AgriLIFE EXTENSION
Texas A&M System

E-530
10/99

Athletic Fields

and Water Conservation

Water Supply and
Conservation
Education
Programs

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Water is rapidly becoming a limited resource in Texas and will become more limited as the population increases. Unless water conservation efforts are strengthened, water rationing programs will become more prevalent across the state and water prices will increase drastically.

Water conservation must be considered by anyone working in turf and grounds maintenance. Athletic field managers must know how to conserve water, yet provide a safe and aesthetically pleasing facility for recreational use.

As an athletic field manager, you must know how your irrigation system performs and understand all the factors that affect turfgrass water use in order to develop a sound irrigation management program. You must be able to answer the following questions.

- How does your irrigation system operate?
  Know how to program your irrigation controller.
  Know how much water is applied in a given amount of time for each zone.
  Know the distribution pattern of the system.
- What is the soil type?
- What is the rooting depth of the turf?
- What are the water requirements of the turfgrass as determined by the specific turf species and varieties, the specific use of the grass, and the level of management?
- What environmental conditions affect turf water use rates?

HOW does your irrigation system operate?

To develop an efficient watering program, the first key is to understand the performance and capabilities of your irrigation system. Thoroughly understand the features of your controller including options such as dual programming, multiple start times and sensor override capabilities. The controller should be frequently modified for seasonal changes in turfgrass growth and variable environmental conditions. It is vital to know the application rate and distribution pattern of each sprinkler zone, and the soil type and the rooting depth to establish an effective and efficient irrigation schedule.

A Texas A&M certified landscape irrigation auditor can evaluate your system and provide a detailed report containing this information. Your county Extension agent should have a directory of certified irrigation auditors in your area. If you choose to perform your own irrigation audit, simply follow the 18-step procedure in “Performing an Irrigation Audit.”

Besides performing a complete irrigation audit, you should routinely check your system to ensure that each sprinkler head operates properly. Record any problems on the report form. Look for broken sprinkler heads, misaligned heads, sunken heads, high water pressure, low water pressure, leaks in the lines, and improper rotation.

PERFORMING an irrigation audit

1. To obtain the most accurate results, perform the audit at the same time of day the system normally operates. Avoid extremely windy or rainy conditions.
2. Determine the square foot area of irrigated turf and record this value on the audit report. Draw the area on graph paper to scale.
3. Turn the irrigation system on and flag each sprinkler head in individual zones. Use a different color flag to represent separate zones to eliminate confusion. Plot each sprinkler head on the graph and label it with a letter (a-b-c).
4. Measure and record the distance between each sprinkler head (head spacing).
5. Use a soil probe to pull multiple soil samples from across the irrigated area.
6. Examine the soil samples and determine the effective rooting depth. The plant’s effective rooting depth is the depth of soil, in inches, that contains a large number of live, growing roots. Find an average rooting depth from all soil samples. Record the average rooting depth on the report form.
7. Determine the soil type using the “feel method.” A clay soil will feel sticky and form a ribbon when squeezed between the fingers. A sandy soil will feel gritty, and a loamy soil will be a mixture of sand, silt and clay. Record this information for later use.
8. Conduct the remaining steps of the audit individually on each irrigation zone, beginning with zone 1.
9. You will need 15 to 20 catch cans or devices to perform the irrigation audit (depending on the number of sprinkler heads in a zone). Straight-sided containers such as coffee cans, tuna and cat food cans work well, or rain gauges can be used.
10. Place the catch cans at each sprinkler head and halfway between heads. This simple placement pattern requires the least number of catch cans while providing adequate coverage of the tested area. When placing catch cans at each head, make sure the cans are far enough away from the heads so as not to interfere with the spray pattern. Plot the location of each catch can on the graph and label with a number (1-2-3).
11. Irrigate the zone for a short period of time. The run time should be long enough to allow for five to 10 rotations of a geared rotor or impact sprinkler head. Normally, testing run times range from 10 to 30 minutes for large sprinklers. While shorter testing run times permit faster auditing, running the system longer will lead to more accurate results. Record the run time.
12. While the system is running, use a pressure gauge to check and record the water pressure at each sprinkler head.
13. After the zone designated run time is completed, measure and record the depth of water caught in each catch can. A ruler can be used to accurately determine the depth.
14. Record all individual catch depths and head pressures to their appropriate locations on the graph.
15. Average all catch can depths for the zone. Record this value.
16. Look for distribution problems within the system. Keep in mind that other heads not on that particular zone could add to the depth of some catch cans, especially those cans near each head.
17. If problems exist, determine the cause (pressure, wind, head alignment, etc.).
18. Repeat steps 10 through 17 for the remaining zones.

