunity for the applicator to check the equipment for leaks or malfunctioning components. Tractor/vehicle-mounted booms are typically used to apply liquid products uniformly to large areas. Hand-held or backpack pump sprayers are useful for very small turf areas or spot spraying individual weeds in turf or ornamental plantings. With all liquid applications, the pressure in the spray tank will be partially responsible for the output rate and quite often the uniformity and droplet size of the product. Nozzle types affect output

rate and can be dependent on pressure. Generally, pump pressure must be quadrupled to double the output. Most nozzles are designed to function within a defined range of pressures, usually approximately 40 psi. Exceptions are nozzles designed for low volume (low pressure) applications and "extended range" nozzles which can be identified by an XR or similar acronym on the nozzle. Consult the nozzle and/or sprayer guide for the appropriate type of nozzle to use for a given situation (fertilizer, system versus contact herbicide, fungicide, or insecticide). Ground speed also affects the output rate: as the ground speed is doubled, the output rate decreases by half. Some of the most common misapplication problems are related to worn nozzles, clogged strainers or nozzles, mismatched or even missing nozzles, and malfunctioning equipment (e.g., pump).

Calibration of boom sprayer

- Remove all nozzles from the sprayer and check for clogged or missing check valves/strainers while the tank is being filled with water.
- Record the type and capacity of the nozzles being used. (Table 16)
- Select a speed and pressure setting.
- Turn pump on. Check for leaks in the system: hoses, connections, nozzle assemblies.
- With the sprayer parked in place, collect water from the nozzles for 1 minute in calibrated collection vessels. These are available from your fertilizer/pesticide dealer.
- Record the amount of liquid collected from each nozzle. Calculate an average volume per nozzle (in gallons or liters).
- Repeat steps 4-5 until water has been collected from all nozzles.
- Record the average output from all nozzles. If any nozzle varies more than 10% from the average, check the nozzle and/or strainer for wear or clogging. Replace the nozzle if necessary, and be sure to use the exact same type and size (rated output) of nozzle.
- If output from all nozzles is acceptable, operate the sprayer for one minute while traveling at the selected speed (throttle and gear settings can be kept constant if the sprayer does not have a speedometer).
- Measure the distance traveled.
- What was the area covered? = *boom width x distance traveled.*
- Determine the output rate using the formula: **Rate** = ([average volume per nozzle x number of nozzles] / test area) x unit area.

Calibration of a pump sprayer

Pump sprayers are simple and relatively easy to use. They tend to be good for spot spraying individual weeds or along fence lines, around trees or other objects.

- Fill the sprayer full with water using a known quantity of water (measure with a graduated cylinder or collection vessel which was used to calibrate the boom sprayer)—stop at a calibrated line.
- Place the sprayer on your back, or hold by hand, and pump the lever several times until the lever becomes difficult to pump.
- Determine the nozzle's capacity (gal/minute) by collecting and measuring the amount of liquid emitted during one minute. If possible, maintain steady pumping on the pump handle while measuring.
- Determine area covered per unit time by determining walking speed in ft/min. Measure a 25 ft distance and 4 foot width area, staking it with flags or marking it with turf paint. Begin applying the water, slowly moving the wand back and forth as you walk at a steady pace. **Pump the lever as needed to maintain a**

steady pressure. A typical walking speed is 2.5 mph, or 88 ft per minute. Sq ft/min = speed in ft/min x swath width (in feet).

- Compute the gallons per acre. The above information is used to compute the gallons of spray that will be applied per acre.
  GPA = (gal/min x 43560 sq ft/acre) / sq ft/min

Herbicides for Weed Control in Turf

There are many herbicides available for use on turf and ornamental plantings. Herbicide selection will depend on several factors, including effectiveness for the target weeds (hence, weed identification is critical), relative safety, formulation, and cost. Pre-emergent herbicides should only be used when sensitive weed species have historically been a problems (e.g., crabgrass)—applying pre-emergent herbicides when there is little or no history of a weed problem does not make good economical or environmental sense. Of the post-emergent herbicides for broadleaf weeds, both annuals and perennials, three are most commonly used, generally in various combinations with one another: 2,4-D, MCPP, and dicamba. Research has shown the three herbicides, when applied in combination, have a synergistic action which means the relative effects of the combination are greater than the sum of the individual activities. Another reason for mixing the three herbicides together is that some weeds are resistant to one or two of the compounds, but rarely if ever is a weed resistant to all three compounds because they have different modes of action.

Monitoring Weed Populations

The transect method is an easy and fairly reliable method to track weed populations over time.