Measure the area to be irrigated by a zone.

WHAT is the soil type?

To develop an effective irrigation schedule, it is crucial to know and understand the characteristics of your specific soil type. Soil type influences how often you need to water and how much water you need to apply per application.

Soil types have different water holding capabilities. As soils dry, they hold onto their remaining water more tightly. Eventually water is held so tightly by the soil that the turfgrass roots are unable to extract it for use. The remaining water is unavailable to the grass. Available water is the fraction of water held by the soil that can be extracted by plant roots. When there is a high loss of water from the soil both by evaporation and by transpiration from the plants (evapotranspiration or ET), a percentage of the available water might not be available rapidly enough to prevent drought stress. Therefore, for irrigation scheduling, it is important to have readily available water, or a volume of water in the soil that will effectively prevent drought stress injury regardless of environmental conditions.

Table 1 gives general approximations of the amount of readily available water held in each soil type (given in inches of water per foot of soil). With the irrigation audit, you determined your soil type (see Irrigation Audit, step 7). Locate your soil type in Table 1 and record the volume of readily available water for your soil type on the Auditing Report.

Table 1. Estimates of readily available water for different soils.

Soil Texture	*Readily Available Water (in./ft.)*
Sand	0.9
Sandy Loam	1.4
Loam	1.7
Silt Loam	1.8
Clay Loam	2.0
Clay	2.1

WHAT is the rooting depth of the turf?

To establish an effective irrigation schedule, you must know the effective rooting depth, or the depth of actively growing roots. Use this depth to determine how deeply to water each time you irrigate. Deeper water within the effective root zone results in less frequent irrigation. Water to a depth just below the effective rooting depth. Irrigation water below this depth is unavailable to the roots, and is wasted. Shallow irrigation significantly less than the effective rooting depth can lead to a decrease in rooting depth and will require more frequent irrigation to prevent drought stress. During the irrigation audit, an average effective rooting depth for the irrigated area was determined (see Irrigation Audit, step 6). This information will be used when establishing your irrigation schedule.

Check your system to ensure that each sprinkler head is working.

WHAT are the water requirements?

Water requirements of turf can vary significantly depending on species and variety, specific use of the grass and its level of management.

Grass species and even varieties within each species can vary significantly in their water use rates. Table 2 gives a general ranking of the water use rates for the more common turfgrass species

used on Texas athletic fields. Record on the Auditing Report which ranking your turfgrass species is given. For more specific information, contact your county Extension agent.

Table 2. Rankings of turfgrass water use rates by species.

Ranking	***Turfgrass Species***
High	Perennial Ryegrass, Annual Ryegrass, *Poa trivialis,* Kentucky Bluegrass
Medium	Tall Fescue, Hybrid Bermudagrass
Low	Common Bermudagrass, *Zoysia japonica*

The specific use of the grass determines the level of management and directly influences the water use rates of turf and its irrigation requirements. An athletic field that receives heavy traffic or is a high priority field will require a high level of management to maintain an appropriate turfgrass quality. The intensity of traffic also will affect the level of management. College football causes more stress and injury to turf than high school baseball, and thus would require a higher level of management.

Fertilization, mowing and management of thatch and soil compaction are all management practices that influence the water requirements of a turfgrass area. Specific use of the field and the financial operating budget dictate the frequency at which you perform each of these tasks. A good fertilization program provides all essential nutrients to the turf in the required amounts. Proper fertilization helps promote optimum shoot and root development. A deep root system enables a plant to use water held deep in the soil, significantly reducing the frequency of irrigation.

Fertilization programs that supply excess nutrients, especially nitrogen, promote shoot growth at the expense of root development. This results in turf with a short, weak root system. Nutrient deficiencies are equally as bad, increasing a turf's susceptibility to stresses such as disease, insects, weed invasion and drought. Therefore, practice moderation when developing a fertilization program. Table 3 provides recommended nitrogen rates for most common athletic field turfgrass species used in Texas.

Determine the soil type by feeling soil in the palm of your hand.

Table 3. Yearly nitrogen fertilizer requirements for common Texas athletic field turfgrass species.

Grass Species	***Maintenance Needs*** ***(Pounds of N per 1,000 sq. ft. per year)***
Tall Fescue	3-6
Common Bermudagrass	4-6
Hybrid Bermudagrass	4-8
Zoysia japonica	3-6
Kentucky Bluegrass	3-6
Perennial Ryegrass	3-6
Annual Ryegrass	2-5
Poa trivialis	2-5

Mowing also affects root and shoot development. Turf that is maintained at a higher mowing height normally has a deeper, more extensive root system. However, as the leaf area increases, transpiration can increase and result in higher water use rates. Therefore, moderate mowing heights should be used during high stress periods. Mowing frequency should be determined using the "one-third" rule. No more than one-third of the leaf area should be removed at any one time. Frequent mowing leads to thicker, denser turf. The higher the density, the lower the evaporative water loss from the soil. Also, dense turfgrass is more competitive against weed invasion. Table 4 gives recommended mowing heights for common athletic field turfgrass species.

Flag each sprinkler head. Use a different color of flag for each zone.

Table 4. Recommended mowing heights for turfgrasses used on athletic fields in Texas.

Grass Species	*Mowing Height (inches)*
Hybrid Bermudagrass	0.5 - 1.5
Common Bermudagrass	1.0 - 1.5
Zoysia japonica	1.0 - 2.0
Tall Fescue	1.5 - 2.0
Kentucky Bluegrass	1.0 - 2.0
Perennial Ryegrass	0.5 - 2.0
Annual Ryegrass	1.0 - 2.0
Poa trivialis	0.5 - 2.0

Thatch, the layer of nondecomposed organic matter found between the soil surface and the base of the leaves, can slow water movement into the soil and lead to runoff. Thatch accumulation results from heavy fertilization, improper mowing and overwatering.

Certain management practices used during low stress periods help control thatch development. They are topdressing, vertical mowing and aeration.

Soil compaction limits both water and air movement into the soil profile, and reduces shoot and root development. A good aeration program, which significantly increases air exchange and water infiltration rates, should be established to break up compacted layers. The frequency of aeration for a specific turf area is dictated by the intensity of traffic the area receives. Areas that receive heavy traffic require frequent aeration.

Consider the overall management level of the turfgrass area by noting how often and at what rates you fertilize and how often you aerate and topdress. Give your personal management level a ranking of high, medium or low and record this on the Auditing Report.

WHAT environmental conditions affect turf water use rates?

Environmental conditions influence irrigation requirements. Low humidity, high temperatures, and/or high wind speeds can significantly increase water lost from the soil and plants by potential evapotranspiration (PET). When PET is high, soil water is lost more rapidly and irrigation must be more frequent. PET rates and, therefore, the frequency of irrigation are much lower when conditions are cool, humid and/or calm. The time of year also impacts irrigation frequency. During the summer, when temperatures are high and days are long, supplemental irrigation requirements are high. During late fall, winter and early spring, temperatures are cool, days are short, and rain is frequent, thus irrigation requirements are low.

Check for obstructions to spray.