- String a grid over the turf area. The string can be held with nails, although the nails will need to be picked up before the area is mowed! The same sized grid, using the same corners, must be used every time the area is surveyed to provide reliable data. The size of the grids will depend on the size of the area being surveyed, with larger grids used for larger areas and smaller grids used for smaller areas. For a football field, grids should be spaced at 5 yard intervals.
- Estimate the percentage of weeds by tallying the number of grid intersections with weeds: if weeds exist at 30 intersections out of 200 total intersections, the percentage of weeds is 15% x 100 = 15%).
- Record the species of weeds present.
- Keep records from year to year. This will allow you to document increasing (or hopefully steady or even decreasing!) weed pressure, providing a rational basis for non-routine cultural control (e.g., aerification on a Level B athletic field) or chemical control. Records will also allow the types of weeds to be tracked so management programs can be assessed for effectiveness.
- Depending on the area, weed populations may need to be assessed two times a year or less.

Low Maintenance Turf grass

Certain turf grass species and cultivars are better adapted to low fertility, irrigation, and irregular mowing than others. Most fine fescues currently on the market require little if any fertilization or irrigation, and will perform acceptably with mowing as infrequently as once every two weeks. While Kentucky bluegrasses are generally considered a

moderate to high maintenance turf grass, several cultivars have been shown to provide acceptable quality turf in low traffic areas which receive little fertilization and irrigation and are mowed at the high end of the optimum mowing height range for Kentucky bluegrasses (mostly common types).

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DESIGNATING SCHOOL TURF AREAS

Table 1. Turf Management Practices According to Turf Designation

Turf Management Practices						
	Mowing	**Irrigation**	**Fertilization**	**Aerification**	**Topdressing**	**Overseeding**
Athletic A	Follow J Rule.	Supply 1 inch of water every week.	4-6 lb N/1000 ft^2 Apply fertilizer in 1lb N/ft^2 intervals.	Once every 2-3 weeks; once in summer, once in fall may be sufficient.	Perform as needed.	Overseed all areas with lower turf density.
Athletic B	Once a week; J Rule if possible.	Restoration only	4 lb N/1000 ft^2 Apply fertilizer in 1lb N/ft^2 intervals.	Aerate once in summer and once in fall.	Apply to heavily used areas of the field only.	Overseed areas with less than 70% turf coverage.
Athletic C	Once every 7-10 days; J Rule if possible.	Restoration only	0-2 lb N/1000 ft^2 Apply fertilizer in 1lb N/ft^2 intervals.	Can consider aeration for better field performance.	None	Overseed Large bare areas.
Landscape A	Once a week; J Rule if possible.	Restoration only	2 lb N/1000 ft^2 Apply fertilizer in 1lb N/ft^2 intervals.	No, unless there is heavy traffic.	None	Usually not needed.
Landscape B	Once every 7-10 days; J Rule if possible.	Restoration only	0-2 lb N/1000 ft^2 Apply fertilizer in 1lb N/ft^2 intervals.	No, unless there is heavy traffic.	None	Usually not needed.

LEVEL A ATHLETIC FIELDS

Table 2. Nitrogen requirements and timing of application for Level A athletic fields.

Field Type/Usage Level	**Total lb. N/1000 ft^2/yr.**	**Typical application times**
Low to Medium Use	4	mid-late May, early July, late August, mid-October
High Use	6	Late April, late May, late June, late August, late September, late October
Sand based	6-10*	Apply 1/3-½ lb. N/M at 10-21 day intervals, early April through early November

* High use, frequent and high amounts of rainfall and/or irrigation will require higher N inputs; the greater the percentage of sand and the lower the amount of peat/soil in the root zone will also require higher N inputs.

LEVEL A ATHLETIC FIELDS

Table 3. Conventional Nitrogen Sources for Level A athletic fields.