While performing the audit, look for broken or damaged heads.

PUT it all together.

Now that you have considered the components that influence irrigation scheduling and how they apply to your situation, put it all together to generate an irrigation schedule that is specific to your situation.

To determine the run time for your irrigation system, you need to know:

- average effective rooting depth,
- volume of readily available water for your soil type, and
- average depth of water caught in each catch can per zone.

Your goal is to thoroughly wet the soil to a depth at or just below the effective rooting depth. To do this, you need to determine how much water to apply and how long the system needs to run to put out that volume of water.

Calculating Run Time

1. Convert the average effective root depth from inches to feet by dividing by 12.

   6 inches ÷ 12 inches per foot = 0.5 foot

2. Multiply that number by the depth of readily available water for your soil type (given in inches of water per foot of soil). This gives the total volume of readily available water for the effective root zone or the total depth of water that must be applied.

   0.5 foot x 1.4 inches per foot of sandy loam = 0.7 inches

3. The precipitation rate for zone 1 is the average depth of water from all catch cans in zone 1 divided by the run time. For example, if the system runs for 5 minutes with an average depth of 0.25 inch, then you have applied 0.25 inch per 5 minutes.
4. Convert this number to inches per hour by multiplying the number by 60 minutes and then dividing by 5 minutes. This gives an average precipitation rate, in inches per hour, for that particular zone.

$$\frac{0.25 \text{ in. x } 60 \text{ minutes per hour}}{5 \text{ minutes}} = \frac{15 \text{ inches}}{5 \text{ minutes}} = 3 \text{ inches per hour}$$

5. To determine the actual irrigation run time for the zone, divide the total depth of water that must be applied (from step 2) by the average precipitation rate (inches per hour) (from step 4). This gives the run time in hours for that particular zone. Record this value.

   0.7 ÷ 3 = 0.23 hour

6. To convert this value to minutes multiply by 60.

   0.23 x 60 = 13.9 minutes

7. Repeat for all other zones.
8. Set the controller to run each zone for its specified time. You may need to use split applications to prevent runoff.

To determine the irrigation frequency, you need to know:

- the depth of readily available water for your soil type;
- the ranking of the water use rate of your grass species;
- the ranking of your level of management; and
- the effects PET has on irrigation frequency.

Your goal is to irrigate as infrequently as possible without causing severe drought stress injury to the turf. This will produce higher quality turfgrass while saving water and money. To meet this goal, you must determine how long the water applied during irrigation will sustain the grass. This will vary significantly with changing environmental conditions.

Place the catch can far enough away from the sprinkler head to avoid obstructing the spray pattern.

There are two methods—visual assessment and PET based irrigation—to determine irrigation frequency. Both work and are well-accepted methods. Choose the method that best serves your purposes.

Visual Assessment for Irrigation Needs

This system is very simple but slightly more time intensive than the PET based method. After watering, do not irrigate again until the grass begins to show symptoms of drought stress: grass leaves turning a dull, bluish color; leaf blades rolling or folding; or footprints that persist for an extended period of time after you walk across the turf.

When drought stress symptoms develop, irrigate using the appropriate run times and then wait for symptoms to redevelop before the next irrigation. This method requires routine checks (daily or more) of the field for signs of drought stress. When conditions are hot, dry (not humid), and/or windy, pay closer attention because symptoms will develop more rapidly.

The longer you use this system, the easier it will become. You will begin to “get a feel” for how long the field will go between irrigations, and what areas will show stress first.

PET Based Irrigation

This method allows you to spend less time checking your field, but does require some math and access to daily PET data. The premise behind PET based irrigation scheduling is simple. After irrigation, you know how much readily available water is in your effective root zone. PET is an estimate of the depth of water lost from the soil each day. Therefore, you irrigate when the depth of water lost by PET equals the depth of readily available water you originally applied.

To use this method, you first need to determine a crop coefficient. To do this, you will use the ranking of water use rate of your grass species (Table 2) and the level of management. Use Table 5 to determine the crop coefficient, then follow the steps to develop a PET based irrigation program.

Table 5. Estimating crop coefficient based on grass species and level of management.

Water use rate of grass species	*Level of management*	*Crop coefficient*
High	High	0.90
High	Medium	0.85
High	Low	0.80
Medium	High	0.75
Medium	Medium	0.70
Medium	Low	0.65
Low	High	0.70
Low	Medium	0.65
Low	Low	0.60

Check water pressure at each sprinkler and record pressure problems.

Setting up a PET based irrigation program

1. After the soil has been thoroughly watered to the appropriate depth, start recording daily PET rates.
2. Multiply each daily PET value by the crop coefficient. This new value is called the irrigation index.
3. The first irrigation index value is the day following irrigation. Each subsequent day is added to this value until they total the depth of readily available water (depth of water applied with the previous irrigation). Then, irrigate. The following day, start again.

Measure and record the depth of water collected in each cup.

Example:

Wednesday	Irrigated	= 1” applied
Thursday	PET x Crop coefficient	= 0.25”
Friday	PET x Crop coefficient	= 0.20”
Saturday	PET x Crop coefficient	= 0.15”
Sunday	PET x Crop coefficient	= 0.25”
Monday	PET x Crop coefficient	= 0.10”
Time to irrigate again		= 0.95”

For information on obtaining daily PET data, contact your county Extension agent.

CONSIDER other recommendations.

Early morning is considered the best time to water. Wind speed and temperatures are low, and water pressure is usually good, which allows irrigation to be applied uniformly. Watering late in the evening or at night maintains wet leaves for an extended period of time and significantly increases the chance for disease. Midafternoon watering with high wind speeds can lead to nonuniform distribution.

Water movement into some soils, especially the finer textured clays and loams, can be very slow. If a sprinkler head applies water faster than it can move down into the soil, significant amounts of water can be lost as runoff. To avoid this problem, use sprinklers with low application rates and/or irrigate to a point just before runoff, and then stop watering. Let the surface dry and then begin watering again. Repeat this process until the desired volume of water is applied. Multiple cycle irrigation controllers can be programmed to do this automatically.

Irrigation Auditing Report

Square Foot Area							
Soil Sample	**1**	**2**	**3**	**4**	**5**	**Ave. Depth (inches)**	**Readily Available Water (inches)**
Rooting Depths							

Soil Type	Clay	Clay Loam	Loam	Sandy Loam	Sand	Silt Loam

Zone	Head Spacing (feet)	Head Type (impact, rotor, spray)	Noted Problems or Comments	Head Pressure (psi)					
				A	B	C	D	E	F
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									

Ranking–Turfgrass Water Use Rate	High	Medium	Low
Ranking–Level of Management	High	Medium	Low
Crop Coefficient			

Irrigation Auditing Report (cont.)

		Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8	Zone 9	Zone 10	Zone 11	Zone 12
Catch Device Measurements (inches)	Run Time (minutes)												
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
	13												
	14												
	15												
	16												
	17												
	18												
	19												
	20												
	21												
	22												
	23												
	24												
	25												
	Average Depth per Zone												
	Average Precipitation Rate (inches/hr)												
	Run Time (hrs)												
	Run Time (min.)												