Quickly available (water soluble nitrogen, or WSN)

Urea, Ammonium Sulfate [$(NH_4)_2SO_4$], Ammonium nitrate [$(NH_4NO_3$], Ammonium phosphate [$(NH_4)_xH_yPO_4$], Potassium nitrate [KNO_3], Calcium nitrate [$Ca(NO_3)_2$]

Slowly available

Sulfur coated urea (SCU), isobutylenediurea (IBDU); ureaformaldehyde, methylene urea, Milorganite™ (all three may be listed as water insoluble N, or WIN)

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LEVEL A ATHLETIC FIELDS

Table 4. Sand particle size range for putting green root zone construction
(adapted from United States Golf Association at http://www.usga.com/green/coned/greens3.htm#root_zone)

Description	Particle diameter	Recommendation (by weight)
Fine gravel	2.0-3.4 mm	Not more than 10%, including maximum of 3% gravel
Very coarse sand	1.0-2.0 mm	Not more than 10%, including maximum of 3% gravel
Coarse sand	0.5-1.0 mm	Minimum of 60% of particles must be in this range
Medium sand	0.25-0.50 mm	Minimum of 60% of particles must be in this range
Fine sand	0.15-0.25 mm	< or = 20% particles in this range
Very fine sand	0.05-0.15 mm	< or = 5%
Silt	0.002-0.05 mm	< or = 5%
Clay	less than 0.002 mm	< or = 3%
Total fines	Very fine sand + silt + clay	< or = 10%

LEVEL B ATHLETIC FIELDS

Table 5. Nitrogen requirements and timing of application for Level B athletic fields.

Field Type/Usage Level	Total lb. N/1000 ft^2/yr.	Typical application times
Low to Medium Use	4	mid-late May, early July, late August, mid-October
High Use	6	Late April, late May, late June, late August, late September, late October

LEVEL B ATHLETIC FIELDS

Table 6. Conventional Nitrogen Sources for Level B athletic fields.

Quickly available (water soluble nitrogen, or WSN)	Slowly available
Urea, Ammonium Sulfate [$(NH_4)_2SO_4$], Ammonium nitrate [$(NH_4NO_3$], Ammonium phosphate [$(NH_4)_xH_yPO_4$], Potassium nitrate [KNO_3], Calcium nitrate [$Ca(NO_3)_2$]	Sulfur coated urea (SCU), isobutylenediurea (IBDU); ureaformaldehyde, methylene urea, Milorganite™ (all three may be listed as water insoluble N, or WIN)

LEVEL B ATHLETIC FIELDS

Table 7. Sand particle size range for putting green root zone construction
(adapted from United States Golf Association at http://www.usga.com/green/coned/greens3.htm#root_zone)

Description	Particle diameter	Recommendation (by weight)
Fine gravel	2.0-3.4 mm	Not more than 10%, including maximum of 3% gravel
Very coarse sand	1.0-2.0 mm	Not more than 10%, including maximum of 3% gravel
Coarse sand	0.5-1.0 mm	Minimum of 60% of particles must be in this range
Medium sand	0.25-0.50 mm	Minimum of 60% of particles must be in this range
Fine sand	0.15-0.25 mm	< or = 20% particles in this range
Very fine sand	0.05-0.15 mm	< or = 5%
Silt	0.002-0.05 mm	< or = 5%
Clay	less than 0.002 mm	< or = 3%
Total fines	Very fine sand + silt + clay	< or = 10%

LEVEL C ATHLETIC FIELDS

Table 8. Nitrogen requirements and timing of application for Level C athletic fields.

Field Type/Usage Level	Total lb. N/1000 ft^2/yr.	Typical application times
No input	0	none
Lowest input	1	early September or mid to late October
Low input	2	early September and mid to late October or early September or mid-to late October and late May

LEVEL C ATHLETIC FIELDS

Table 9. Conventional Nitrogen Sources for Level C athletic fields.

Quickly available (water soluble nitrogen, or WSN)	Slowly available
Urea, Ammonium Sulfate [$(NH_4)_2SO_4$], Ammonium nitrate [$(NH_4NO_3$], Ammonium phosphate [$(NH_4)_xH_yPO_4$], Potassium nitrate [KNO_3], Calcium nitrate [$Ca(NO_3)_2$]	Sulfur coated urea (SCU), isobutylenediurea (IBDU); ureaformaldehyde, methylene urea, Milorganite™ (all three may be listed as water insoluble N, or WIN)

LANDSCAPE AREA A: ORNAMENTALS & TURF

Table 10. Nitrogen types and timing of for Level A ornamental turf.

Type of Fertilizer	Total lb. N/1000 ft^2/applic.	Typical application times
Mixture of water soluble and water insoluble	1	mid-late May (Memorial Day)
Slow release (SCU, IBDU or organic)	1	mid-summer (July 4)-optional*
Mixture of water soluble and water insoluble	1	early autumn (Labor Day)
Water soluble and/or insoluble	1	dormant application (mid-late Oct.)

* Should be skipped if irrigation is unavailable and/or summer is hot and dry

LANDSCAPE AREA A: ORNAMENTALS & TURF

Table 11. Conventional Nitrogen Sources for Level A ornamental turf.