Graph - Irrigation Area

Head-Letter

Catch Device-Number

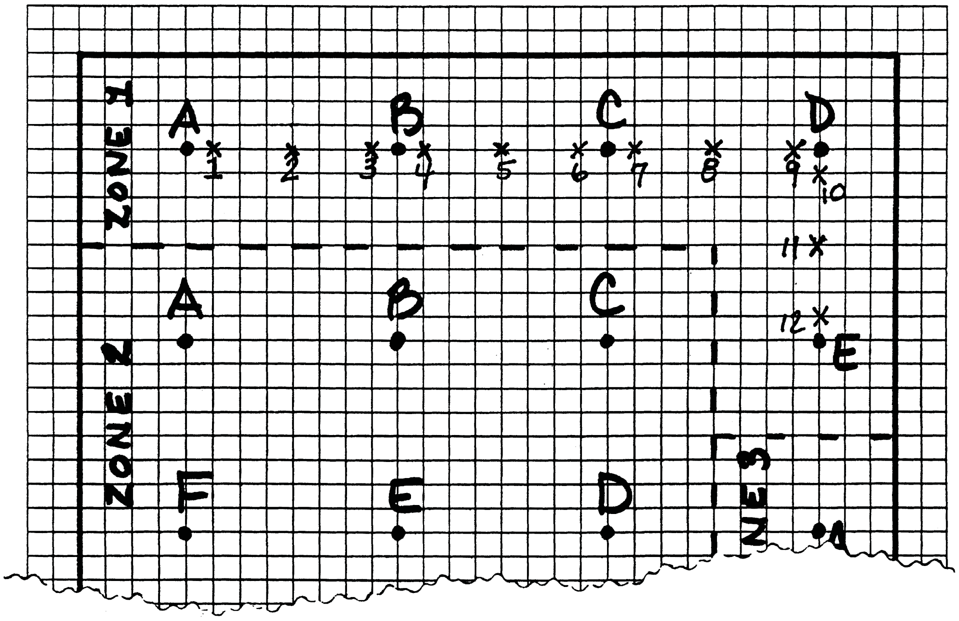
Sample Irrigation Auditing Report

Square Foot Area	12,800 ft²						
Soil Sample	**1**	**2**	**3**	**4**	**5**	**Ave. Depth (inches)**	**Readily Available Water (inches)**
Rooting Depths	6	5.5	6.3	5.0	6.1	5.8 inches	0.87
Soil Type	Clay	Clay Loam	Loam	[✓ Sandy Loam]	Sand	Silt Loam	

Zone	**Head Spacing (feet)**	**Head Type (impact, rotor, spray)**	**Noted Problems or Comments**	**Head Pressure (psi)**					
				A	**B**	**C**	**D**	**E**	**F**
1	20.0	rotor	Leaky Head (D_I)	40	36	38	30	40	
2	20.3	rotor	Head C_{II} Spraying too high	35	38	36	33	33	34
3	20.0	rotor		33	36	35	32	34	
4	20.4	rotor	Poor Rotation (B_{IV})	34	32	33	30	29	
5	20.0	spray		31	29	33	34	30	
6	21.0	spray	Leaky Head (E_{VI})	33	30	34			
7									
8									
9									
10									
11									
12									

Ranking–Turfgrass Water Use Rate	High	[✓ Medium]	Low
Ranking–Level of Management	[✓ High]	Medium	Low
Crop Coefficient	.75		

Sample Graph - Irrigation Area



Example Worksheet

Irrigation Audit

Step 6

a) 6.0 + 5.5 + 6.3 + 5.0 + 6.1 = 28.9 inches

b) 28.9 inches ÷ 5 samples = 5.8 inches of roots

Step 14

a) .16 + .10 + .17 + .17 + .12 + .18 + .20 + .13 + .19 + .17 + .10 + .18 = 1.87

Determining the Run Time

Step 1

5.8 inches ÷ 12 inches per foot = .483 feet

Step 2

.483 feet x 1.8 inches of water per foot of soil = .87 inches of available water = total depth water that must be applied

Step 4

a) .16 x 60 = 9.6

b) 9.6 ÷ 5 = 1.9 inches of water per hour = precipitation rate

Step 5

.87 ÷ 1.9 = .46 hour

Step 6

.46 x 60 = 28 minutes

For more information,
see the Web site at
http://aggieturf.tamu.edu.

Produced by AgriLife Communications and Marketing, The Texas A&M University System
Texas AgriLife Extension publications can be found on the Web at: http://AgriLifebookstore.org

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Edward G. Smith, Director, Texas AgriLife Extension Service, The Texas A&M University System.
Revision