Quickly available (water soluble nitrogen, or WSN)	Slowly available
Urea, Ammonium Sulfate [$(NH_4)_2SO_4$], Ammonium nitrate [$(NH_4NO_3$], Ammonium phosphate [$(NH_4)_xH_yPO_4$], Potassium nitrate [KNO_3], Calcium nitrate [$Ca(NO_3)_2$]	Sulfur coated urea (SCU), isobutylenediurea (IBDU); ureaformaldehyde, methylene urea, Milorganite™ (latter three may be listed as **w**ater **i**nsoluble **N**, or WIN)

LANDSCAPE AREA B: TURF

Table 12. Nitrogen requirements and timing of application for Landscape Area B turf.

Field Type/Usage Level	Total lb. N/1000 ft^2/yr.	Typical application times
No input	0	none
Lowest input	1	early September or mid to late October
Low input	2	early September and mid to late October or early September or mid-to late October and late May

LANDSCAPE AREA B: TURF

Table 13. Conventional Nitrogen Sources for Landscape Area B turf.

Quickly available (water soluble nitrogen, or WSN)	Slowly available
Urea, Ammonium Sulfate [$(NH_4)_2SO_4$], Ammonium nitrate [$(NH_4NO_3$], Ammonium phosphate [$(NH_4)_xH_yPO_4$], Potassium nitrate [KNO_3], Calcium nitrate [$Ca(NO_3)_2$]	Sulfur coated urea (SCU), isobutylenediurea (IBDU); ureaformaldehyde, methylene urea, Milorganite™ (all three may be listed as water insoluble N, or WIN)

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MOWING AND CLIPPINGS

Table 14. Suggested mowing heights for cool season turf grasses for Iowa.

Turf grass species/type	**Suggested Mowing Height Range**
Kentucky bluegrass (*Poa pratensis*)	
Common types	3-3.5"
Elite types	1-2.5"
Supina bluegrass (*Poa supina*)	1-1.5"
Perennial ryegrass (*Lolium perenne*)	2-3"
Tall fescue (*Festuca arundinacea*)	
Improved types	2-3"
Dwarf types	1.25-3"
Fine fescues (*Festuca rubra, F. commutata*)	1.5" and higher (including no mowing)

SEED SELECTION/OVERSEEDING

Table 15. Description of the common turf grass species in Iowa

Grass species	**Scientific name**	**Growth habit**	**Management requirement**	**Seeding rate (lb/1000 ft^2)**
Kentucky bluegrass	*Poa pratensis*	Rhizomatous	Low-high*	1-2
Supina bluegrass	*Poa supina*	Stoloniferous	High	1-1.25**
Perennial ryegrass	*Lolium perenne*	Bunch	Medium-high	7-9
Tall fescue	*Festuca arundinacea*	Bunch	Low-medium	4-5
Fine fescues: Red, hard, Chewings	*F. rubra, F. longifolia*, *F. rubra* var. *commutata*	Red: Rhizomatous Hard/Chewings: Bunch	Low-medium	4-5

* Cultivar-dependent

** Can be used as low as 5% in athletic field seed mix and will dominate stand within 2-3 years depending on level of traffic, fertility, and irrigation.

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CALIBRATION

Table 16. Sample table for tracking the amount of fertilizers applied at various spreader settings.

Fertilizer		Spreader setting	Area of coverage	Amount collected	Amount of N (in lbs)	Within 10% desired?
Brand	Analysis					

LOW MAINTENANCE TURFGRASS

Table 18. Selected list of low maintenance Kentucky bluegrass cultivars for the upper Midwest (adapted from 1998 NTEP results).

Cultivar	Quality rating†	Leafspot rating‡	Patch disease rating¶
Eagleton	6.3	3.7	2.7
Caliber	6.0	2.7	7.7
Baronie	5.7	4.0	11.7
Baron	5.8	4.0	2.0
Bartitia	5.7	4.0	5.0
Canterbury	5.8	3.7	24.7
South Dakota	6.1	1.3	8.7
Kenblue	5.8	1.0	4.3
LSD (0.05)	**0.9**	**1.2**	**25.3**

† Rated on 1-9 scale where 1=dead turf, 9=high quality turf. These were top-ranked cultivars from Iowa for 1997, maintained at > 2.5 inch height and low maintenance.

‡ Rated on 1-9 scale, where 1=100% turf diseased, 9=no turf diseased. Data from New Jersey.

¶ Rated percentage scale from 0-100% disease. Data from Kentucky.